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Stem Cell Therapy for Spinal Cord Injuries

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Stem Cell Therapy for Spinal Cord Injuries

Abstract
Stem cell-based therapies are an emerging branch of medicine with the purpose of restoring tissue function for patients with serious injuries, such as a spinal cord injury. As a result, scientists and engineers are increasing research efforts in the field of regenerative medicine. Due to the delicate nature of stem cells, producing the large quantity required for a successful therapy has proved challenging. In recent years, research has shown the potential of stem cell-based therapies, and thus there is a need for the commercialization of these treatments. The proposed facility targets the demand for spinal cord injury treatments and can support production for both clinical trials and a commercial release. Bioreactors designed specifically for the culture and growth of stem cells have flexibility in their ability to support different stem cell lines for various therapies. Small reactors in parallel can easily adapt to changes in production size. This process also takes advantage of the best options currently available for purification and preservation to maximize the product yield.

Due to the strict regulations set in place by the FDA and lack of adequate funding, there is an untapped market for stem cell therapies for spinal cord injuries. Approximately 250,000 people in the United States suffer from spinal cord injuries, varying in severity, and this patient base increases at a rate of 12,000 new injuries every year (“Spinal Cord Injury Facts and Figures”, 2009). Future markets include expansion into Europe and Asia.

There are two steps to this proposal: the upstream process and the downstream process. The upstream process includes the scale-up, differentiation, and purification of human embryonic stem cells; the downstream process consists of the scale-up of neurons for injection. The upstream process will be built initially and yield enough cells for clinical trials, without incurring the capital costs of building the entire plant. Upon success of the clinical trials, the downstream process will be built for maximum production.

The profitability of this proposal is based on running 26 batches a year at $1.02 \times 10^{10}$ cells per batch or $2.66 \times 10^{11}$ cells per year. By targeting 5,000 patients, two percent of the current market, and charging $45,000 per dose, a profitable profile can be created. Assuming 50% production capacity the first year and a ten-year plant life, the ROI, NPV, and IRR of the proposal are 226.09%, $961,892,600, and 242.81% respectively. Using a 50% production capacity allows for higher profit margins upon expansion. The proposed plan will meet the need of this growing market.

Disciplines
Biochemical and Biomolecular Engineering | Chemical Engineering | Engineering

Comments
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Stem Cell Therapy for Spinal Cord Injuries

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Project Advisor: Dr. Miriam Wattenbarger, University of Pennsylvania
Project Recommendation: Dr. Tiffany Rau, Eli Lilly
Dear Professor Fabiano and Dr. Wattenbarger,

Following is our complete report for CBE Senior Design: "Stem Cell Therapy for Spinal Cord Injuries." For this project, we were given the assignment of designing a manufacturing facility for the production of a stem cell-based, regeneration treatment for spinal cord injuries that would allow patients to fully recover from their injuries. Currently, there is no treatment in the market for spinal cord injuries that would yield this kind of significant functional improvement. Our treatment would meet this need. Further, we were tasked with creating a custom design for the bioreactor within which the stem cells for the therapy would be cultured. The stem cells are very sensitive to shear stresses and require very precise control of pH, dissolved oxygen levels, and temperature. There are vessels on the market that can be used to grow these fragile cell lines. However, our company aims to create and optimize a reactor for use under cGMP conditions. This proposal targets two percent of the current market for spinal cord injured patients in the United States (5,000 patients). To determine the economic feasibility of this proposal, net present value, return on investment, and internal rate of return were analyzed. In order for this project to be profitable in the first year of operation, the minimum number of patients treated must be 680, a very conservative target. The pursuit of this project is economically feasible, yet further research is required to verify the success of these proposed processes on a large scale. We recommend that the necessary research be explored with the intention that this proposal be carried out in full in future years.

Sincerely,

Priya Kumar    Diana Moock    Adam Muncan    Michelle Sorkin
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1.0 Abstract

Stem cell-based therapies are an emerging branch of medicine with the purpose of restoring tissue function for patients with serious injuries, such as a spinal cord injury. As a result, scientists and engineers are increasing research efforts in the field of regenerative medicine. Due to the delicate nature of stem cells, producing the large quantity required for a successful therapy has proved challenging. In recent years, research has shown the potential of stem cell-based therapies, and thus there is a need for the commercialization of these treatments. The proposed facility targets the demand for spinal cord injury treatments and can support production for both clinical trials and a commercial release. Bioreactors designed specifically for the culture and growth of stem cells have flexibility in their ability to support different stem cell lines for various therapies. Small reactors in parallel can easily adapt to changes in production size. This process also takes advantage of the best options currently available for purification and preservation to maximize the product yield.

Due to the strict regulations set in place by the FDA and lack of adequate funding, there is an untapped market for stem cell therapies for spinal cord injuries. Approximately 250,000 people in the United States suffer from spinal cord injuries, varying in severity, and this patient base increases at a rate of 12,000 new injuries every year (“Spinal Cord Injury Facts and Figures”, 2009). Future markets include expansion into Europe and Asia.

There are two steps to this proposal: the upstream process and the downstream process. The upstream process includes the scale-up, differentiation, and purification of human embryonic stem cells; the downstream process consists of the scale-up of neurons for injection. The upstream process will be built initially and yield enough cells for clinical trials, without incurring the capital costs of building the entire plant. Upon success of the clinical trials, the downstream process will be built for maximum production. The profitability of this proposal is based on running 26 batches a year at $1.02 \times 10^{10}$ cells per batch or $2.66 \times 10^{11}$ cells per year. By targeting 5,000 patients, two percent of the current market, and charging $45,000 per dose, a profitable profile can be created. Assuming 50% production capacity the first year and a ten-year plant life, the ROI, NPV, and IRR of the proposal are 226.09%, $961,892,600, and 242.81% respectively. Using a 50% production capacity allows for higher profit margins upon expansion. The proposed plan will meet the need of this growing market.
2.0 Introduction

Stem cells are cells that have the ability to develop into different types of cells in the human body as well as repair damage to tissues by dividing without limit to replenish other cells. They are an essential building block in the body and can develop from unspecialized into specialized cells. The earliest stem cells come from inside an embryo and are pluripotent, meaning they are unspecialized, but can divide into any one of the 220 different types of cells as shown in Figure 2.a (Watson, 2014).

The process of obtaining these embryonic stem cells is either through in vitro fertilization, therapeutic cloning, or umbilical cord. In vitro fertilization is when a couple’s sperm and eggs are fertilized in a culture dish and the embryo can be frozen and donated to stem cell research. Therapeutic cloning is a technique that merges a cell from the patient with a donor egg, thus creating an embryo with the patient’s genetic material. Finally, umbilical cord blood comes from a donated umbilical cord after the mother gives birth. This cord contains stem cells from the fetus that can be harvested and grown in a culture.

An embryo begins as a small clump of cells that are totipotent, or able to develop into all cell types, as shown in Figure 2.b. After about four days, the embryo has grown to a ball of cells called a blastocyst (about 100 cells) that contains pluripotent stem cells. These pluripotent stem cells, which can be obtained from human umbilical cord blood, are the ones that are cultured and used for stem cell therapies (Watson, 2014).

Once these embryonic stem cells have been obtained, they need to be grown into multiple stem cell lines in order for specific injury treatment. In order to do this, certain genes in the stem cells need to be expressed so that the stem cells will differentiate into the specified cell. The way this is done is through the specific medias that are used to grow the cells. When the cells are
plated, an undifferentiated cell growth media is fed into the reactor and grows the undifferentiated cells into more undifferentiated cells. Then, specific medias are used to induce differentiation. If the therapy calls for blood cells, a different media is used than if the therapy calls for neurons. This differentiation media expresses the targeted gene. Once cells have been differentiated, a differentiated cell growth media is used to grow the cells. This process takes longer than traditional mammalian or bacterial cells, since the doubling time of stem cells is much longer. Once differentiated, grown, and purified, the stem cells are frozen in order to preserve them for long periods of time, and when a patient requires them for injury treatment, the cells are thawed and then administered to the patient.

The facility being proposed begins with a vial of 100,000 undifferentiated pluripotent stem cells that have been recovered from umbilical cord blood. These cells will be scaled-up by a lab technician using traditional lab techniques until there are enough cells to be plated in a customized 3 L bioreactor. This 2-dimensional bioreactor uses disposable plates as a platform for cell growth. This type of bioreactor was chosen in order to mimic the lab-bench scale up techniques in order to introduce the least amount of difference between small scale and large-scale techniques. Various media will be flown through this bioreactor, to first grow, and then to differentiate the stem cells into neurons for use in spinal cord injury therapies. These differentiated cells are then purified using the latest lectin array technologies in order to have the highest yield possible in the process. These cells can then be further scaled-up in larger customized bioreactors using growth media to increase the number of cells produced per year by this facility. Due to the fact that stem cells have a relatively short shelf life, cells will be preserved cryogenically in liquid nitrogen until delivered to a hospital for infusion of cells in the patient.

A facility such as this requires a large up front capital cost and thus will be built in two stages. The first stage will include the lab-bench scale up equipment, the initial 3 L bioreactor, purification methods, and preservation methods. This one bioreactor process will yield enough stem cell product to support clinical trials that need to be conducted before the commercialization of the neural stem cells. Once phase 3 trials have begun and are promising, the construction of the rest of the facility, which includes the larger 17 L bioreactors and increased preservation space, will begin. This facility is being built in two stages so that if the
clinical trials were to fail, the additional capital costs of building the whole facility will not be incurred.

Finally, since Massachusetts is a popular site for biopharmaceutical companies, and the greater Boston area was the top choice in 2013 for Life Science/Pharma companies, Springfield, Massachusetts is a great fit as a location for the production facility ("The Top-10 Cities for Life Sciences Companies", 2013). This city is near Boston, but the annual occupancy costs are relatively low compared to other surrounding cities (Crawford, 2013). It also is located in an area that contains many of the best universities and medical schools, resulting in a large and talented group of individuals. This location is also optimal since there is a large concentrated population on the east coast, and building the stem cell therapy near areas with a large population will decrease cost and increase the speed associated with shipping and supply chain. Given that the product is not viable for very long periods of time, and needs to be stored in extreme conditions, the location of this plant is critically important. Locating the facility in Springfield will allow the facility to meet demands at the lowest cost.
## 2.1 Project Charter

<table>
<thead>
<tr>
<th><strong>Project Name</strong></th>
<th>Stem Cell Therapy for Spinal Cord Injuries</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Project Champions</strong></td>
<td>Priya Kumar, Diana Moock, Adam Muncan, Michelle Sorkin</td>
</tr>
<tr>
<td><strong>Project Leader</strong></td>
<td>Dr. Tiffany Rau</td>
</tr>
<tr>
<td><strong>Specific Goals</strong></td>
<td>Design a profitable manufacturing facility for the production of a stem cell treatment for spinal cord injuries</td>
</tr>
</tbody>
</table>
| **Project Scope** | In Scope:  
- Scale-up of stem cells (embryonic NSPCs)  
- Specification and design of a novel bioreactor  
- Downstream processing (purification and isolation)  
- Analysis of the market and cost of production  
- Profitability analysis  
- Determination of plant location  
- Compliance with FDA regulations  
- Conformity to cGMP  
Out-of-Scope:  
- Packaging, distribution, and final formulation and fill  
- Procurement of initial stem cells  
- Clinical trials and federal approval for sale of therapy |
| **Deliverables** | Business Opportunity Assessment:  
- What is the market for patients suffering from paraplegia?  
- What current therapies exist?  
- How do current therapies compare from the perspective of the patient?  
Bioreactor Specification Assessment:  
- What bioreactor specifications and design will optimize production of this therapy?  
Manufacturing Capability Assessment:  
- Can the drug therapy be manufactured with a reasonable amount of capital investment, given the size and resources of the parent company? |
| **Timeline** | Complete analysis of plant specifications and business potential by April 23, 2014 |
2.2 Innovation Map

MATERIAL TECHNOLOGY

- Adult NSPCs
- Cooling
- Media, Nutrients, and Oxygen

PROCESS/ MANUFACTURING TECHNOLOGY

- Bioreactor
- Impeller, Cellular
- Cell Bank Storage
- Purification System
- Freezer

TECHNICAL DIFFERENTIATION

- Regeneration Therapy
- Custom Scale-Up
- Custom Multiphase Bioreactor

PRODUCT TECHNOLOGY

- Neural Stem Progenitor
- Biological Waste

CUSTOMER VALUE

- Affordable Cost
- Lower Rate of Immune Rejection
- Superior Results to Former Treatments
- Minimized Treatment Time
- Environmentally Friendly
3.0 Concept Stage

3.1 Total Market and Competitive Analysis

This company will produce neural stem cells for a regenerative cell therapy that will be administered to those who have moderate to severe spinal cord injuries. The specific market segment that is being targeted is people in the United States that have lost function in one or all of their limbs due to spinal cord damage. According to the Center for Disease Control and Prevention, an estimated 250,000 Americans are currently living with a spinal cord injury and there are about 12,000 to 20,000 new cases each year (“Spinal Cord Injury Facts and Figures”, 2009). Many of these injuries occur early in life (predominantly ages 16 to 30). Hence, these people are forced to live a substantial portion of their lives with this disability. The number of persons with spinal cord injuries in the U.S. has grown steadily since the early 1970’s. With increasing life expectancy, the prevalence of spinal cord injuries can be expected to continue to rise in the future. Billions of dollars each year are spent by private companies on embryonic research, and thus the market has proven that there is continued interest and need for this type of therapy.

The available treatments for spinal cord injuries are targeted for pain management as opposed to finding an outright cure. The first involves a series of drugs and medications, which act to either induces nerve cell regeneration or improve function of remaining nerves at the site of the injury. Various anticoagulants and steroids are used to decrease inflammation, but this is only a temporary solution with current existing medications. Another method of treatment includes immobilization by means of a brace. This stabilization has been shown to properly align the spine in some cases, but is not very effective and tends to lead to patient discomfort. Surgical options are exercised in extreme cases. This spinal cord decompression surgery is used to remove fragments of bone or herniated disks. If none of the above treatments are successful and the patient is willing, experimental drugs can be administered. These work in a similar way to clinical trial experiments for cancer, where a physician will let the patient know of any new drugs and it is up to the patient to volunteer to try these drugs. There is no guarantee for successful results in these cases (Mayo Clinic Staff, 2011).

As of 2012, Geron Corporation is the only major company that has made a significant attempt to bring a stem cell therapy for spinal cord injuries to the masses (Krassowska, 2011). Due to its nature, the FDA regulations on this type of stem cell therapy are very stringent,
and clinical trials are difficult to get approved for testing and pass. Also, the topic of stem cells can be very controversial and is sometimes ethically difficult to justify. Companies often do not have the resources for development in an area that they are not familiar with and the risk of failure in this type of venture is very high. Additionally, many companies do not have the capital to invest in this type of venture, since many of the bioreactors and purification methods used for bacterial or mammalian cells cannot be used for the scale up of stem cells. This is due to the extreme delicacy of the cells, which are the product. The current production capacity for the culturing of stem cells seems to be one limiting factor for the capture of this spinal cord injury market, as the current means of production is typically at the lab bench scale. The difficulty in tapping this market is the lack of ability to produce a high enough stem cell product yield while also proving that this therapy is safe and effective.

As a result of these difficulties, many companies have decided against contributing a portion of their funds to developing a stem cell therapy, thus leaving a significant absence in stem cell therapy options for spinal cord injury patients. The technology has been proven within R&D, and thus this project is focused on creating a facility that is flexible enough to produce quantities of stem cells for both clinical trials as well as a commercial launch. This product will improve the patients’ quality of life. This facility will employ the latest technology and methods in stem cell research, as well as use a customized two-dimensional bioreactor for the scale up process of the stem cells. This will allow the company to gain approval of this cell therapy, and also ensure they are first to the market with a life-changing and improving treatment for those with spinal cord injuries. The facility will also allow other cell therapies to be produced by the company in the future based on business need. The venture looks to take advantage of the current market’s demand by concentrating on the need for a large capacity manufacturing facility, a bioreactor that is a safe environment for stem cells, and the current and future growth of the spinal cord injury market.

3.2 Principle Competition Production Level and Sales

The major competitors within the stem cell research market are both large and small, well-established companies such as Geron™, Genetech™, Advanced Cell Technology™, Invitrogen™, and Athersys™. All of these companies have revenue expectations that are exceedingly high in comparison to the company’s projected revenues in the first years since these companies have other already established products bringing in revenue. New market space
will be created since no other company is currently producing stem cells for large-scale uses. The niche within the market that the facility will fall into is specific to higher volumes of production, on the scale of hundreds of billions of cells per year, whereas established competitive companies are producing stem cells only for use in clinical trials, which is on the scale of hundreds of thousands of cells. As a result, companies seeking large scale production of stem cells will be forced to stock and employ a facility whose capacity is fitted to those large scale needs. The stem cell scale-up facility will be the first of its kind, and it is likely that no other existing company will want to make the necessary up-front investment while having to compete with this already existing facility.
3.3 Customer Requirements

Stem cell research is a dynamic and evolving field of science and new medical uses for the stem cell products are being discovered and developed constantly. Due to this, the customer requirements will vary on a case-by-case basis and the goal of the facility will be to provide the most up-to date technology befitting to those medical needs while maintaining the quality and safety of the product. The customer requirements will be qualified as new-unique-and-difficult. The first and most important requirement that the facility will fulfill is that it will produce a product that meets both FDA and European standards for clinical trials and eventual distribution to patients in a specified doctoral procedure upon commercial launch. This will include purity and viability of the product as well as the efficacy and safety of the spinal cord therapy produced. The field of stem cell research is continually changing and process improvements are being made to increase the yield of the desired cells. Thus, a requirement of this facility is that it will be flexible in order to accommodate advances in stem cell therapies. It will permit the production of various types of stem cells (i.e. neural, cardiac, etc.) as well as employ the most viable technology available. To provide the most efficient, cleanest, and safest product to the customers, disposable plates will be used in the bioreactors to avoid contamination between the stages of the process. In summary, this facility will meet customer requirements by providing a safe and up to date technology in conjunction with sophisticated engineering to make possible the large-scale production of human embryonic stem cells without compromising the quality of the final product.
3.4 Block Flow Diagram

The following is an illustration of the overall process, including preparation, upstream, and downstream procedures.
4.0 Decisions and Alternative Analysis

4.1 Stem Cell Line

Human umbilical cord blood neural stem cell and neural progenitor (HUCB-NSC/NP) is the cell line chosen for this spinal cord injury therapy. More generally, these are neural stem progenitor cells (NSPCs) derived from human embryonic stem cells (hESCs). NSPCs are committed to the neural lineage and can differentiate into neurons, astrocytes, and oligodendrocytes after transplantation. The NSPCs are the spinal cord injury therapy; these cells will be directly injected into the site of injury on the spinal cord.

Several studies with non-primate and primate subjects support potential of NSPCs and their use in a spinal cord injury therapy. One study performed at the Reeve-Irvine Research Center at the University of California at Irvine examined the effects of hESC-derived neural progenitor cell transplants on recovery after a cervical spinal cord injury in rats. In the study, rats were injected with 1.5 million cells at the site of contusion 7 days after the injury. Compared to the control group, the transplant group had an oligodendrocyte-remyelination efficiency 680% more than untreated rats. (Sharp 2010) Results indicated a significant correlation for mean motor neuron sparing and proximal forelimb range of motion, suggesting the efficacy of neural progenitor cells in restoring some spinal cord mediated function.

A second study published in the Journal of Neuroscience Research observed the effects of transplantation of neural stem progenitor cells after a spinal cord injury in marmosets. Marmosets were injected with 1 million cells at the lesion site 9 days post injury. Researchers tested the subject’s bar grip ability as well as spontaneous movement. Statistical analysis indicated significant increases in both areas of functional recovery. (Iwanami 2005) This trial utilizing marmoset test subject serves to bridge the gap between rodent and human trials. Very few clinical trials with human test subjects have been published for a variety of reasons, including lack of funding and difficulty in finding qualified subjects under current regulations.

After choosing NSPCs as the cell therapy, both embryonic-derived and adult cells were considered and the relevant advantages and disadvantages evaluated in depth (Table 4.1). Embryonic derived NSPCs were chosen due to the numerous advantages and the ability to work around the disadvantages. Primarily, many more studies using embryonic derived NSPCs have been published. Since this company is not participating in the R&D component of this project
(although an R&D team will be present at the facility for development of this therapy), it was beneficial to choose a cell line with a great amount of literature readily available.

Table 4.1. This table outlines the differences between embryonic and adult stem cells.

<table>
<thead>
<tr>
<th></th>
<th>Embryonic NSPCs</th>
<th>Adult NSPCs</th>
</tr>
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<tbody>
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<td>Differentiation Potential</td>
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<td>Potential for Tumorigenicity</td>
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<td>Safety Tested in Human Trials</td>
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<td>No</td>
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<tr>
<td>Doubling Time</td>
<td>96 hours</td>
<td>220 hours</td>
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</tbody>
</table>

Producing a stem cell therapy is a time sensitive process. Research shows that NSPCs are able to propagate and differentiate ex-vivo for approximately 200 days without loss of multipotency and proliferative activity. (Kanemura 2002) This limits the time over which the production process in the bioreactor can occur. Embryonic-derived NSPCs have a doubling time of approximately 96 hours; adult NSPCs have a doubling time of over 200 hours. (Nowakowski, 2004) In order to obtain the desired number of cells, adult NSPCs would require more than double the amount of time in the bioreactor than embryonic NSPCs. Consequently, it is difficult to scale up adult stem cells to the desired quantity within a limited time frame.

Embryonic stem cells are pluripotent and are not initially committed to the neural lineage. One implication of choosing ESCs is that the bioreactor must be adapted to induce and control differentiation into NSPCs. The ability of ESCs to self-renew and differentiate makes them uniquely susceptible to tumor formation. HESCs may generate tumors after being terminally differentiated before transplantation. (Blum 2008) The rate of tumor formation is directly proportion to the degree of differentiation (commitment to specific cell type) of the cells. Finding a method of eliminating the tumorigenicity of ESCs is crucial for clinical applications. As these methods are not well established, downstream methods will include purification, separation, and elimination of any teratomas. Ultimately, this process will yield viable and healthy NSPCs that can then be directly injected into the spinal cord.
The use of human embryonic stem cells is not widely accepted due to the ethical concerns with extracting cells from an embryo. The hESCs used in this stem cell therapy will be obtained in a purely humane manner: from the umbilical cord blood once a child has been born. Also, the cord blood will be taken from approved banks. According to the Council on Ethical and Judicial Affairs of the American Medical Association,

“Informed consent for the collection of umbilical cord blood stem cells should be obtained, when feasible, before the onset of labor. Physicians' ties to public and private cord blood banks must be disclosed during the informed consent process. Physicians shall not accept financial or other inducements for providing samples to cord blood banks”. (AMA, 2007)

The blood is obtained by puncturing the umbilical cord stub. A density gradient is used to separate out the mononuclear cells from the desired stem cells. (Song 2008) Once the red blood cells have been removed, the remaining cells are stored in cryopreservative and liquid nitrogen until use. The cells are cultured in-vitro, supplemented with fetal bovine serum and embryonic growth factors. These undifferentiated cells can give rise to neural stem progenitor cells when exposed to the appropriate growth factors and vectors. Although obtained after birth and not from a human embryo, stem cells obtained from umbilical cord blood are classified as embryonic stem cells. In this regard, the ethical considerations that are typically associated with hESCs do not apply.

4.2 Bioreactor Design

The scale up process for stem cells after lab bench procedures requires a bioreactor that can both grow the stem cells at an acceptable rate as well as minimize the shear stress applied to the cells. The bioreactor must have the ability to closely monitor and control temperature, dissolved oxygen levels, and pH levels in order to ensure the quality and survival of the stem cells. The three main bioreactor options that are most commonly used for stem cell scale up processes are a stacked 2-dimensional surface based system, a microcarrier system, and a 3-dimensional fixed/packed bed system.
**Stacked 2-Dimensional System**

The mechanism of a stacked 2-dimensional system for stem cell scale up takes the lab bench process of growing cells on plates and mimics the process on multiple layers of thin trays that are placed in a reactor. The plates are made from hydrophilized polystyrene and the cells are harvested using an enzyme solution, such as trypsin, to separate the cells from the surface (Eglof). In order to optimize space for cell growth, the plates are only a few millimeters thick and the spacing between the plates is minimized as well. These stacked trays are placed in a bioreactor and medium is circulated through the plates using a propeller at the bottom of the reactor. These plates can be either disposable or reusable after the bioreactor step has concluded. The reactor includes temperature, dissolved oxygen, and pH probes, and can adjust the parameters based on the status of the process. An example of this type of reactor is the Xpansion™ which is a compact, single use 2-dimensional surface-based system (Integrity Xpansion™) shown in Figure 4.a and 4.b. The advantages of this system are that the lab-bench scale up process is more readily transferrable to this reactor and that it is a very flexible and cost efficient scale-up method. Also, outside contaminants are less likely in this process because it is a direct mimicry of the lab-bench process, and no other additives are needed (i.e. beads, solutions). This method is best used for smaller scale-up processes that have outputs of hundreds of millions of cells per batch (Eglof).

**Microcarrier System**

Microcarriers are small beads that allow cells to adhere and grow in a bioreactor. The microcarriers are mixed in with the cells and medium so the process can go on relatively continuously, without having to stop and change out components before further steps (Figure 4.c). The reservations that come with microcarrier scale-up systems are shear stress.

---

*Figure 4.a. Inner workings of Xpansion System. 1-3 represent the oxygen and pH meters. 4 is the top of the bioreactor. 5 and 6 are the plates. 8-11 are the components of the propeller. 12 is connector system.*

*Figure 4.b Xpansion Bioreactor System.*

*Figure 4.c. Microcarrier Bioreactor. This image shows the components required in a microcarrier bioreactor system.*
Human embryonic stem cells grow in multilayer colonies on extracellular matrices and are more susceptible to shear stress than other types of stem cells. Although this is true, many variations of microcarriers have been developed for cultivation and can have special coatings and seeding conditions that can eliminate much of the shear stress (Chen). These beads also must be mixed in with the cells and medium, and agitation must be kept at a minimum. This is done by slow and smooth mixing of the cells (Integrity PadReactor™). This method has much higher yield of product than the traditional 2-dimensional surfaces and can result in batches on the scale of billions of cells per batch. The cells are harvested using trypsin, a recombinant cell dissociation enzyme that is animal-free. Dissolved oxygen, temperature, and pH levels are easily monitored through an existing bioreactor system, since this scale-up method does not necessarily require a specially designed reactor (a stirred tank bioreactor can be used), only the addition of the microcarriers.

3-Dimensional/Fixed Bed System

A 3-dimensional fixed-bed system is another option for adherent stem cell growth. In this system, the cells are entrapped in a fixed-bed that contains all of the nutrients needed for cell growth. The cells are grown in a hollow fiber-based system in order to limit shear stress in the reactor (Eglof). Additionally, the absence of a stirrer in this fixed-bed process also reduces the amount of shear stress on the stem cells. This method also allows for the largest output volume of any of the current processes being used. This system may also combine the use of microcarriers into its mechanism in order to promote more growth in the reactor. The output of this process is usually on the scale of hundreds of billions of cells per batch. Due to its 3-dimensional nature, there is a large possibility that the stem cells in this process may behave differently than expected, since small-scale studies on plates are 2-dimensional (Eglof). This means that a large amount of testing and downstream purification must be done to ensure precise replication of the process over time. In effect, cells that have been shown in earlier work to be able to grow on 2-dimensional plates were selected.

For Process:

A 2-dimensional stacked system will be used for the scale-up of the NSPC stem cells. This is the best option for the process due to similar features of the lab bench process and the growth that occurs in the bioreactor, as well as the ability to manipulate the size and configuration of the plates to yield the highest output. Disposable plates will be used, which
allow for an easier cleanup and less cleaning validation and qualification. Although the 2-dimensional system results in a lower output per batch than the other two systems, multiple systems will be running in parallel in order to reach the desired output. This means lower risk for the facility, since it could plausibly have an unsuccessful batch, without losing a large percentage of the output. The 2-dimensional system avoids increased shear stress all together, and this is the reason that microcarriers were not chosen. The 3-dimensional fixed-bed system was eliminated because not enough is known about the success rate of this method, and many unwanted results may arise from this new method (e.g. incorrect differentiation and cell death). The facility will utilize the 2-dimensional plating system in the bioreactors for the scale-up process of NSPC stem cells.

The human embryonic stem cells used for this therapy are very fragile, attached cell lines. Traditional bioreactors and fermenters are best for suspension cultures, but not ideal for growth of these delicate cells. Since the stem cells are the product for this therapy, it is imperative that the cells are not damaged in production. Hence, a custom, low-shear bioreactor was designed (with controls for pH, dissolved oxygen, and temperature). There are some systems on the market for growth of attached cell lines. However, the company wanted to generate a custom solution for scale-up of this spinal cord cell therapy under GMP conditions. It has been a challenge in the past to achieving these standards while minimizing costs. The vessel aims to be a compact, cost-efficient, and clean system. The design drew upon features of the Integrity® Xpansion™ bioreactor, which was developed specifically for delicate attached cell lines and industrialized for safe scale-up of traditional two-dimensional cell cultures.

The bioreactor is essentially a stack of single-use, polystyrene plates (shown in Figure 4.d) contained within a reusable cylindrical shell (i.e. an outer tube). Having multiple plates promotes a larger surface area for growth of the cells. Having disposable plates and a closed system helps to diminish the risk of contamination and optimize sterility. There will be 12 bioreactors at the manufacturing facility in total, with 8 running in parallel. Six of the bioreactors will be composed of 19 plates, and the remaining 6 of these bioreactors will be composed of 147...
plates. The plates will have a diameter of 280 mm and alternate between two 10 mm thick types, depicted in Figure 4.e. The plate of Figure 4.e.A contains 26 radial channels, while the circumference of the plate in Figure 4.e.B is smooth. Additionally, the hole in the center of the plate in Figure 4.e.A is smaller (diameter of 50mm) compared to the hole in the plate in Figure 4.e.B (diameter of 66.8mm). A thin silicon tube used for media aeration (via gas diffusion) will run through the center of these plates, fitting exactly into the hole of Figure 4.e.A and leaving extra space around the tube for the plates in Figure 4.e.B. The plates will have two small feet on them (Figure 4.f) to produce a 0.16 cm headspace between each plate. The plates will be treated (hydrophilized) to promote attachment of the cells. At the bottom of the vessel is a magnetic impeller used to ensure proper mixing and circulation of the media. The impeller will rotate at a very small speed (20 rpm) because the cells are extremely sensitive to shear stress. Due to the shear stress inevitably induced at the center of the plates near the tubing, the plate coating will not cover the entire plate; there will be an annular area of no growth near the center of the plate.

Media flows upwards through the first channel of one plate and then horizontally over the cells on the smooth-edged plate. After, the media flows through the space between the tubing and the inner diameter of the plate, under the next plate, and then starts again flowing around the jagged edge (Figure 4.g). Sensors will be placed on the top and on one side of the bioreactor to measure levels of pH, dissolved oxygen, and temperature. These measurements are non-invasive, optical, and real-time. Injected gas composition is regulated by a controller according to the pH and DO levels measured.
<table>
<thead>
<tr>
<th></th>
<th>3-L Bioreactor</th>
<th>17-L Bioreactor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Plates</td>
<td>19</td>
<td>147</td>
</tr>
<tr>
<td>Cell Culture Surface</td>
<td>$1.16 \times 10^4$ cm$^2$</td>
<td>$9.00 \times 10^4$ cm$^2$</td>
</tr>
<tr>
<td>Ratio of Media Volume /</td>
<td>0.18 mL/cm$^2$</td>
<td>0.18 mL/cm$^2$</td>
</tr>
<tr>
<td>Surface Area</td>
<td>1.16 x $10^4$ cm$^2$</td>
<td>9.00 x $10^4$ cm$^2$</td>
</tr>
<tr>
<td>Media Volume</td>
<td>2.09 L</td>
<td>16.19 L</td>
</tr>
<tr>
<td>Volume of Bioreactor</td>
<td>2.14 L</td>
<td>16.24 L</td>
</tr>
<tr>
<td>Volume of Central Column</td>
<td>49.4 mL</td>
<td>382.2 mL</td>
</tr>
<tr>
<td>Plate Surface</td>
<td>612 cm$^2$</td>
<td>612 cm$^2$</td>
</tr>
<tr>
<td>Plate Thickness</td>
<td>0.1 cm</td>
<td>0.1 cm</td>
</tr>
<tr>
<td>Distance Between Two Plates</td>
<td>0.16 cm</td>
<td>0.16 cm</td>
</tr>
<tr>
<td>Volume Between Two Plates</td>
<td>98 mL</td>
<td>98 mL</td>
</tr>
<tr>
<td>Volume of Head Space</td>
<td>50 mL</td>
<td>50 mL</td>
</tr>
</tbody>
</table>
4.3 Cell Storage

The storage life of the NSPC stem cells is around two weeks and patients will only receive one or two doses of treatment. This results in the need for storage of stem cells where they can be easily transported and thawed when a dosage is needed. There are multiple options for preservation that include refrigeration, mass cryopreservation, vitrification cryopreservation, and alginate encapsulation.

Refrigeration

Refrigeration is commonly used for short-term storage of hESC. In a refrigerator at 4 °C, the differentiated NSPC stem cells can survive for about 2-5 days. The cell medium would be replaced every 1-2 days to ensure maximum survival of the cells. No special additives are needed for this preservation technique, and cells will be warmed to 37 °C prior to administering them to a patient.

Controlled-rate Cryopreservation

Cryopreservation is a process where cells that are susceptible to damage or to changes caused by additional reactions are preserved by cooling them to extremely low temperatures. This stops any chemical activity that might cause this damage and effectively puts the cells to sleep. (Lee, 2010) Cells are commonly cryopreserved in liquid nitrogen. Controlled-rate cryopreservation is a method that uses gradual freezing to avoid lethal intracellular freezing that can result from other methods. The slow cooling is done at the rate of 1 °C/minute after a treatment with cryoprotectants such as glycerol. Once the cells have reached a temperature of -80 °C for a period of about 12 hours, the cells are then put into liquid nitrogen (below -130 °C) and kept there until thawing is necessary. Rapid thawing is necessary to ensure survival of the cells in this technique, and should take between 60-90 seconds. This controlled-rate technique is the most commonly used cryopreservation technique in the industry today, yet has a very low survival rate of cells, only about 15-35%. (“Rate Controlled Cyroperservation”, 2014)

Vitrification Cryopreservation

Vitrification cryopreservation is the process of rapidly cooling cells in order to preserve them for future use. Vitrification solutions, often composed of ethylene glycol, DMSO, and culture media increase the viscosity of the solutions and allow for this rapid cooling while protecting the cells from damage that can be caused by quickly exposing them to extreme temperatures. In this method of preservation, cells are placed in liquid nitrogen and the cooling
process takes less than one minute. The cells remain in this liquid nitrogen storage until they need to be thawed. These two cryopreservation techniques have been tested using differentiated hESCs, and the vitrification technique has been shown to have a higher yield (about 45-60%) of cells. This yield is even further increased when thawed in the presence of a ROCK inhibitor, a compound that regulates the shape and movement of cell components to increase stability and survival rates.

*Alginate Encapsulation*

Alginate Encapsulation is a storage method that uses hydrogels to encapsulate, store, and release stem cells without the use of liquid nitrogen. The hydrogels are semipermeable and are mixed in with the cell solution, capturing and storing the cells. (Chen, 2013) This is advantageous because it eliminates the possibility of contaminants that may result from liquid nitrogen storage, and does not put the cells under the stress of extremely cold environments. The cells are stored in air-tight conditions at ambient temperatures in the alginate gel. This process has a much higher yield of viable cells that are extracted after storage and the hydrogel is less expensive than liquid nitrogen storage.

*The Design*

The NSPC stem cells that are produced from the process are going to be stored using vitrification cryopreservation. This is because cryopreservation is the only method that has been scientifically proven to be feasible with differentiated stem cells and accepted by regulatory agencies. Many of the existing studies that have been conducted for the preservation of stem cells have been done prior to differentiation. A study conducted by Yoon Young Kim showed that cryopreservation on cardiomyocyte stem cells yielded viable cells upon thawing. It can be assumed that a similar behavior will occur with neural stem cells. After thawing, more of the cells preserved through vitrification survived than those preserved through mass cryopreservation (or controlled-rate cryopreservation). This increase in yield justifies the choice of vitrification over controlled-rate techniques. Problems also arise with refrigeration and alginate encapsulation storage methods. Refrigeration techniques and alginate encapsulation techniques only keep the cells viable for 1-2 weeks after they have been produced. Although both of these methods eliminate the need for additives and potentially hazardous chemicals, as well as greatly increase the yield of viable cells, the decrease in storage time greatly complicates the supply chain. It would be necessary to perfectly time the production of cells with the demand.
of cells, and this is improbable for a large-scale facility. Thus, the most viable option that produces the highest yield of product is storage through vitrification cryopreservation.

4.4 Downstream Purification

*Lectin Array*

Once the scale up process of the cells is complete and the cells have been removed from the bioreactor using trypsin, a thorough purification process will be carried out in order to remove any undifferentiated cells or impurities. Undifferentiated cells are those that, during the scale up process, did not differentiate into the NSPC stem cells that are required for a patient’s treatment. If administered to a patient, these undifferentiated cells have possibility of being tumorigenic and can cause multiple problems in the patient. Also, the use of an impure dosage to a patient can lead to inaccurate results of the drug efficacy. For these reasons, the first step in the purification process will be to remove the undifferentiated cells, as the goal is to have a high purity product.

Although there are a variety of ways to separate the cells, the facility will use lectin array technology to remove the undifferentiated cells. This technology uses the presence of specific glycosylation patterns that result from pluripotency, and use lectins as probes to determine the presence of theses glycan markers. Lectins are comprised of natural plant products and therefore should will not introduce any safety concerns or new impurities into the mixture. In a previous study done by Yu-Chieh Wang, specific lectins were tested and identified as useful for separating pluripotent cells (Figure 4.h). (Wang, 2011) In the experiment, UEA-I lectin, FOU5F1, and SSEA-4 were mixed with a mixture of pluripotent and non-pluripotent cells. FOU5F1 and SSEA-4 are well-known markers of pluripotency. The UEA-I
lectin bound selectively to the pluripotent hESCs, thus confirming its accuracy in identifying successfully differentiated stem cells. UEA-1 showed the lowest reactivity with non-pluripotent cells.

In order to test the ability of UEA-1 lectin to separate a mixture of differentiated and undifferentiated cells, magnetic submicron beads mediated by UEA-1 lectin are used. The mixed population will be incubated in biotinylated UEA-1 lectin (6.5 microgram/ml lectins) at 4°C for 45 minutes. The successfully differentiated cells bind to the UEA-1 lectin, and then bind to the beads. The bead-attached cells are captured by a magnetic column, and the undifferentiated cells flow out of the column. The cells captured by the beads are isolated using a MagSweeper™ in order to harvest the beads. The successfully differentiated cells are released from the lectin using a fructose buffer, and then a sample of the purified mixture will be stained and flown through a flow cytometer to ensure the process has been carried out successfully. This process was tested and shown to be extremely accurate as shown in Figure 4.i, where the undifferentiated cells were Calcein AM-labeled and in a 1:1 mixture with differentiated hESC. In Figure XX, the different color bars represent three different lectin samples tested in the experiment. The unreacted mixture and the mixture with only beads show that around 50% of the cells not captured were those that were differentiated. This is the expected result in a 1:1 mixture of differentiated and undifferentiated cells. When analyzing the un-captured mixture in the sample with UEA-1 lectin and beads, almost 100% of cells contained the Calcein AM-label, suggesting that the undifferentiated cells had been removed, and the differentiated cells were successfully isolated.

**Alternative Purification Options**

An alternative method to remove subpopulations of undifferentiated stem cells relies on antibodies to bind to the cell surface. This method can be used as a complement to type-specific lectins, but lectins do offer some key advantages that antibodies cannot offer. For example,
antibodies are not as easily removed from the cells without damaging them. As the cells are very sensitive, it is important that the purification methods keep the yield of the cells as high as possible. Also, cell surface antibodies are often species-specific, whereas lectins can be more universally used. This is important as the facility may eventually expand to different types of hESC other than NSPCs, without requiring a major change of equipment. Finally, lectins are significantly less expensive than antibodies. Not only is the lectin less expensive, but the magnetic beads can be reused for other batches, again decreasing cost. This is important since it is desirable to keep costs low in this large-scale facility.

These results suggest that lectin array technology is a viable option for purifying hESC. This technique can be easily scaled up and is relatively inexpensive to perform. This technique is what this facility will use to purify the stem cell mixture.
5.0 Process Flow Diagrams

5.1 Upstream Process
5.2 Downstream Process
### 5.2.1 Cell Balances for Downstream Process Over Each Reactor

#### Cell Balance (P-21 / BR-102)

<table>
<thead>
<tr>
<th>Component</th>
<th>Input (mg)</th>
<th>Output (mg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biomass (cells)</td>
<td>5.40</td>
<td>86.40</td>
</tr>
<tr>
<td>Glucose</td>
<td>311.54</td>
<td>0.00</td>
</tr>
<tr>
<td>Glutamine</td>
<td>130.85</td>
<td>0.00</td>
</tr>
<tr>
<td>Oxygen</td>
<td>90.77</td>
<td>0.00</td>
</tr>
<tr>
<td>Lactic Acid</td>
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<td>280.38</td>
</tr>
<tr>
<td>Ammonia</td>
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</tr>
<tr>
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<td><strong>538.55</strong></td>
</tr>
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</table>

#### Cell Balance (P-22 / BR-104)

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<th>Input (mg)</th>
<th>Output (mg)</th>
</tr>
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<tbody>
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<td>Biomass (cells)</td>
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<td>691.20</td>
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<td>Glucose</td>
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<tr>
<td>Glutamine</td>
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<tr>
<td>Oxygen</td>
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</tr>
<tr>
<td>Lactic Acid</td>
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</tr>
<tr>
<td>Ammonia</td>
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</tr>
<tr>
<td>Carbon Dioxide</td>
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<td>1015.06</td>
</tr>
<tr>
<td>Water</td>
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<td>204.73</td>
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<tr>
<td><strong>TOTAL</strong></td>
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<td><strong>4308.42</strong></td>
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</table>

#### Cell Balance (P-23 / BR-103)

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<th>Output (mg)</th>
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<tbody>
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<td>Biomass (cells)</td>
<td>43.20</td>
<td>691.20</td>
</tr>
<tr>
<td>Glucose</td>
<td>2492.31</td>
<td>0.00</td>
</tr>
<tr>
<td>Glutamine</td>
<td>1046.77</td>
<td>0.00</td>
</tr>
<tr>
<td>Oxygen</td>
<td>726.14</td>
<td>0.00</td>
</tr>
<tr>
<td>Lactic Acid</td>
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<td>Ammonia</td>
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<td>Carbon Dioxide</td>
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<td>Water</td>
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<tr>
<td><strong>TOTAL</strong></td>
<td><strong>4308.42</strong></td>
<td><strong>4308.42</strong></td>
</tr>
</tbody>
</table>
6.0 Process Descriptions

6.1 Buffer Preparation

The buffers needed during the various processes are made in sanitary disposable containers. Making the buffers in house lowers their cost. The disposable containers also eliminate the need for Sterilization-In-Place (SIP) and Cleaning-In--Place (CIP), which can be costly both time-wise and financially. All buffers used are made with the WFI, which ensures minimal contamination and the ability to use these buffers at all points of the process. To further guarantee this, the buffers are run through a 0.2-micrometer sterile filter before use.
6.2 Initial Laboratory Scale-Up

6.2.1 6-Well Plate

A vial of cells from the screening lab is thawed and 1x10^5 cells are suspended in 7 mL of warm mTeSR1 media in a 15 mL conical tube. The cells are centrifuged and re-suspended in 2 mL of mTESR1 media. The cell aggregates in media are plated onto a pre-coated single well of a 6-well plate. The coating used is Matrigel hESC-qualified Matrix (see Appendix A for preparation). The 6-well plate is stored in an incubator at 37°C, with 5% CO₂ and 95% humidity, for approximately seven days. The media will equilibrate to a pH of approximately 7.0. The cells are observed daily under a microscope, and fresh media is added daily. Appendix A contains a detailed protocol to be performed by the laboratory technician.

Approximately seven days after thawing, the cells are detached and transferred to a new pre-coated single well of a 6-well plate. The single well contains 1x10^5 cells in 2 mL mTeSR1 media. Cells detach by washes with dispase (a protease used for the dissociation of cells) and DMEM/F-12 followed by gentle scraping with a cell scraper by a technician. The 6-well plates are stored in an incubator at 37°C, with 5% CO₂ and 95% humidity for approximately seven days. The media will equilibrate to a pH of approximately 7.0. The cells are observed daily under a microscope. Differentiated regions can be removed by scraping with a pipette tip or by aspiration. Cells are passaged after 4-7 days at a split ratio 1:6. Scale-up in production was calculated assuming 15% of cells differentiated and were removed. Appendix A contains a detailed protocol to be performed by the laboratory technician.

When the cells are 60-75% confluent, the cells are detached and transferred to five pre-coated wells of a 6-well plate. Each well contains 1.02x10^5 cells in 2 mL mTeSR1 media. Cells detach by washes with dispase and DMEM/F-12 followed by gentle scraping with a cell scraper. The 6-well plate is stored in an incubator at 37°C, with 5% CO₂ and 95% humidity for approximately seven days. The media will equilibrate to a pH of approximately 7.0. The cells are observed daily under a microscope. Differentiated regions can be removed by scraping with a pipette tip or by aspiration. Cells are passaged after 4-7 days at a split ratio 1:6. Scale-up in production was calculated assuming 15% of cells differentiated and were removed. Appendix A contains
a detailed protocol to be performed by the laboratory technician.

6.2.2 100-mm dish

When the cells are 60-75% confluent, the cells are detached and transferred to four pre-coated 100-mm dishes. Each dish contains $6.50 \times 10^5$ cells in 14 mL mTeSR1 media. Cells detach by washes with dispase and DMEM/F-12 followed by gentle scraping with a cell scraper. The 100-mm dishes are stored in an incubator at 37°C, with 5% CO$_2$ and 95% humidity for approximately seven days. The media will equilibrate to a pH of approximately 7.0. The cells are observed daily under a microscope. Differentiated regions can be removed by scraping with a pipette tip or by aspiration. Cells are passaged after 4-7 days at a split ratio 1:6. Scale-up in production was calculated assuming 15% of cells differentiated and were removed. Appendix A contains a list of materials and a detailed protocol to be performed by the laboratory technician.

6.2.3 150-mm dish

When the cells are 60-75% confluent, the cells are detached and transferred to six pre-coated 150-mm dishes. Each dish contains $2.21 \times 10^6$ cells in 38 mL mTeSR1 media. Cells detach by washes with dispase and DMEM/F-12 followed by gentle scraping with a cell scraper. The 150-mm dishes are stored in an incubator at 37°C, with 5% CO$_2$ and 95% humidity for approximately seven days. The media will equilibrate to a pH of approximately 7.0. The cells are observed daily under a microscope. Differentiated regions can be removed by scraping with a pipette tip or by aspiration. Cells are passaged after 4-7 days at a split ratio 1:6. Scale-up in production was calculated assuming 15% of cells differentiated and were removed. Appendix A contains a list of materials and a detailed protocol to be performed by the laboratory technician.

6.2.4 T-225 flasks

When the cells are 60-75% confluent, the cells are detached and transferred to twenty pre-coated T-225 flasks. Each flask contains $6.77 \times 10^7$ cells in 55 mL mTeSR1 media. Cells detach by washes with dispase and DMEM/F-12 followed by gentle scraping with a cell scraper. The T-225 flasks are stored in an incubator at 37°C, with 5% CO$_2$ and 95% humidity for approximately seven days. The media will equilibrate to a pH
of approximately 7.0. The cells are observed daily under a microscope. Differentiated regions can be removed by scraping with a pipette tip or by aspiration. Cells are passaged after 4-7 days at a split ratio 1:6. Scale-up in production was calculated assuming 15% of cells differentiated and were removed. Appendix A contains a list of materials and a detailed protocol to be performed by the laboratory technician.
6.3 Upstream Process

6.3.1 Neural Induction Media Prep (P-1/V-101)

Media is prepared in a medium sized 850 L mixing tank at room temperature. The mixing tank will be charged with STEMdiff Neural Induction Media that is used to convert hESCs to NSPCs. The media is an “off-the-shelf” product and thus the process will not filter this media before use. After mixing, the liquid media is pumped (P-3/PM-101) and stored in a 850 L storage tank until it is needed for the bioreactor. The tank is sterilized using standard CIP and SIP procedures after each batch.

6.3.2 Differentiation Media Prep (P-2/V-103)

Media is prepared in a medium sized 400 L mixing tank at room temperature. The tank will be charged with Complete NeuroCult NS-a Differentiation Medium. This media will be used to convert NSPCs to neurons, astrocytes, oligodendrocytes. After the generation of NSPCs from hESCs, this differentiation media will be pumped (P-4/P-102) into an 850 L storage tank until it is needed for the bioreactor. The tank is sterilized using standard CIP and SIP procedures after each batch.

6.3.3 Media Storage Tank (P-5/V-102)

The media from the two media prep tanks will be stored in this 850 L holding tank that will be kept at 37 C. First, the neural induction media will be held here, and will be pumped through (P-6/P-103) into the bioreactor. Once the first media leaves the tank, the tank is sterilized using standard CIP and SIP procedures. After sterilization, differentiation media from the second media prep tank will be stored in this tank. Once cells in the bioreactor are converted to NSPCs, the differentiation media will be pumped out of this storage tank and into the bioreactor. The tank will again be sterilized using standard CIP and SIP procedures.

6.3.4 3-L Bioreactor (P-7/BR-101)

When the cells are 60-75% confluent, the cells from twenty T-225 flasks are detached and differentiated in a custom reactor similar to the Integrity Xpansion™ system manufactured by Pall LifeSciences. The reactor is plated with $2x10^8$ cells over a surface area of $1.16x10^4$ cm$^2$ split among 19 plates, yielding a seeding density of
1.72x10^4 cells/cm^2. The reactor is inoculated with 2.09 L of STEMdiff Neural Induction Medium supplemented with 10 \( \mu \)M Rock inhibitor Y-27632 to promote the generation of neural stem progenitor cells from hESCs. Process control of the reactor is achieved through a controller with measurement/control hardware and a gassing system with a digital control. The reactor is maintained at 37°C, with 5% CO\(_2\) and 95% humidity for approximately seven days. The dissolved oxygen is maintained above 4%. The media will equilibrate to a pH of approximately 7.0. Each day, for twelve days, old media is removed and fresh media is added. After the twelve day period, all the media is removed and 2.09 L DMEM/F-12 is cycled through the reactor. Next, 2.09 L of STEMdiff Neural Rosette Selection Reagent is added to the reactor for one hour.

Next, the reagent is removed and 2.09 L PBS is cycled through the reactor. The reactor is inoculated with 2.09 mL of Complete NeuroCult NS-A Differentiation Medium, and the continuous media flow cycle begins. The reactor is maintained at 37°C, with 5% CO\(_2\) and 95% humidity for five to ten days. The dissolved oxygen is maintained above 4%, the minimal oxygen required for stem cell growth. The media will equilibrate to a pH of approximately 7.0. Appendix A contains a detailed protocol.

The generation of NSPCs from hESCs takes approximately twelve days. The differentiation of NSPCs into neurons, astrocytes, and oligodendrocytes takes approximately eight days. The cells are differentiated in the reactor for a total of 20 days, after which they are transferred from the reactor, and the reactor is cleaned. The cells are detached from the plates using 2.09 L of trypsin-EDTA, a cell dissociation reagent. The reactor operates for 260 days per year.

**6.3.5 Differentiation Assay (P-8/Assay)**

On day six of the process of generating NSPCs from hESCs, a small sample of cells is removed and immunocytochemistry is used to identify NPCs. Neural rosettes stain positive for Pax 6, an early NPC marker. In contrast, “flat” cells stain positive for Sox10. Immunocytochemical staining allows visualization of recognizable morphological indicators of commitment to the neural lineage.

After the differentiation of NSPCs into neurons, astrocytes, and oligodendrocytes, a small sample of cells is removed and immunolabeling is used to identify differentiated cell types. The cells are fixed in 4% paraformaldehyde, permeabilized in 0.3% Triton X-
100 in PBS, and blocked and labeled with a primary antibody. Appendix A contains a detailed protocol.

6.3.6 Lectin Array (P-10/Array)

This step is to ensure that the hESCs have been successfully differentiated into neurons, astrocytes, and oligodendrocytes by removing any of those cells that remained un-differentiated. This is done through a lectin array technology, that uses the presence of specific glycosylation patterns that result from pluripotency, and use lectins as probes to determine the presence of these glycan markers. To do this, magnetic beads mediated by UEA-1 lectin are used. The mixed population will be incubated in biotinylated UEA-1 Lectin (6.5 microgrm/ml lectins) at 4 C for 45 minutes (step not shown). A specialized robot will pipet the solution of cells that results from the bioreactor into 13 ml tubes filled with the UEA-1 infused magnetic beads. The successfully differentiated cells will bind to the beads, and the undifferentiated cells will flow through the tube. This solution will be discarded. The successfully differentiated cells are released from the lectin using a fructose buffer. Each sample will be centrifuged and then resuspended in media, in preparation for scale-up in proceeding bioreactors.

As sample of the purified mixture will be stained and flowed through a flow cytometer to ensure the process of differentiation was effective. Cells will be stained with Calcein AM and if it can be shown that over 98% of cells in solution have been differentiated, the process will continue. If not, the batch will be discarded.
6.4 Downstream Process

6.4.1 Neuron Media Prep (P-11/V-104)

This media will be prepared in order to promote growth and stability for the neurons in the bioreactor. It will be prepared in a 2000 L mixing tank at 4 °C. The mixing tank will be charged with Basal Medium. The media is “off-the-shelf” and this media will be enough to support the scale-up process for up to 14 months. After mixing, the liquid media is pumped (P-12/PM-105) to a filter. The tank is sterilized using standard CIP and SIP procedures.

6.4.2 Media Filtration (P-13/DE-101)

The media that will be used for stem cell growth in subsequent bioreactors is used in large quantities and may be stored for long periods of time, and thus will need to be filtered before used in production. The filter must be a 10 nm filter in order to ensure that no contaminants are present in the neural media. The operation is performed using a traditional flow filtration method, where the fluid flows perpendicular to the filter. The media will pass through the filter and any unwanted impurities will be retained. The waste is collected as biowaste and the filter will be replaced before every batch.

6.4.3 Large Media Storage Tank (P-15/V-105)

This storage tank will store the amount of neural media to be used for two batches, or one cycle, of the process. The two batches will be running in parallel and the tank will hold 200 L of media at room temperature. This media will be pumped (P-16/PM-107) and separated equally into two blending tanks to be used in the proceeding bioreactors. The tank is sterilized using traditional SIP and CIP procedures after each cycle.

6.4.4 Small Media Mixing Tank (2) (P-17/V-106)

This mixing tank will have a capacity of 100 L and will be kept at 37 °C. The tank will mix and supply the medium to all 3 bioreactors for each batch. The medium will continuously be recycled into this mixing tank, ensuring the supply of fresh medium to the process. First, the medium will be supplied to the 3 L bioreactor, and once that process is complete, the mixing tank will supply the medium to the two 17 L bioreactors. Glutamax and B-27 supplement will be replenished in the mixing tank, totaling 0.69 L
and 0.07 L for the 3 L bioreactor and 5.31 L and 0.53 L for each 17 L bioreactor, respectively. These additives will allow for the medium to be recycled and replenished for continuous use by the growing stem cells.

6.4.5 3-L Bioreactor (P-21/BR-102)

Next, the differentiated neurons are grown in custom reactor (same as P-7/BR-101). The reactor is plated with $2 \times 10^8$ cells over a surface area of $1.16 \times 10^4$ cm$^2$ split among 19 plates, yielding a seeding density of $1.72 \times 10^4$ cells/cm$^2$. The reactor is inoculated with 2.09 L of neuronal culture media, and the continuous medium flow cycle begins. Process control of the reactor is achieved through a controller with measurement/control hardware and a gassing system with a digital control. The dissolved oxygen is maintained above 4%, the pH is maintained at 7.0, and the temperature maintained at 37° C. These are typical cell culture parameters for neurons.

The cells are expanded in the reactor for 16 days, after which they are transferred from the reactor, and the reactor is cleaned. The cells are detached from the plates using 2.09 L of trypsin-EDTA, a cell dissociation reagent. The reactor operates for 208 days per year.

6.4.6 17-L Bioreactor (P-22/BR-104)

Next, the cells obtained from the small bioreactor are divided equally and grown in two larger custom reactors (similar to P-7/BR-101). The reactor is plated with $1.6 \times 10^9$ cells over a surface area of $9.00 \times 10^4$ cm$^2$ split among 147 plates, yielding a seeding density of $1.78 \times 10^4$ cells/cm$^2$. The reactor is inoculated with 16.19 L of neuronal culture media, and the continuous media flow cycle begins. Process control of the reactor is achieved through a controller with measurement/control hardware and a gassing system with a digital control. The dissolved oxygen is maintained above 4%, the pH is maintained at 7.0, and the temperature maintained at 37° C. These are typical cell culture parameters for neurons. The cells are harvested the products from the two bioreactors are combined.

The cells are expanded in the reactor for 16 days, after which they are transferred from the reactor, and the reactor is cleaned. The cells are detached from the plates using
16.19 L of trypsin-EDTA, a cell dissociation reagent. The reactor operates for a total of 208 days per year.

6.4.7 17-L Bioreactor (P-23/BR-103)

Next, the cells obtained from the small bioreactor are divided equally and grown in two larger custom reactors (same as P-22/BR-104). The reactor is plated with $1.6 \times 10^9$ cells over a surface area of $9.00 \times 10^4$ cm$^2$ split among 147 plates, yielding a seeding density of $1.78 \times 10^4$ cells/cm$^2$. The reactor is inoculated with 16.19 L of neuronal culture media, and the continuous media flow cycle begins. Process control of the reactor is achieved through a controller with measurement/control hardware and a gassing system with a digital control. The dissolved oxygen is maintained above 4%, the pH is maintained at 7.0, and the temperature maintained at 37° C. These are typical cell culture parameters for neurons. The cells are harvested the products from the two bioreactors are combined.

The cells are expanded in the reactor for 16 days, after which they are transferred from the reactor, and the reactor is cleaned. The cells are detached from the plates using 16.19 L of trypsin-EDTA, a cell dissociation reagent. The reactor operates for a total of 208 days per year.

6.4.8 Cryopreservation of Cells (2) (P-27/TTR-101)

The process of vitrification cryopreservation will be used to preserve and store the differentiated NSPC stem cells after purification. This process entails a rapid cooling of the cells and storage in liquid nitrogen.

For this process, two vitrification solutions be prepared in order to increase the viscosity of the solution in order to protect the cells from damage caused by the rapid cooling. The more viscous the solution, there is a higher probability that the solution will freeze into a glass-like state and preserve the cells. The first solution will be supplemented with 10% ethylene glycol, 10% DMSO and 80% culture media. The second vitrification solution will include 20% ethylene glycol, 20% DMSO, .5M sucrose, and basal media. The vitrification solutions will be mixed in two 100 L blending tanks (not shown) (Yoon, 3).
First, the cell solution will be sent through a double microfilter (not pictured). The neural cells are about 20 microns. The first filter will be 50 micron mesh filter, to filter out and larger contaminants. The second filter will be a 1 micron mesh filter. This will allow for any smaller contaminants (e.g. 50 nm viruses) to flow through the mesh, and the cells will be recovered from the filter. The cells will be placed into cell 50 ml vials (2x10^7 cells per vial) from a large stock solution containing the cells that have previously been purified. A specialized automated machine will separate the cells into the vials, filling multiple vials at one time. The strainer caps allow the cells to come into contact with whatever solution they are submerged in. The vials will first be incubated in the first vitrification solution at 37 C for one minute. The vials will then be transferred into the second vitrification solution and incubated for 30 seconds at 37 C. After incubation in the vitrification solutions, the vials containing the cells will be submerged into liquid nitrogen and stored (Yoon, 4).

Cells can be viably thawed after storage in the liquid nitrogen for about 2-3 months. The vitrification cryopreservation process itself has a yield of around 35-50%, and thus half or more of the cells will be lost in this process (Yoon, 4).

6.4.9 Media Microfilter (P-28/MF-101)

A microfilter will be used to separate out any unwanted contaminants from the recycled media. This microfilter will have a one-micron mesh. The neural stem cells are about 20 microns in diameter and thus any cells that have been removed from the plates (either due to shear stress or other detachment from the plate) will be filtered out and removed. This will be performed by traditional flow filtration, where the media will flow perpendicular to the filter and the desired media will pass through the filter. The waste will be disposed of and the filter will be replaced after every batch. Once filtered, the medium will return back to the small medium mixing tank and will cycle through the process again.
7.0 Major Unit Descriptions

7.1 Initial Laboratory Scale Up

7.1.1 6-Well Plate

The 6-well plates are used for the first and second passaging of the human embryonic stem cell lines. The plates are purchased from Corning Inc.™ and have a surface area of 9.5 cm². The flasks are TC-treated polystyrene, individually wrapped, and sterile. The flasks are made of polystyrene with a low evaporation lid. The well volume is 16.8 mL mL, but the recommended medium well volume is 1.9-2.9 mL. They are sold in a case of 50 for $116.30. One 6-well plate is used per batch. The wells are manipulated in a biosafety cabinet and are disposed as biohazardous waste after use.

7.1.2 100-mm dish

The 100-mm dishes are used for the third passaging of the stem cell lines. The dishes are purchased from Corning Inc.™ and have a surface area of 55 cm². The flasks are certified nonpyrogenic, TC-Treated, and gamma irradiation sterilized. The flasks are made of polystyrene and supplied with vents for consistent gas exchange. The recommended medium volume is 11.0-16.5 mL. They are sold in a sleeve of 20 with packs of 100 for $195.10. Two dishes are used per batch. The wells are manipulated in a biosafety cabinet and are disposed as biohazardous waste after use.

7.1.3 150-mm dish

The 150-mm dishes are used for the fourth passaging of the stem cell lines. The dishes are purchased from Corning Inc.™ and have a surface area of 148 cm². The flasks are certified nonpyrogenic, TC-Treated, and gamma irradiation sterilized. The flasks are made of polystyrene and supplied with vents for consistent gas exchange. The recommended medium volume is 30.0-45.0 mL. They are sold in a case of 60 for $188.65. Three dishes are used per batch. The wells are manipulated in a biosafety cabinet and are disposed as biohazardous waste after use.

7.1.4 T-225 flasks

The T-225 flasks are used for the fifth passaging of the stem cell lines. The T-flasks are purchased from Corning Inc.™ and have a surface area of 225 cm². The flasks
are certified nonpyrogenic, TC-Treated, and gamma irradiation sterilized. The flasks are made of polystyrene and are purchased with a vented cap for optimal airflow. The maximum working volume is 370 mL, but the recommended medium volume is 45-67.5 mL. They are sold in a case of 25 for $236.66. Ten flasks are used per batch. The flasks are manipulated in a biosafety cabinet and are disposed as biohazardous waste after use.

7.2 Upstream Process

7.2.1 Neural Induction Media Prep (P-1/V-101)

This blending/storage tank will be the first tank that begins the upstream process. This tank will hold and prepare the differentiation media #1 (STEMdiff Neural Induction Media), which will be sent through to the first 3 L bioreactor in order to convert hESC’s to NSPC’s. It is an 850 L mixing tank made of Stainless Steel 316, and will be purchased from Sharpsville Container. The conditions in this storage tank will be 25°C and 1 bar. The vessel will be cleaned in between batches with standard SIP/CIP procedures. The purchase cost of this storage and blending tank will be roughly $56,000.

7.2.2 Differentiation Media Prep (P-2/V-103)

This blending/storage tank will be the next tank in the upstream process. It will hold the differentiation media #2 that will convert the NSPC’s to neurons in the first 3L bioreactor. The complete NeuronCult NS-A Differentiation Medium will be pumped through the upstream process once the STEMdiff Neural Induction Media has been used to its full extent in the batch. This reactor is a smaller, 400 L mixing tank made of Stainless Steel 316. The reactor will be maintained at 25°C and 1 bar as well. This vessel will also be cleaned with standard SIP/CIP procedures. The vessel will be purchased from Sharpsville Container for $36,000.

7.2.3 Pump #1 (P-3/PM-101)

This first pump will be used to send the first Neural Induction Media from the first blending/storage tank (P-1/V-101) to the storage tank (P-5/V-102). The 620DuN/RE NEMA 4x model to be purchased from Watson-Marlow. This peristaltic pump will be able to handle a flow rate of 18.17 L/min and a maximum of .2 kW. The pump will
operate at 25°C and will undergo a pressure change of 25 psi. It will only require 0.056 kW to function properly, which is under the allowable limit. The combination of the pump and the Bioprene Thermoplastic Tubing will be $4,576.

7.2.4 Pump #2 (P-4/PM-102)

This is the same 620DuN/RE NEMA 4x model peristaltic pump as the one previously described above (7.2.3). This pump will send the NeuronCult NS-A Differentiation Medium from the 400 L blending/storage tank (P-2/V-103) to the storage tank (P-5/V-102).

7.2.5 Storage Tank (P-5/V-102)

This medium storage tank will hold the product that will be sent from the 850 L and 400 L medium preparation tanks previously described. First, the 850 L tank will send its medium contents to this storage tank, which will then be sent to the first 3L bioreactor. In that same batch, the 400 L tank will send the neural induction medium to this storage tank, which will hold the medium until it is needed by the same 3L bioreactor. Therefore, this storage tank must be able to handle the contents of only the larger reactor, and will be 850 L. The storage tank will be constructed from Stainless Steel 316. It will operate 37°C and at 1 bar and will be sterilized with SIP/CIP procedures. The tank can be purchased from DCI Inc.™ for $79,000.

7.2.6 Pump #3 (P-6/PM-103)

This is the same 620DuN/RE NEMA 4x model peristaltic pump as the ones previously described above (7.2.3). It will be used to transfer whichever medium is in the storage tank (P-5/V-102) to the first 3 L bioreactor.

7.2.7 3 L Bioreactor #1 (P-7/BR-101)

This custom multi-plated bioreactor will be used to differentiate the cells prior to the scale up process. The original hESC’s will be converted to neurons, astrocytes, and oligodendrocytes. A working volume of 2.09 L is suggested, and so the total volume of this reactor will be 3 L. The operating conditions include 37°C, 1 bar, and 95% humidity. The cells will be plated in this reactor for 20 days to allow the correct number of cells to
multiply. Pall Life Sciences™ manufactures this bioreactor, which will be customized. Therefore, the price must be adjusted to a final purchase price of $75,000.

**7.2.8 Differentiation Assay (P-8/Assay)**

The samples from the 3L differentiation bioreactor are sent here in order to be analyzed. This will determine the viability of the cells as well as the percentage that have been differentiated. If the minimum threshold is reached, the batch will be sent to the next step for scale-up. Materials needed for this process may be found in Appendix A.

**7.2.9 Pump #4 (P-9/PM-104)**

This is the same 620DuN/RE NEMA 4x model peristaltic pump as the ones previously described above (7.2.3). It will be used to transfer the cells and medium to the lectin array in order to separate the differentiated and undifferentiated cells.

**7.2.10 Lectin Array (P-10/Array)**

The lectin array will be used to separate the differentiated cells to be used for the scale up process. The cells will be flow through this array and will be captured on the sides of the column, which will be released by a fructose buffer. The LS Cell Separation model from Miltenyl Biotec™ will be used. The array will be made out of acrylic and can bind 100 million cells per column. A velocity of 2 mL/min of the cells in the media will be passed through the columns, which are disposable. These columns have a capacity of 13 mL. This can be done at ambient conditions (25°C and 1 bar). These can be purchased in a case of 75 columns for $400, which will be sufficient for 1 batch.
7.3 Downstream Process

7.3.1 Neuron Media Prep (P-11/V-104)

The Neuron Media Prep Tank will begin the downstream process. This is the blending and storage tank used for the medium involved in the scale up process. This will require more medium per batch than previous blending/storage tanks simply because it will be split between multiple reactors. The total volume of the tank will need to be 2000 L in order to be able to blend the media for 1 batch. The vessel is constructed from Stainless Steel 316 and will operate at 25 °C and 1 bar. It will be cleaned using SIP/CIP procedures. The tank can be purchased from Sharpville Container for $94,000.

7.3.2 Pump #5 (P-12/PM-105)

This is the same 620DuN/RE NEMA 4x model peristaltic pump as the ones previously described above (7.2.3). It will be used to send the basal media from the Neuron Media Prep Tank to the filter prior to use in the scale-up.

7.3.3 Filter (P-13/DE-101)

The filtration system will be used to remove any filterable contaminants from the basal media stream. The Sartopure GF Plus MaxiCaps Filter Capsules will be used in order to achieve this filtration. The filters are made of glass fibers that have a filter size of 1.2 micrometers. The filter’s operating limits are 20°C and 4 bar or 50°C and 3 bar. It will operate at ambient conditions (25 °C and 1 bar). It can be purchased from Sartorious Stedim for $723, and can be reused following an autoclave cycle. It will be autoclaved after every batch is run.

7.3.4 Pump #6 (P-14/PM-106)

This is the same 620DuN/RE NEMA 4x model peristaltic pump as the ones previously described above (7.2.3). It will be used to transfer the basal media from the filtration device to the storage tank (P-15/V-105).

7.3.5 Storage Tank (P-15/V-105)

This storage tank will receive the basal medium that has been filtered. It will retain enough media for four batches, as needed for the next part of the scale-up. Once its
contents become depleted during a batch, it is refilled from Neuron Media Prep Tank. Therefore, this storage tank only needs to be 200 L. It will be made out of Stainless Steel 316 and can be cleaned with SIP/CIP protocols. The vessel will operate at ambient conditions (25 °C and 1 bar) and can be purchased from DCI Inc.™ for $34,000.

7.3.6 Pump #7 (P-16/PM-107)

This is the same 620DuN/RE NEMA 4x model peristaltic pump as the ones previously described above (7.2.3). It will be used to transfer the basal media from the storage tank to the media-blending tank, just prior to use in the bioreactors.

7.3.7 Small Media Mixing Tank (P-17/V-106)

This media-mixing tank will prepare the basal medium in order to be used in the bioreactors. This involves a number of media additives that will be mixed into the mixing tank. The tank will be constructed from Stainless Steel 316 and will only be 100 L in volume. This is because two of these are running in parallel, along with the rest of the downstream process. The vessel will be cleaned using SIP/CIP procedures. It can operate at ambient conditions, and will be purchased from Sharpsville Container for $16,000.

7.3.8 Pump #8 (P-18/PM-108)

This is the same 620DuN/RE NEMA 4x model peristaltic pump as the ones previously described above (7.2.3). It will be used to pump the basal medium, along with its additives, from the small medium-mixing tank to the 3L scale-up bioreactor.

7.3.9 Pump #9 (P-19/PM-109)

This is the same 620DuN/RE NEMA 4x model peristaltic pump as the ones previously described above (7.2.3). It will be used to pump the basal medium, along with its additives, from the small medium-mixing tank to one of the 17L scale-up bioreactors.

7.3.10 Pump #10 (P-20/PM-110)

This is the same 620DuN/RE NEMA 4x model peristaltic pump as the ones previously described above (7.2.3). It will be used to pump the basal medium, along with its additives, from the small medium-mixing tank to the other 17L scale-up bioreactor.
7.3.11 3 L Bioreactor #2 (P-21/BR-102)

This bioreactor will be the first step of the scale-up process. It will be plated with the differentiated cells from the upstream process. A continuous stream of basal medium will flow through the bioreactor. The suggested capacity of this reactor is 2.09 L, so a 3 L bioreactor will be used. The model used is similar to the Custom Integrity Xpansion™ 19-plate Bioreactor. Once the cells are allowed to grow on these plates, they will be removed and sent to the larger bioreactors. There will be a magnetic impeller that slowly circulates the media through. These reactors will run at 37 °C and 1 bar. A dissolved concentration of oxygen will be maintained above 4% to ensure cell growth, as well as a neutral pH of 7.0. The cells will remain in this reactor for about 4 doubling times, or 16 days total. This Bioreactor can be bought from Pall Life Sciences for $75,000.

7.3.12 17 L Bioreactor #1 (P-22/BR-104)

This bioreactor will be the next step of the scale-up process. It will be plated with the differentiated cells from the 3 L bioreactor (P-21/BR-102). The resulting cells of that reactor are split between two 17 L bioreactors. A continuous stream of basal media will flow through this bioreactor also. The suggested capacity of this reactor is 16.24 L, so a 17 L bioreactor will be used. The model used is similar to the Custom Integrity Xpansion™ 19-plate Bioreactor. Once the cells are allowed to grow on these plates, they will be removed and sent for cryopreservation. There will be a magnetic impeller that slowly circulates the media through this reactor also. These reactors will run at 37 °C and 1 bar. A dissolved concentration of oxygen will be maintained above 4% to ensure cell growth, as well as a neutral pH of 7.0. The cells will remain in this reactor for about 4 doubling times, or 16 days total. This Bioreactor can be bought from Pall Life Sciences for $100,000.

7.3.13 17 L Bioreactor #2 (P-23/BR-103)

This 17 L bioreactor is the same as the 17 L bioreactor discussed above (P-22/BR-104). It will receive the other half of the cells produced by the 3L scale-up bioreactor and will result in the same number of cells as the other 17 L bioreactor. These finished cells will be sent for cryopreservation.
7.3.14 Pump #11 (P-24/PM-111)

This is the same 620DuN/RE NEMA 4x model peristaltic pump as the ones previously described above (7.2.3). It will send the basal medium from the 3 L bioreactor to the filter, in order to be sent back to the blending/storage tank. This is where media additives can be combined again, to be re-circulated back through the bioreactor system.

7.3.15 Pump #12 (P-25/PM-112)

This is the same 620DuN/RE NEMA 4x model peristaltic pump as the ones previously described above (7.2.3). It will send the basal medium from one of the 17 L bioreactors to the filter, in order to be sent back to the blending/storage tank. This is where media additives can be combined again, to be re-circulated back through the bioreactor system.

7.3.16 Pump #13 (P-26/PM-113)

This is the same 620DuN/RE NEMA 4x model peristaltic pump as the ones previously described above (7.2.3). It will send the basal medium from the other 17 L bioreactor to the filter, in order to be sent back to the blending/storage tank. This is where media additives can be combined again, to be re-circulated back through the bioreactor system.

7.3.17 Vitrification Solution 1 Mixing Tank (Not Pictured)

A mixing tank is needed in order to prepare a vitrification solution that will be used in the cryopreservation of the cells. The tank will be made of Stainless Steel 316 and will be 15 L in total volume. The vessel can be cleaned with SIP/CIP procedures and operates at ambient conditions. It will be purchased from Sharpsville Container for $5,100.

7.3.18 Vitrification Solution 2 Mixing Tank (Not Pictured)

This tank will be similar to the one above in all dimensions, but will be used to prepare the second solution needed for cryopreservation. The same vessel for this cannot be used since this preservation process is quick and must be done in rapid succession.
7.3.19 Filter (P-28/MF-101)

This filtration system will filter all of the recycled medium from all three bioreactors. It will be similar to the filter system in the beginning of the downstream process (P-13/DE-101). It will be the same model as that filter, and will be subject to the same operating conditions. It will, however, be a smaller size than the previous filter and therefore will only cost $536 per batch.

7.3.20 Pump #14 (P-29/PM-114)

This is the same 620DuN/RE NEMA 4x model peristaltic pump as the ones previously described above (7.2.3). It will send the filtered basal medium back to the small blending/storage tank (P-17/V-106) where the media additives are supplemented. This will then be pumped and re-circulated through all of the bioreactors, as previously explained.
8.0 Additional Equipment

8.1 Ventilation Systems

The ventilation systems will be used in the culture and micro labs to ensure proper cleanliness and sanitation when bench work needs to be done. This work will be done prior to growing cells in any of the bioreactors, as a certain concentration of cells needs to be available to enter the reactors. These ventilation systems will cost about $28,600 each including installation costs. The systems come with water, air, gas, and vacuum fixtures and are depressurized. Five ventilation hoods are required between all of the laboratories in the facility. The Hamilton Scientific SafeAire II Fume Hood from Thermo Fisher will be purchased.

8.2 BioSafety Cabinets

The biosafety cabinets are needed in order to transfer the human embryonic stem cells to the first bioreactors for differentiation. The aseptic and sterile transfer from the flasks to the bioreactors must be ensured to maintain the cell culture viability. The KS18 model of the Thermo Scientific Herasafe Class II Biosafety Cabinets will be purchased, and ten total cabinets are required throughout the labs. These cabinets, including installation fees, will cost about $17,300 each.

8.3 Incubators

The incubators will be used to maintain the cell cultures at optimal conditions while they are in the culture labs. Temperature, humidity, and carbon dioxide concentration are set and monitored in these devices. For the stem cells specifically, the temperature will need to be maintained at 37°C to ensure survival of the cells. The Fisher Scientific Isotemp Incubators will be used and will cost $7,900 each. Between all of the labs, ten incubators will be required.

8.4 Centrifuges

The centrifuges will be used to spin down the cell cultures when needed. The supernatant is usually sent to the analytical department. The Sorvall Primo R benchtop centrifuge will be purchased from Thermo Scientific for $6320. These centrifuges can be refrigerated if needed, ranging from -9°C to 40°C. The samples loaded can reach up to
400 mL. A separate rotor and adapter package must be purchased for $2410 that can hold 4 50-100 mL tubes.

8.5 Refrigerated Microcentrifuges

These are similar to the larger centrifuges above, including speed and temperature settings. The capacity, however, is roughly 50 mL, with 24-2.0 mL eppendorf tube holders. The accuSpin Micro17R microcentrifuges can be purchased from Fisher Scientific, and like the centrifuges above, about 4 will be used between all of the labs. The purchase price of these microcentrifuges is $5,760.

8.6 Refrigeration

A liquid nitrogen freezer is used to store the cell banks following the scale up process. The temperature of storage affects their viability following the process, and lowering the temperature of storage will further ensure cell viability. The Thermo Scientific CryoPlus Storage System has precise control with 16 parameters to ensure that the cells are properly maintained. The model chosen has a capacity of 200 L and costs $13,900.

There are some problems associated with this type of freezing. The cells cease metabolism and must be maintained at these low temperatures. Low cell recovery can be a major problem, which can be solved by controlled rate freezing in combination with the CryoPlus Storage System above. The CryoMed Controlled Rate Freezer is used here, at a cost of $22,700. This freezer is 1.7 cu. Ft. and can range in temperature from -180°C to 50°C. These are made of stainless steel, and two are required.

A -86°C -50°C freezer will be used to store some materials, samples and analytical kits. The Fisher Scientific Isotemp Ultra-Low Temperature Freezer will be purchased for $11,800. It is a 17.3 cu. ft freezer equipped with alarms and sensors to maintain temperature. Two of these are required.

Finally, all of the media and other reagents are stored in a refrigerator. The Fisher Scientific Isotemp General Purpose Refrigerator is 27 cu. ft and costs $8,600 to purchase and install per unit. Based on the large amount of media and reagents required at any given time, the facility will need to install 7 units in the labs. It is equipped with a microprocessor for temperature control at a temperature range of 1 to 12 °C.
8.7 ViCell Counter

The ViCell XR is the cell counter that will be purchased from Beckman Coulter. With installation of the equipment and other fees, the total cost of the machine should be $50,500. This machine can test a variety of different properties of the stem cells at the end of the scale up process. This includes viable cell concentration, viability, and the average cell size in the culture. The range that this piece of equipment covers 2-70 micrometers, which should be in the range of the viable stem cells. Only one ViCell XR needs to be purchased and will be used at the end of each batch to determine the amount of cells that were successfully grown, prior to packaging. This machine follows all Good Manufacturing Practices and the attached documentation provides all of the specifications and instructions for use.

8.8 Spectrophotometer

The bench-top spectrophotometer is used to analyze nucleic acid concentration as well as any purified protein concentration. This will be in the labs and can be used to test any of the samples, using a unique NanoDrop microvolume technology. The Thermo Scientific NanonDrop Spectrophotometer is roughly $6,200 and five of them are needed between all of the labs.

8.9 Osmometer

The Advanced Model Multi-Sample Osmometer used will be able to handle 20 samples at one time, each with a 20 microliter sample size. This device can determine the osmolality of solutions using the freezing point depression method. This specific osmometer is accurate for fluids in clinical applications and media formulations. One of these devices costs roughly $33,200 and five of them are dispersed between all of the labs.

8.10 Lab Scales

Analytical balances will be used throughout the labs and production area in order to measure out the mass of certain solid materials. The model that will be in the labs will be at a capacity of 0-200g and can be purchased from Fisher Science for $2300.
8.11 pH meters

pH meters will be distributed throughout all of the labs to monitor pH of various solutions. The Fisher Science Education pH meter has accuracy to 0.01 pH, with a three-point calibration. Each meter can be purchased for $700 and ten are required.

8.12 Microscopes

Fisher Scientific Stereomaster Zoom Microscopes will be used due to their magnification levels and high quality zoom optics. They are required in the labs to magnify images of the cell cultures and stains. These microscopes are easily customizable and can be supplemented with lenses. Each binocular microscope (up to 60x) will cost $3,700.

8.13 Consumables

All other equipment that are needed for the labs will be consumables. This will include filters, graduated cylinders, pipettes, spray bottles and all flasks (Erlenmeyer, volumetric, etc.). These will all vary in size up to about 2000 mL. These will be purchased from Cole-Parmer, and it is estimated that this total cost will be about $20,000.

8.14 Bag Holders/Glass Waste Containers

In the labs, biohazard bag holders and glass waste containers must be purchased. They will be dispersed throughout the laboratories to dispose of any non-hazardous waste. The 100 L bag holders can be purchased from Bel-Art Scienceware for $100 and five are required. The glass waste containers can be purchased from Fisherbrand, with a pack of 6 costing about $150.

8.15 Autoclaves

Much of the waste is biological and will require sterilization before disposal. Anything that is disposable, including culture plates, must be sterilized in a depyrogenation oven before removal from the facility. The autoclave system that is being used will be built into the wall of the sterilization area. They are devices that are used to sterilize equipment, subjecting them to high-pressure steam at 121 °C for 15 minutes. All bacteria, viruses and fungi are inactivated during these autoclave cycles. With this system,
the equipment is put through one side and devices sterilized on the other side. They will be made out of stainless steel and five of these in wall systems are required throughout the labs and facility. The autoclaves used will have a capacity of 250 L, vertical sliding doors and will comply with all cGMP regulations. Each in-wall autoclave sterilizing system will cost about $200,000 to install. They will be purchased from Getinge GE Model.

8.18 Waste Neutralization System

During production, any streams that are created must be neutralized to a pH = 7.0. This system comes with a 10,000 L tank that can hold both hazardous and non-hazardous material. From this holding tank, the streams are fed to a continuous three-step neutralization system. This ensures that even the most extreme pH’s can be controlled. The system can handle 25 gallons/min and includes all of the filters and pumps. The entire system can be purchased from OMEGA for $150,000.

8.17 Air Compressor

The air compressor package will be used to convert power in the form of electricity into kinetic energy. It compresses and pressurizes the air, allowing for the kinetic energy to be used to run certain pieces of equipment. The package purchased includes the rotary compressor, receiver tank, dryers, filters, and coolers. The entire package can be purchased for $120,000.

8.18 USP Water System

The USP grade water can convert tap water into purified, filtered water through a treatment package. This package will cost $140,000 with installation and shipping costs. The package includes a carbon filter, water softener and a continuous deionization system to enhance purity. Siemens carries a water system package that will be purchased.

8.19 Still Package for WFI

The still package is used to produce WFI from the USP grade water in the previous step. This still package can withstand 2300 L/h and can be purchased from Puretech for $350,000.
8.20 WFI Tank and Distribution System

This system will be used to circulate WFI throughout the facility to wherever it may be needed. This system will keep the WFI sterile and pump it to all of the pieces of equipment that need it. This comes with all of the pumps, heaters and coolers necessary and can be purchased from IPEC for $225,000.

8.21 Pure Steam Generator

Pyrogen-free steam must be used for various parts of the process, including CIP/SIP procedures. This generator can be purchased from the Spirax Sarco Company for $200,000.

8.22 CIP Skid

A clean-in-place system is needed to clean all of the vessels and equipment units after a certain number of batches. This system can cover the entire plant and includes all tanks, pumps, and chemical dosing equipment. It is portable and can be moved throughout the facility to clean each vessel. Multiple tanks for rinsing and washing are used. The automated system can be purchased from GEA Process Engineering Inc. for $250,000.

8.23 Glucose and Lactate Analyzer

An analyzer is needed in the labs, which allows for determination of metabolites and substrates in mammalian cell cultures. Some of the major metabolites that are monitored will be glucose and lactate levels of the cells. Other things that can be recorded include glutamate, glutamine, sodium, potassium, and ammonia. The Cedex Bio HT Analyzer can be purchased from Roche for $100,000.

8.24 Blood Gas Analyzer

A blood gas analyzer is needed in the labs to test the content of the cell cultures. This will be able to measure pH and dissolved gas levels (oxygen, carbon dioxide, etc.). These tests will indicate the metabolic state of the cells. The Rapidlab 1260 System will be purchased from Siemens for $35,500.
# 9.0 Unit Specification Sheets

## 9.1 Initial Laboratory Scale Up

### 6-Well Plates

<table>
<thead>
<tr>
<th>Function:</th>
<th>TC-Treated sterile well plates for the adherence and growth of cell cultures</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manufacturer:</td>
<td>Corning</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Operation:</th>
<th>Semi-Continuous</th>
</tr>
</thead>
<tbody>
<tr>
<td>Materials Handled:</td>
<td></td>
</tr>
<tr>
<td>Input</td>
<td>Quantity (mL/batch)</td>
</tr>
<tr>
<td>Matrigel Matrix</td>
<td>2.75</td>
</tr>
<tr>
<td>DMEM/F-12</td>
<td>27.5</td>
</tr>
<tr>
<td>Dispase</td>
<td>2.75</td>
</tr>
<tr>
<td>mTESR1 Serum</td>
<td>11.0</td>
</tr>
</tbody>
</table>

| Characteristics: | |
| Model: | Falcon 6-Well Multiwell |
| Material of Construction: | Plate |
| Cap: | Polystyrene |
| Vessel Type: | Low evaporation |
| Total Volume: | Multi-well plate |
| Suggested Working Volume: | 16.8 mL |
| Additional Features: | Disposable |

| Operating Conditions: | |
| Temp: | 37° |
| Pressure: | 1 bar |
| Carbon Dioxide: | 5% |
| Humidity: | 95% |
| Duration: | 14 days |

| Purchase Cost: | 6-Well Plates | $116.30 case of 50 |
# 100-mm Dish

## Function:
TC-Treated sterile dishes for the adherence and growth of cell cultures

## Manufacturer:
Corning

## Operation:
Semi-Continuous

<table>
<thead>
<tr>
<th>Input</th>
<th>Quantity (mL/batch)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Matrigel Matrix</td>
<td>35</td>
</tr>
<tr>
<td>DMEM/F-12</td>
<td>350</td>
</tr>
<tr>
<td>Dispase</td>
<td>35</td>
</tr>
<tr>
<td>mTESR1 Serum</td>
<td>140</td>
</tr>
</tbody>
</table>

## Materials Handled:

- Matrigel Matrix: 35 mL/batch
- DMEM/F-12: 350 mL
- Dispase: 35 mL
- mTESR1 Serum: 140 mL

## Characteristics:

- **Model:** Corning 100mm Culture Dish
- **Material of Construction:** Polystyrene
- **Vessel Type:** Petri dish
- **Suggested Working Volume:** 11.0-16.5 mL
- **Additional Features:** Disposable

## Operating Conditions:

- **Temp:** 37°C
- **Pressure:** 1 bar
- **Carbon Dioxide:** 5%
- **Humidity:** 95%
- **Duration:** 7 days

## Purchase Cost:

100-mm dish $195.10 case of 100
150-mm Dish

Function: TC-Treated sterile dishes for the adherence and growth of cell cultures

Manufacturer: Corning

Operation: Semi-Continuous

<table>
<thead>
<tr>
<th>Input</th>
<th>Quantity (mL/batch)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Matrigel Matrix</td>
<td>114</td>
</tr>
<tr>
<td>DMEM/F-12</td>
<td>1140</td>
</tr>
<tr>
<td>Dispase</td>
<td>114</td>
</tr>
<tr>
<td>mTESR1 Serum</td>
<td>456</td>
</tr>
</tbody>
</table>

Materials Handled:

<table>
<thead>
<tr>
<th>Model:</th>
<th>Corning 150mm Culture</th>
</tr>
</thead>
<tbody>
<tr>
<td>Material of Construction:</td>
<td>Dish</td>
</tr>
<tr>
<td>Vessel Type:</td>
<td>Polystyrene</td>
</tr>
<tr>
<td>Suggested Working:</td>
<td>Petri dish</td>
</tr>
<tr>
<td>Volume:</td>
<td>30.0-45.0 mL</td>
</tr>
<tr>
<td>Additional Features:</td>
<td>Disposable</td>
</tr>
</tbody>
</table>

Characteristics:

| Temp:                      | 37°C                  |
| Pressure:                  | 1 bar                 |
| Carbon Dioxide:            | 5%                    |
| Humidity:                  | 95%                   |
| Duration:                  | 7 days                |

Operating Conditions:

| Purchase Cost:             | 150-mm dish $188.65 case of 60 |
## T-225 Flask

**Function:** TC-Treated sterile flasks for the adherence and growth of cell cultures

**Manufacturer:** Corning

**Operation:** Semi-Continuous

<table>
<thead>
<tr>
<th>Input</th>
<th>Quantity (mL/batch)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Matrigel Matrix</td>
<td>550</td>
</tr>
<tr>
<td>DMEM/F-12</td>
<td>5500</td>
</tr>
<tr>
<td>Dispase</td>
<td>550</td>
</tr>
<tr>
<td>mTESR1 Serum</td>
<td>2200</td>
</tr>
</tbody>
</table>

**Materials Handled:**

- Input: Matrigel Matrix, DMEM/F-12, Dispase, mTESR1 Serum

**Characteristics:**

- **Model:** Corning 150mm Culture Dish
- **Material of Construction:** Polystyrene
- **Cap:** High density polyethylene
- **Vessel Type:** Rectangular flask
- **Total Volume:** 370 mL
- **Suggested Working Volume:** 45.0-67.5 mL
- **Additional Features:** Disposable

**Operating Conditions:**

- **Temp:** 37°C
- **Pressure:** 1 bar
- **Carbon Dioxide:** 5%
- **Humidity:** 95%
- **Duration:** 7 days

**Purchase Cost:**

- **T-225 flask:** $236.66 case of 25
### 9.2 Upstream Process

**Neural Induction Media Prep (P-1/V-101)**

<table>
<thead>
<tr>
<th><strong>Function:</strong></th>
<th>Stainless steal mixing tank to prepare media for conversion of hESC to NSPCs</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Manufacturer:</strong></td>
<td>Sharpsville Container</td>
</tr>
<tr>
<td><strong>Operation:</strong></td>
<td>Batch</td>
</tr>
<tr>
<td><strong>Materials Handled:</strong></td>
<td>Input STEMdiff Neural Induction Media</td>
</tr>
<tr>
<td><strong>Quantity (per batch):</strong></td>
<td>800 L</td>
</tr>
<tr>
<td><strong>Characteristics:</strong></td>
<td>Materials of Construction: Stainless Steel 316</td>
</tr>
<tr>
<td></td>
<td>Height: 1 m</td>
</tr>
<tr>
<td></td>
<td>Diameter: 1.1 m</td>
</tr>
<tr>
<td></td>
<td>Total Volume: 850 L</td>
</tr>
<tr>
<td></td>
<td>Sterilization: SIP/CIP</td>
</tr>
<tr>
<td><strong>Operating Conditions:</strong></td>
<td>Temp: 25°C</td>
</tr>
<tr>
<td></td>
<td>Pressure: 1 bar</td>
</tr>
<tr>
<td><strong>Purchase Cost:</strong></td>
<td>$56,000</td>
</tr>
</tbody>
</table>
## Differentiation Media Prep (P-2/V-103)

<table>
<thead>
<tr>
<th>Function:</th>
<th>Stainless steel mixing tank to prepare media for conversion of NSPCs to neurons</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manufacturer:</td>
<td>Sharpsville Container</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Operation:</th>
<th>Batch</th>
</tr>
</thead>
</table>

### Materials Handled:

<table>
<thead>
<tr>
<th>Input</th>
<th>Quantity (per batch)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Complete NeuronCult NS-A Differentiation Medium</td>
<td>375 L</td>
</tr>
</tbody>
</table>

### Characteristics:

<table>
<thead>
<tr>
<th>Materials of Construction:</th>
<th>Stainless Steel 316</th>
</tr>
</thead>
<tbody>
<tr>
<td>Height:</td>
<td>1 m</td>
</tr>
<tr>
<td>Diameter:</td>
<td>.75 m</td>
</tr>
<tr>
<td>Total Volume:</td>
<td>400 L</td>
</tr>
<tr>
<td>Sterilization:</td>
<td>SIP/CIP</td>
</tr>
</tbody>
</table>

### Operating Conditions:

| Temp: | 25° |
| Pressure: | 1 bar |

| Purchase Cost: | $36,000 |
**Pump (P-3/PM-101)**

<table>
<thead>
<tr>
<th>Feature</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Function:</strong></td>
<td>To transfer neural induction media from blending tank to storage tank</td>
</tr>
<tr>
<td><strong>Manufacturer:</strong></td>
<td>Watson-Marlow</td>
</tr>
<tr>
<td><strong>Operation:</strong></td>
<td>Batch</td>
</tr>
<tr>
<td>Materials Handled:</td>
<td>STEMdiff Neural Induction Media</td>
</tr>
<tr>
<td></td>
<td><strong>Quantity (per batch)</strong>: 800 L</td>
</tr>
<tr>
<td>Model:</td>
<td>620DuN/RE NEMA 4x(IP66) washdown pump</td>
</tr>
<tr>
<td>Pump Type:</td>
<td>Peristaltic</td>
</tr>
<tr>
<td>Flow Rate:</td>
<td>18.17 L/min</td>
</tr>
<tr>
<td>Power:</td>
<td>.2 kW</td>
</tr>
<tr>
<td>Sterilization:</td>
<td>SIP/CIP</td>
</tr>
<tr>
<td>Temp:</td>
<td>25°</td>
</tr>
<tr>
<td>Power:</td>
<td>.056 kW</td>
</tr>
<tr>
<td>Pressure Change:</td>
<td>25 psi</td>
</tr>
<tr>
<td><strong>Purchase Cost:</strong></td>
<td></td>
</tr>
<tr>
<td>Pump</td>
<td>$4,300</td>
</tr>
<tr>
<td>Bioprene Thermoplastic</td>
<td>$276</td>
</tr>
<tr>
<td>Elastomer Tubing 40 ft roll</td>
<td></td>
</tr>
</tbody>
</table>
**Pump (P-4/PM-102)**

<table>
<thead>
<tr>
<th><strong>Function:</strong></th>
<th>To transfer differentiation media from blending tank to storage tank</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Manufacturer:</strong></td>
<td>Watson-Marlow</td>
</tr>
<tr>
<td><strong>Operation:</strong></td>
<td>Batch</td>
</tr>
<tr>
<td><strong>Materials Handled:</strong></td>
<td>Input Complete NeuronCult NS-A Differentiation Medium</td>
</tr>
<tr>
<td><strong>Quantity (per batch):</strong></td>
<td>375 L</td>
</tr>
<tr>
<td><strong>Model:</strong></td>
<td>620DuN/RE NEMA 4x(IP66) washdown pump</td>
</tr>
<tr>
<td><strong>Pump Type:</strong></td>
<td>Peristaltic</td>
</tr>
<tr>
<td><strong>Flow Rate:</strong></td>
<td>18.17 L/min</td>
</tr>
<tr>
<td><strong>Power:</strong></td>
<td>.2 kW</td>
</tr>
<tr>
<td><strong>Sterilization:</strong></td>
<td>SIP/CIP</td>
</tr>
<tr>
<td><strong>Temp:</strong></td>
<td>25°</td>
</tr>
<tr>
<td><strong>Power:</strong></td>
<td>.056 kW</td>
</tr>
<tr>
<td><strong>Pressure Change:</strong></td>
<td>25 psi</td>
</tr>
<tr>
<td><strong>Operating Conditions:</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Purchase Cost:</strong></td>
<td>Pump $4,300</td>
</tr>
<tr>
<td>Bioprene Thermoplastic Elastomer Tubing 40 ft roll): $276</td>
<td></td>
</tr>
</tbody>
</table>
Media Storage Tank (P-5/V-102)

**Function:**
To hold the product stream from media prep tanks in preparation for differentiation of cells in first bioreactor

**Manufacturer:**
DCI Inc.

**Operation:**
Batch

**Materials Handled:**
- Complete NeuronCult NS-A Differentiation Medium
- STEMdiff Neural Induction Media

**Characteristics:**
- **Materials of Construction:** Stainless Steel 316
- **Height:** 1 m
- **Diameter:** 1.1 m
- **Total Volume:** 850 L
- **Sterilization:** SIP/CIP

**Operating Conditions:**
- **Temp:** 37°C
- **Pressure:** 1 bar

**Purchase Cost:** $79,000
## Pump (P-6/PM-103)

**Function:** To transfer media to first bioreactor  

**Manufacturer:** Watson-Marlow  

---

**Operation:** Batch  

**Input**  
- Complete NeuronCult NS-A Differentiation Medium  
- STEMdiff Neural Induction Media  

**Quantity (per batch):**  
- 375 L  
- 800 L  

**Materials Handled:**  
- Complete NeuronCult NS-A Differentiation Medium  
- STEMdiff Neural Induction Media  

**Model:** 620DuN/RE NEMA 4x(IP66) washdown pump  
**Pump Type:** Peristaltic  
**Flow Rate:** 18.17 L/min  
**Power:** .2 kW  
**Sterilization:** SIP/CIP  

**Operating Conditions:**  
- Temp: 25°  
- Power: .056 kW  
- Pressure Change: 25 psi  

---

**Purchase Cost:**  
- Pump: $4,300  
- Bioprene Thermoplastic Elastomer Tubing 40 ft roll: $276
Bioreactor (P-7/BR-101)

**Function:** Reactor for the generation of NSPCs from hESCs and differentiation into neuron, astrocytes, and oligodendrocytes

**Manufacturer:** Pall Life Sciences

**Operation:** Semi-Continuous

<table>
<thead>
<tr>
<th>Input</th>
<th>Quantity (per batch)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biomass</td>
<td>5.40 mg (hESCs)</td>
</tr>
<tr>
<td>Neural Induction Medium</td>
<td>26.65 L</td>
</tr>
<tr>
<td>Rock Inhibitor Y27632</td>
<td>85.35 mg</td>
</tr>
<tr>
<td>DMEM/F-12</td>
<td>2.09 L</td>
</tr>
<tr>
<td>Neural Rosette Reagent</td>
<td>2.09 L</td>
</tr>
<tr>
<td>PBS</td>
<td>2.09 L</td>
</tr>
<tr>
<td>Differentiation Medium</td>
<td>7.32 L</td>
</tr>
</tbody>
</table>

**Materials Handled:**

<table>
<thead>
<tr>
<th>Model</th>
<th>Custom Integrity Xpansion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vessel Type</td>
<td>Multiplate Bioreactor</td>
</tr>
<tr>
<td>Total Volume</td>
<td>2.14 L</td>
</tr>
<tr>
<td>Suggested Working Volume</td>
<td>2.09 L</td>
</tr>
<tr>
<td>Additional Features</td>
<td>Magnetic impeller</td>
</tr>
<tr>
<td><strong>Temp:</strong></td>
<td>37°C</td>
</tr>
<tr>
<td><strong>Pressure:</strong></td>
<td>1 bar</td>
</tr>
<tr>
<td><strong>Carbon Dioxide:</strong></td>
<td>5%</td>
</tr>
<tr>
<td><strong>Humidity:</strong></td>
<td>95%</td>
</tr>
<tr>
<td><strong>Duration:</strong></td>
<td>20 days</td>
</tr>
</tbody>
</table>

**Purchase Cost:**

3-L Bioreactor $75,000
9.3 Downstream Process

Pump (P-9/PM-104)

**Function:** To transfer cells and media to be purified by the lectin array

**Manufacturer:** Watson-Marlow

**Operation:** Batch

<table>
<thead>
<tr>
<th>Materials Handled</th>
<th>Quantity (per batch)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input Cells Complete NeuronCult NS-A</td>
<td>350 L</td>
</tr>
<tr>
<td>Differentiation Medium</td>
<td></td>
</tr>
</tbody>
</table>

**Characteristics:**

<table>
<thead>
<tr>
<th>Model: 620DuN/RE NEMA 4x(IP66)</th>
<th>Washdown pump</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pump Type:</td>
<td>Peristaltic</td>
</tr>
<tr>
<td>Flow Rate:</td>
<td>18.17 L/min</td>
</tr>
<tr>
<td>Power: 0.2 kW</td>
<td></td>
</tr>
<tr>
<td>Sterilization:</td>
<td>SIP/CIP</td>
</tr>
</tbody>
</table>

**Operating Conditions:**

<table>
<thead>
<tr>
<th>Temp: 25°C</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Power: 0.056 kW</td>
<td></td>
</tr>
<tr>
<td>Pressure Change: 25 psi</td>
<td></td>
</tr>
</tbody>
</table>

**Purchase Cost:**

- Pump: $4,300
- Bioprene Thermoplastic: $276
- Elastomer Tubing 40 ft roll: $276
**Lectin Array (P-10/Array)**

**Function:** To separate viable differentiated cells from undifferentiated cells

**Manufacturer:** Miltenyl Biotec

<table>
<thead>
<tr>
<th>Operation:</th>
<th>Batch</th>
</tr>
</thead>
</table>

**Materials Handled:**
- UEA-1 Lectin
- Magnetic Biotinylated beads
- Fructose Buffer

<table>
<thead>
<tr>
<th>Input</th>
<th>Quantity (per batch)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cells</td>
<td></td>
</tr>
</tbody>
</table>

**Characteristics:**
- **Model:** LS Cell Separation
- **Material of Construction:** Acrylic
- **Binding Capacity:** 1x10^8 cells per column
- **Volume of Column:** 13 ml
- **Working Flow Velocity:** 2 ml/min
- **Sterilization:** Disposable

| Operating Conditions: |
|---|---|
| Temp: | 25° |
| Pressure: | 1 bar |

**Purchase Cost:**
- LS Columns plus tubes (75 pieces) $400
### Neuron Media Prep (P-11/V-104)

<table>
<thead>
<tr>
<th><strong>Function:</strong></th>
<th>Stainless steel mixing tank to prepare media for growth of stem cells</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Manufacturer:</strong></td>
<td>Sharpsville Container</td>
</tr>
<tr>
<td><strong>Operation:</strong></td>
<td>Batch</td>
</tr>
</tbody>
</table>
| **Materials Handled:** | Input  
Basal Medium  
Quantity (per batch)  
1800 L |
| **Materials of Construction:** | Stainless Steel 316 |
| **Characteristics:** | Height:  
1.8 m  
Diameter:  
1 m  
Total Volume:  
2000 L  
Sterilization:  
SIP/CIP |
| **Operating Conditions:** | Temp:  
25°  
Pressure:  
1 bar |
| **Purchase Cost:** | $94,000 |
Pump (P-12/PM-105)

<table>
<thead>
<tr>
<th>Function:</th>
<th>To transfer Basal Medium from the blending tank to be filtered</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manufacturer:</td>
<td>Watson-Marlow</td>
</tr>
</tbody>
</table>

| Operation:           | Batch                                                        |

| Materials Handled:   | Input Basal Medium                                           |
|                      | Quantity (per batch) 1800 L                                  |

| Characteristics:     | Model: 620DuN/RE NEMA 4x(IP66) washdown pump Peristaltic     |
|                      | Pump Type: Peristaltic                                       |
|                      | Flow Rate: 18.17 L/min                                      |
|                      | Power: .2 kW                                                |
|                      | Sterilization: SIP/CIP                                      |

| Operating Conditions:| Temp: 25°                                                   |
|                      | Power: .056 kW                                             |
|                      | Pressure Change: 25 psi                                     |

| Purchase Cost:       | Pump $4,300                                                 |
|                      | Bioprene Thermoplastic $276                                 |
|                      | Elastomer Tubing 40 ft roll: $276                           |
Media Filtration (P-13/DE-101)

**Function:** To remove contaminants from media stream

**Manufacturer:** Sartorious Stedim

**Operation:** Batch

**Materials Handled:**
- **Input:** Basal Medium
  - **Quantity (per batch):** 1800 L

**Characteristics:**
- **Model:** Sartopure GF Plus MaxiCaps Filter Capsules
- **Filter type:** 1.2 μm
- **Filter Size:** 2 m²
- **Filter Area:** Glass Fibers
- **Filter Material:** 20°C and 4 bar or 50°C and 3 bar
- **Maximum Pressure Differential:** Autoclave

**Operating Conditions:**
- **Temp:** 25°C
- **Pressure:** 1 bar

**Purchase Cost:**
- Sartopure GF Plus MaxiCaps $723
## Pump (P-14/PM-106)

<table>
<thead>
<tr>
<th><strong>Function:</strong></th>
<th>To transfer Basal Medium from the filter to a holding tank</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Manufacturer:</strong></td>
<td>Watson-Marlow</td>
</tr>
<tr>
<td><strong>Operation:</strong></td>
<td>Batch</td>
</tr>
<tr>
<td><strong>Materials Handled:</strong></td>
<td></td>
</tr>
<tr>
<td>Input</td>
<td>Basal Medium</td>
</tr>
<tr>
<td><strong>Characteristics:</strong></td>
<td></td>
</tr>
<tr>
<td>Model:</td>
<td>620DuN/RE NEMA 4x(IP66) washdown pump</td>
</tr>
<tr>
<td>Pump Type:</td>
<td>Peristaltic</td>
</tr>
<tr>
<td>Flow Rate:</td>
<td>18.17 L/min</td>
</tr>
<tr>
<td>Power:</td>
<td>.2 kW</td>
</tr>
<tr>
<td>Sterilization:</td>
<td>SIP/CIP</td>
</tr>
<tr>
<td><strong>Operating Conditions:</strong></td>
<td></td>
</tr>
<tr>
<td>Temp:</td>
<td>25°</td>
</tr>
<tr>
<td>Power:</td>
<td>.056 kW</td>
</tr>
<tr>
<td>Pressure Change:</td>
<td>25 psi</td>
</tr>
<tr>
<td><strong>Purchase Cost:</strong></td>
<td></td>
</tr>
<tr>
<td>Pump</td>
<td>$4,300</td>
</tr>
<tr>
<td>Bioprene Thermoplastic</td>
<td>$276</td>
</tr>
<tr>
<td>Elastomer Tubing 40 ft roll):</td>
<td></td>
</tr>
</tbody>
</table>
## Large Media Storage Tank (P-15/V-105)

<table>
<thead>
<tr>
<th><strong>Function:</strong></th>
<th>To hold the product stream of basal medium from the filter for use by the bioreactors</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Manufacturer:</strong></td>
<td>DCI Inc.</td>
</tr>
<tr>
<td><strong>Operation:</strong></td>
<td>Batch</td>
</tr>
<tr>
<td><strong>Materials Handled:</strong></td>
<td><strong>Input</strong>&lt;br&gt;Basal Medium</td>
</tr>
<tr>
<td><strong>Characteristics:</strong></td>
<td><strong>Materials of Construction:</strong> Stainless Steel 316</td>
</tr>
<tr>
<td></td>
<td><strong>Height:</strong> 0.8 m</td>
</tr>
<tr>
<td></td>
<td><strong>Diameter:</strong> 0.6 m</td>
</tr>
<tr>
<td></td>
<td><strong>Total Volume:</strong> 200 L</td>
</tr>
<tr>
<td></td>
<td><strong>Sterilization:</strong> SIP/CIP</td>
</tr>
<tr>
<td><strong>Operating Conditions:</strong></td>
<td><strong>Temp:</strong> 25°</td>
</tr>
<tr>
<td></td>
<td><strong>Pressure:</strong> 1 bar</td>
</tr>
<tr>
<td><strong>Purchase Cost:</strong></td>
<td>$34,000</td>
</tr>
</tbody>
</table>
Pump (P-16/PM-107)

<table>
<thead>
<tr>
<th>Function:</th>
<th>To transfer Basal Medium from the holding tank to a 3 L bioreactor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manufacturer:</td>
<td>Watson-Marlow</td>
</tr>
<tr>
<td>Operation:</td>
<td>Batch</td>
</tr>
<tr>
<td>Materials Handled:</td>
<td>Input Basal Medium Quantity (per batch) 1800 L</td>
</tr>
<tr>
<td>Model:</td>
<td>620DuN/RE NEMA 4x(IP66) washdown pump</td>
</tr>
<tr>
<td>Pump Type:</td>
<td>Peristaltic</td>
</tr>
<tr>
<td>Flow Rate:</td>
<td>18.17 L/min</td>
</tr>
<tr>
<td>Power:</td>
<td>.2 kW</td>
</tr>
<tr>
<td>Sterilization:</td>
<td>SIP/CIP</td>
</tr>
<tr>
<td>Temp:</td>
<td>25°</td>
</tr>
<tr>
<td>Power:</td>
<td>.056 kW</td>
</tr>
<tr>
<td>Pressure Change:</td>
<td>25 psi</td>
</tr>
<tr>
<td>Purchase Cost:</td>
<td>pump $4,300, Bioprene Thermoplastic $276, Bioprene Tubing 40 ft roll):</td>
</tr>
</tbody>
</table>


Small Media Mixing Tank (P-17/V-106)

<table>
<thead>
<tr>
<th>Function:</th>
<th>Stainless steel mixing tank to prepare media for growth of stem cells</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manufacturer:</td>
<td>Sharpsville Container</td>
</tr>
<tr>
<td>Operation:</td>
<td>Batch</td>
</tr>
<tr>
<td>Materials Handled:</td>
<td></td>
</tr>
<tr>
<td>Input</td>
<td></td>
</tr>
<tr>
<td>Cells</td>
<td></td>
</tr>
<tr>
<td>Basal Medium</td>
<td></td>
</tr>
<tr>
<td>B-27 Supplement</td>
<td></td>
</tr>
<tr>
<td>Glutamax</td>
<td></td>
</tr>
<tr>
<td>Quantity (per batch)</td>
<td></td>
</tr>
<tr>
<td>Materials of Construction:</td>
<td>Stainless Steel 316</td>
</tr>
<tr>
<td>Height</td>
<td>0.6 m</td>
</tr>
<tr>
<td>Diameter</td>
<td>0.5 m</td>
</tr>
<tr>
<td>Total Volume</td>
<td>100 L</td>
</tr>
<tr>
<td>Sterilization</td>
<td>SIP/CIP</td>
</tr>
<tr>
<td>Temp</td>
<td>25°</td>
</tr>
<tr>
<td>Pressure</td>
<td>1 bar</td>
</tr>
<tr>
<td>Purchase Cost</td>
<td>$16,000</td>
</tr>
</tbody>
</table>
**Pump (P-18/PM-108)**

**Function:** To transfer Basal Medium from the holding tank to a 3 L bioreactor

**Manufacturer:** Watson-Marlow

---

**Operation:**

<table>
<thead>
<tr>
<th>Materials Handled</th>
<th>Quantity (per batch)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input</td>
<td>Basal Medium</td>
</tr>
</tbody>
</table>

**Characteristics:**

<table>
<thead>
<tr>
<th>Model:</th>
<th>620DuN/RE NEMA 4x(IP66) washdown pump</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pump Type:</td>
<td>Peristaltic</td>
</tr>
<tr>
<td>Flow Rate:</td>
<td>18.17 L/min</td>
</tr>
<tr>
<td>Power:</td>
<td>.2 kW</td>
</tr>
<tr>
<td>Sterilization:</td>
<td>SIP/CIP</td>
</tr>
</tbody>
</table>

**Operating Conditions:**

<table>
<thead>
<tr>
<th>Temp:</th>
<th>25°C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power:</td>
<td>.056 kW</td>
</tr>
<tr>
<td>Pressure Change:</td>
<td>25 psi</td>
</tr>
</tbody>
</table>

**Purchase Cost:**

<table>
<thead>
<tr>
<th>Item</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pump</td>
<td>$4,300</td>
</tr>
<tr>
<td>Bioprene Thermoplastic</td>
<td>$276</td>
</tr>
<tr>
<td>Elastomer Tubing 40 ft roll)</td>
<td></td>
</tr>
</tbody>
</table>
### Pump (P-19/PM-109)

<table>
<thead>
<tr>
<th><strong>Function:</strong></th>
<th>To transfer Basal Medium from the holding tank to a 17 L bioreactor</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Manufacturer:</strong></td>
<td>Watson-Marlow</td>
</tr>
<tr>
<td><strong>Operation:</strong></td>
<td>Batch</td>
</tr>
<tr>
<td><strong>Materials Handled:</strong></td>
<td>Input: Basal Medium, Quantity (per batch): L</td>
</tr>
<tr>
<td><strong>Model:</strong></td>
<td>620DuN/RE NEMA 4x(IP66)</td>
</tr>
<tr>
<td><strong>Pump Type:</strong></td>
<td>washdown pump, Peristaltic</td>
</tr>
<tr>
<td><strong>Flow Rate:</strong></td>
<td>18.17 L/min</td>
</tr>
<tr>
<td><strong>Power:</strong></td>
<td>.2 kW</td>
</tr>
<tr>
<td><strong>Sterilization:</strong></td>
<td>SIP/CIP</td>
</tr>
<tr>
<td><strong>Temp:</strong></td>
<td>25°</td>
</tr>
<tr>
<td><strong>Power:</strong></td>
<td>.056 kW</td>
</tr>
<tr>
<td><strong>Pressure Change:</strong></td>
<td>25 psi</td>
</tr>
<tr>
<td><strong>Operating Conditions:</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Purchase Cost:</strong></td>
<td>Pump: $4,300, Bioprene Thermoplastic Elastomer Tubing 40 ft roll): $276</td>
</tr>
</tbody>
</table>
## Pump (P-20/PM-110)

<table>
<thead>
<tr>
<th>Function:</th>
<th>To transfer Basal Medium from the holding tank to a 17 L bioreactor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manufacturer:</td>
<td>Watson-Marlow</td>
</tr>
<tr>
<td>Operation:</td>
<td>Batch</td>
</tr>
<tr>
<td>Materials Handled:</td>
<td><strong>Input</strong></td>
</tr>
<tr>
<td></td>
<td>Basal Medium</td>
</tr>
<tr>
<td></td>
<td><strong>Quantity (per batch)</strong></td>
</tr>
<tr>
<td></td>
<td>L</td>
</tr>
<tr>
<td>Characteristics:</td>
<td><strong>Model:</strong> 620DuN/RE NEMA 4x(IP66) washdown pump</td>
</tr>
<tr>
<td></td>
<td><strong>Pump Type:</strong> Peristaltic</td>
</tr>
<tr>
<td></td>
<td><strong>Flow Rate:</strong> 18.17 L/min</td>
</tr>
<tr>
<td></td>
<td><strong>Power:</strong> 0.2 kW</td>
</tr>
<tr>
<td></td>
<td><strong>Sterilization:</strong> SIP/CIP</td>
</tr>
<tr>
<td><strong>Operating Conditions:</strong></td>
<td><strong>Temp:</strong> 25°C</td>
</tr>
<tr>
<td></td>
<td><strong>Power:</strong> 0.056 kW</td>
</tr>
<tr>
<td></td>
<td><strong>Pressure Change:</strong> 25 psi</td>
</tr>
<tr>
<td><strong>Purchase Cost:</strong></td>
<td><strong>Pump</strong> $4,300</td>
</tr>
<tr>
<td></td>
<td><strong>Bioprene Thermoplastic</strong></td>
</tr>
<tr>
<td></td>
<td>$276</td>
</tr>
<tr>
<td></td>
<td><strong>Elastomer Tubing 40 ft roll)</strong></td>
</tr>
</tbody>
</table>
Bioreactor (P-21/BR-102)

**Function:** Reactor for the growth and scale-up of neuronal cell cultures

**Manufacturer:** Pall Life Sciences

<table>
<thead>
<tr>
<th>Operation:</th>
<th>Semi-Continuous</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input</td>
<td>Quantity (per batch)</td>
</tr>
<tr>
<td>Biomass</td>
<td>5.40 mg (neuronal cells)</td>
</tr>
<tr>
<td>Neuronal Basal Medium</td>
<td>3.43 L</td>
</tr>
<tr>
<td>B27 Supplement</td>
<td>0.07 L</td>
</tr>
<tr>
<td>Glutamax</td>
<td>0.69 L</td>
</tr>
</tbody>
</table>

**Materials Handled:**

| Model: | Custom Integrity Xpansion |
| Vessel Type: | 19-Plate Multiplate Bioreactor |

**Characteristics:**

| Total Volume: | 2.14 L |
| Suggested Working Volume: | 2.09 L |
| Additional Features: | Magnetic impeller |

| Temp: | 37° |
| Pressure: | 1 bar |

**Operating Conditions:**

| Dissolved Oxygen: | > 4% |
| pH: | 7.0 |
| Duration: | 16 days |

**Purchase Cost:**

| 3-L Bioreactor | $75,000 |
### Bioreactor (P-22/BR-104)

**Function:** Reactor for the growth and scale-up of neuronal cell cultures  

**Manufacturer:** Pall Life Sciences  

**Operation:** Semi-Continuous  

<table>
<thead>
<tr>
<th>Input</th>
<th>Quantity (per batch)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biomass</td>
<td>86.40 mg (neuronal cells)</td>
</tr>
<tr>
<td>Neuronal Basal Medium</td>
<td>26.55 L</td>
</tr>
<tr>
<td>B27 Supplement</td>
<td>0.53 L</td>
</tr>
<tr>
<td>Glutamax</td>
<td>5.31 L</td>
</tr>
</tbody>
</table>

**Materials Handled:**  

| Model:                 | Custom Integrity Xpansion |
| Vessel Type:           | 147-Plate Multiplate Bioreactor |
| Total Volume:          | 16.19 L                   |
| Suggested Working Volume: | 16.24 L              |
| Additional Features:   | Magnetic impeller        |

**Characteristics:**  

| Temp:                  | 37°C                  |
| Pressure:              | 1 bar                 |
| Operating Conditions:  |                       |
| Dissolved Oxygen:      | > 4%                  |
| pH:                    | 7.0                   |
| Duration:              | 16 days               |

**Purchase Cost:**  

| 17-L Bioreactor        | $100,000              |
Bioreactor (P-23/BR-103)

**Function:** Reactor for the growth and scale-up of neuronal cell cultures

**Manufacturer:** Pall Life Sciences

**Operation:** Semi-Continuous

<table>
<thead>
<tr>
<th>Input</th>
<th>Quantity (per batch)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biomass</td>
<td>86.40 mg (neuronal cells)</td>
</tr>
<tr>
<td>Neuronal Basal Medium</td>
<td>26.55 L</td>
</tr>
<tr>
<td>B27 Supplement</td>
<td>0.53 L</td>
</tr>
<tr>
<td>Glutamax</td>
<td>5.31 L</td>
</tr>
</tbody>
</table>

**Materials Handled:**

**Characteristics:**

- **Model:** Custom Integrity Xpansion
- **Vessel Type:** 147-Plate Multiplate Bioreactor
- **Total Volume:** 16.19 L
- **Suggested Working Volume:** 16.24 L
- **Additional Features:** Magnetic impeller

| Temp:     | 37°                  |
| Pressure: | 1 bar                |
| Dissolved Oxygen: | > 4%              |
| pH:       | 7.0                  |
| Duration: | 16 days              |

**Operating Conditions:**

**Purchase Cost:**

- **17-L Bioreactor** $100,000
## Pump (P-24/PM-111)

**Function:**
To transfer Basal Medium from the 3 L bioreactor to the filter

**Manufacturer:**
Watson-Marlow

### Operation:
Batch

### Materials Handled:

<table>
<thead>
<tr>
<th>Input</th>
<th>Quantity (per batch)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basal Medium</td>
<td>L</td>
</tr>
</tbody>
</table>

### Characteristics:

<table>
<thead>
<tr>
<th>Model:</th>
<th>620DuN/RE NEMA 4x(IP66) washdown pump</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pump Type:</td>
<td>Peristaltic</td>
</tr>
<tr>
<td>Flow Rate:</td>
<td>18.17 L/min</td>
</tr>
<tr>
<td>Power:</td>
<td>.2 kW</td>
</tr>
<tr>
<td>Sterilization:</td>
<td>SIP/CIP</td>
</tr>
</tbody>
</table>

### Operating Conditions:

| Temp:             | 25°                                     |
| Power:            | .056 kW                                 |
| Pressure Change:  | 25 psi                                  |

### Purchase Cost:

- **Pump:** $4,300
- **Bioprene Thermoplastic Elastomer Tubing 40 ft roll:** $276
## Pump (P-25/PM-112)

**Function:** To transfer Basal Medium from the 17 L bioreactor to the filter

**Manufacturer:** Watson-Marlow

<table>
<thead>
<tr>
<th>Operation:</th>
<th>Batch</th>
</tr>
</thead>
<tbody>
<tr>
<td>Materials Handled:</td>
<td>Input Basal Medium</td>
</tr>
<tr>
<td><strong>Characteristics:</strong></td>
<td><strong>Model:</strong> 620DuN/RE NEMA 4x(IP66) washdown pump</td>
</tr>
<tr>
<td></td>
<td><strong>Pump Type:</strong> Peristaltic</td>
</tr>
<tr>
<td></td>
<td><strong>Flow Rate:</strong> 18.17 L/min</td>
</tr>
<tr>
<td></td>
<td><strong>Power:</strong> .2 kW</td>
</tr>
<tr>
<td></td>
<td><strong>Sterilization:</strong> SIP/CIP</td>
</tr>
<tr>
<td><strong>Operating Conditions:</strong></td>
<td><strong>Temp:</strong> 25°</td>
</tr>
<tr>
<td></td>
<td><strong>Power:</strong> .056 kW</td>
</tr>
<tr>
<td></td>
<td><strong>Pressure Change:</strong> 25 psi</td>
</tr>
</tbody>
</table>

**Purchase Cost:**
- Pump: $4,300
- Bioprene Thermoplastic: $276
- Elastomer Tubing 40 ft roll: $276
### Pump (P-26/PM-113)

**Function:** To transfer Basal Medium from the 17 L bioreactor to the filter

**Manufacturer:** Watson-Marlow

**Operation:** Batch

<table>
<thead>
<tr>
<th>Materials Handled</th>
<th>Input</th>
<th>Basal Medium</th>
</tr>
</thead>
</table>

**Characteristics:**

<table>
<thead>
<tr>
<th>Model</th>
<th>620DuN/RE NEMA 4x(IP66) washdown pump</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pump Type</td>
<td>Peristaltic</td>
</tr>
<tr>
<td>Flow Rate</td>
<td>18.17 L/min</td>
</tr>
<tr>
<td>Power</td>
<td>.2 kW</td>
</tr>
<tr>
<td>Sterilization</td>
<td>SIP/CIP</td>
</tr>
</tbody>
</table>

**Operating Conditions:**

<table>
<thead>
<tr>
<th>Temp</th>
<th>25°</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power</td>
<td>.056 kW</td>
</tr>
<tr>
<td>Pressure Change</td>
<td>25 psi</td>
</tr>
</tbody>
</table>

**Purchase Cost:**

<table>
<thead>
<tr>
<th>Pump</th>
<th>$4,300</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bioprene Thermoplastic Tubing 40 ft roll</td>
<td>$276</td>
</tr>
</tbody>
</table>
Vitrification Solution 1 Mixing Tank (Not Pictured)

Function: Stainless steel mixing tank to prepare the first vitrification solution for cryopreservation of cells

Manufacturer: Sharpsville Container

Operation: Batch

Materials Handled:

<table>
<thead>
<tr>
<th>Input</th>
<th>Quantity (per batch)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ethylene glycol</td>
<td>1 L</td>
</tr>
<tr>
<td>DMSO</td>
<td>1 L</td>
</tr>
<tr>
<td>Basal Medium</td>
<td>8 L</td>
</tr>
</tbody>
</table>

Materials of Construction: Stainless Steel 316
Height: 0.6 m
Diameter: 0.5 m
Total Volume: 15 L
Sterilization: SIP/CIP

Operating Conditions:
Temp: 25°
Pressure: 1 bar

Purchase Cost: $5,100
### Vitrification Solution 2 Mixing Tank (Not Pictured)

**Function:** Stainless steel mixing tank to prepare the first vitrification solution for cryopreservation of cells

**Manufacturer:** Sharpsville Container

**Operation:** Batch

<table>
<thead>
<tr>
<th>Input</th>
<th>Quantity (per batch)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ethylene glycol</td>
<td>2 L</td>
</tr>
<tr>
<td>DMSO</td>
<td>2 L</td>
</tr>
<tr>
<td>Basal Medium</td>
<td>6 L</td>
</tr>
<tr>
<td>Sucrose</td>
<td>1.711 kg</td>
</tr>
</tbody>
</table>

**Materials Handled:**
- Ethylene glycol: 2 L
- DMSO: 2 L
- Basal Medium: 6 L
- Sucrose: 1.711 kg

**Characteristics:**
- Materials of Construction: Stainless Steel 316
- Height: 0.4 m
- Diameter: 0.3 m
- Total Volume: 15 L
- Sterilization: SIP/CIP
- Temp: 25°
- Pressure: 1 bar

**Operating Conditions:**

**Purchase Cost:** $5,100
Recycled Media Filtration (P-28/MF-101)

**Function:**
To remove contaminants from recycled media stream

**Manufacturer:**
Sartorius Stedim

**Operation:**
Batch

<table>
<thead>
<tr>
<th>Materials Handled</th>
<th>Input</th>
<th>Quantity (per batch)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basal Medium</td>
<td>180 L</td>
<td></td>
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</table>

**Characteristics:**

<table>
<thead>
<tr>
<th>Model:</th>
<th>Sartopure GF Plus MaxiCaps</th>
</tr>
</thead>
<tbody>
<tr>
<td>Filter type:</td>
<td>Filter Capsules</td>
</tr>
<tr>
<td>Filter Size:</td>
<td>1.2 µm</td>
</tr>
<tr>
<td>Filter Area:</td>
<td>.4 m²</td>
</tr>
<tr>
<td>Filter Material:</td>
<td>Glass Fibers</td>
</tr>
<tr>
<td>Temperature:</td>
<td>25°C</td>
</tr>
<tr>
<td>Pressure:</td>
<td>1 bar</td>
</tr>
</tbody>
</table>

**Operating Conditions:**

| Sterilization:       | Autoclave                   |

**Purchase Cost:**
Sartopure GF Plus MaxiCaps  $536
**Pump (P-29/PM-114)**

<table>
<thead>
<tr>
<th>Function:</th>
<th>To transfer Basal Medium from the 17 L bioreactor to the filter</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manufacturer:</td>
<td>Watson-Marlow</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Operation:</th>
<th>Batch</th>
</tr>
</thead>
<tbody>
<tr>
<td>Materials Handled:</td>
<td>Input Basal Medium</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Characteristics:</th>
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</thead>
<tbody>
<tr>
<td>Model:</td>
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<tr>
<td>Pump Type:</td>
</tr>
<tr>
<td>Flow Rate:</td>
</tr>
<tr>
<td>Power:</td>
</tr>
<tr>
<td>Sterilization:</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Operating Conditions:</th>
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</thead>
<tbody>
<tr>
<td>Temp:</td>
</tr>
<tr>
<td>Power:</td>
</tr>
<tr>
<td>Pressure Change:</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Purchase Cost:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pump</td>
</tr>
<tr>
<td>Bioprene Thermoplastic Elastomer Tubing 40 ft roll)</td>
</tr>
</tbody>
</table>
10.0 Important Considerations

10.1 Scheduling

<table>
<thead>
<tr>
<th>Day</th>
<th>BR-103</th>
<th>BR-104</th>
<th>BR-102</th>
<th>Lectin Array</th>
<th>BR-101</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

Legend:
- BR-103
- BR-104
- BR-102
- Lectin Array
- BR-101
10.2 Environmental Concerns

As stated under "Ethical Concerns," this regeneration therapy is classified as a biologics drug. Accordingly, there are environmental issues relating to disposal of biological waste. This waste must be properly stored, collected, transported, and disposed of. The facility is located in Massachusetts and thus will follow the guidelines for generation, storage, and disposal of biological waste governed by the Department of Public Health regulation 105 CMR 480: "Minimum Requirements for Medical or Biological Waste (State Sanitary Code Chapter VIII)." Biological agents must be segregated, ensuring that waste that requires incineration is not mixed with plastics and glasses. Additionally, biologics waste must be separated from chemical and other laboratory trash. This waste is sterilized and disinfected. The waste must be properly labeled with a biohazard symbol or a label indicating nonhazardous biological waste. In terms of handling and transportation, properly trained personnel are responsible for transport of the waste to an incinerator or dumpster. Records are maintained to collect information regarding the date, amount, and method of treatment.

10.3 Current Good Manufacturing Practices

Current Good Manufacturing Practice (cGMP) refers to the regulations enforced by the FDA to ensure the safety, purity, and efficacy of products intended for human use. GMP is a recognize term worldwide for the administration and quality control testing of pharmaceutical and biological products. This practice is held to very high standards by the FDA. For stem cell production, FDA guidance is contained with the "Draft Guidance for Reviewers: Instructions and Template for Chemistry, Manufacturing, and Control (CMC) Reviewers of Human Somatic Cell Therapy for Investigational New Drug Application." These guidelines are applied to every aspect of the manufacturing process (e.g. buildings, staff training, materials, unit operations, and control systems). Raw materials must be traceable, and the entire process - from isolation of the cells to freezing and storage - must follow standard operating procedures. GMP is beneficial in that it ensures quality and makes certain that the cells are manufactured in a reproducible manner.

Since the regeneration therapy will be administered to humans, sterility is of the utmost concern and contamination of the product must be avoided. The stem cells used in the therapy are to be cultured and expanded in a cleanroom under the International Standard Organization
(ISO) class 7, which is the most frequently used ISO specification. The cleanroom facility is designed to minimize the risk of cross-contamination by incorporating unidirectional traffic flow, HEPA-filtered air, and complete exhaust through dedicated ducts of the bio-safety cabinets. Additionally, animal products are avoided for use in the culture process in order to prevent possible immune reactions and infection risks; the culture media does not contain animal substances and feeder cells. The culture matrix meets standards, and the components of the media for culturing and cryopreservation are validated by the GMP quality system.

10.4 Ethical Considerations

This spinal-cord injury, regeneration therapy employs human embryonic stem cells (hESCs). Although the cells are termed "embryonic," those used in the facility will not be derived from human fetuses but rather recovered at birth from the umbilical cord. Once the umbilical cord is cut, the cord blood and tissue is either discarded as medical waste or the remaining blood is collected by syringing out the placenta. Cord blood is a rich source of stem cells and has been used in the treatment of more than eighty diseases including various types of cancer, bone marrow failure syndromes, blood disorders, metabolic disorders, and immunodeficiencies.

When stem cells are derived through the destruction of human embryos, there are considerable ethical issues associated with the moral value of human life. On the other hand, the collection, storage, and usage of cord blood stem cells is not considered controversial. The St. Louis Review provides the following definition for embryonic stem cells derived from human embryos: “derived from fertilized human eggs, their use is against Church teaching. The Church opposes embryonic stem-cell research because harvesting these stem cells kills the living human embryo.” The St. Louis Review definition for stem cells derived from cord blood is as follows: "an ethical source of stem cells found in the umbilical cord after the routine delivery of newborn babies that can be used to treat more than 80 diseases, including leukemia and lymphoma. Cord-blood stem cells are considered adult stem cells, as they are obtained from a developed individual and no one is harmed in the process of obtaining them. Stem cells from cord blood have been accepted as a treatment option for many diseases. The Catholic Church is not opposed to stem cells obtained from adult tissue, bone marrow, muscle, fat, nerves and similar sources."
Aside from the deficiency of ethical concerns, there are additional advantages associated with the use of umbilical cord blood cells. Firstly, umbilical cord blood cells are relatively inexpensive to acquire and readily available. Further, these cells do not induce significant immune responses and there is a low chance of infection associated with their use. Once cord blood is collected, it is cryopreserved and stored in a cord blood bank. Cord blood is regulated under the Federal Food, Drug, and Cosmetic Act and the Public Health Services Act as a biologic drug. It is different from a pharmaceutical drug in that each unit of cord blood collected has its own unique biologic features. As of October 2011, licensing requirements have been associated with current umbilical cord blood usage require collection by a cord blood bank that maintains a biologics drug license.

Geron Corporation™, a biotechnology company based in California, had developed a stem cell treatment for spinal cord injuries. Their treatment, however, used human embryonic stem cells derived from human embryos. As a result of the associated ethical problems, it took the company over a year to obtain approval from the FDA for human trials and trials ended up being challenging and costly. The company ceased its clinical trial in 2011 to shifts its focus on less expensive cancer therapies. The midsize biotechnology company hopes to readdress the development of a stem cell therapy for spinal cord injuries with its use of umbilical cord blood cells (Krassowska, 2011).

10.5 Laboratory and Production Facility

The figure below depicts the floor plan for the stem cell production facility. This facility will contain multiple production suites and ISO class 7 cleanrooms, a laboratory for GMP testing, quality control, multiple storage spaces, and offices. The production suites will be used for culturing and expansion of the neural stem progenitor cells. The testing facility will provide support for product testing and incubation of samples for environmental inspection. As dictated by cGMP production of substances used for clinical trials, the facility is designed to minimize contamination through the use of air handling systems and specialized finishes for ceilings, walls, and floors. There will be a negative pressure gowns entry room for entry into the stem cell facility.
11.0 Market Analysis

Currently, there is no market value price for neural stem cell therapy, since neurons produced from hESCs have never been commercialized before. This product has yet to complete its clinical trials phase, and thus no estimate is available to directly compare the cost of another therapy to the one in this proposal. There are current stem cell therapies being sold in other countries, such as a stem cell therapy in China, costing around $26,500. This cost does not include the cost of travel and living for the extended family during the month that is required for treatment (Griffin, 2009). This treatment is relatively inexpensive, and many American researchers caution those travelling overseas for treatment, since the FDA has not approved it. Another study done in the United States that used reprogrammed adult stem cells estimated that the treatment would cost $512,000 for one stem cell treatment. This estimate, although preliminary and not likely reliable, would be a huge obstacle to overcome and would put lots of stress on health care company budgets (Jensen, 2013). It is obvious from these two findings that the price of a stem cell treatment being administered in the U.S. is unknown and further market research is needed to identify the price point.

In order to best analyze if this therapy would be a more cost effective option, the current treatment for spinal cord injuries was analyzed. The costs endured include frequent physical therapy visits, wheelchair accommodations, a possible home attendant, health care, etc. A study was done on the yearly expenses attributable to spinal cord injuries. As shown in Table 10.a, the results vary greatly according to the severity of injury (“Spinal Cord Injury Facts and Figures”, 2009).

<table>
<thead>
<tr>
<th>Severity of Injury</th>
<th>Average Yearly Expenses (in 2008 dollars)</th>
<th>Estimated Lifetime Costs by Age At Injury (discounted at 2%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>First Year</td>
<td>Each Subsequent Year</td>
</tr>
<tr>
<td>High Tetraplegia (C1-C4)</td>
<td>$801,161</td>
<td>$143,507</td>
</tr>
<tr>
<td>Low Tetraplegia (C5-C8)</td>
<td>$517,356</td>
<td>$58,783</td>
</tr>
<tr>
<td>Paraplegia</td>
<td>$292,740</td>
<td>$29,789</td>
</tr>
<tr>
<td>Incomplete Motor Functional at Any Level</td>
<td>$236,109</td>
<td>$16,547</td>
</tr>
</tbody>
</table>

Table 10.a Average Yearly Expenses of Spinal Cord Injury Patient. This table shows how much money a person with a spinal cord injury must pay over the course of their lifetime due to various medical costs.

The figures in the table do not include any indirect costs such as losses in wages, fringe benefits, and productivity, which in December 2008, averaged out at around $64,443 per year.
This figure also varies substantially because it is based on previous education and employment, although more than half of persons with a spinal cord injury report being employed at the time of their injury. Regardless of age or type of injury, victims of spinal cord injuries are often paying upwards of $1,000,000 over their lifetime. These costs were used as a benchmark for profitability analysis.

Although this data can be compared to the price of the neural stem cell therapy it is not a perfect comparison. Patients who undergo the therapy will still need to pay the cost of continued physical therapy and other expenditures once the dosage has been administered. Due to the fact that these costs cannot be separated out, and that the level of success of the therapy on each person will vary, it is difficult to get an accurate standard to compare costs.

The cost of this therapy would likely be around $45,000 per dose. The facility is capable of outputting $2 \times 10^{12}$ cells per year at full capacity. This translates into the facility supplying 13,312 doses (approximately 10,000 patients), yielding revenues of $599,040,000 per year.

Expecting to run at maximum capacity in the first year is a very unreasonable assumption, as there are many factors that can potentially have negative effects on production capacity and sales in the market. Varying yields of stem cells for each batch will be a big contributor to adversely affect production capacity. The process is expected to have a 20% yield after preservation, yet undoubtedly there will be faulty batches during the year. Also, the demand for this product is unknown. This therapy is extremely new, and it will be unknown whether people are going to be willing to take on the financial risk for a therapy that cannot guarantee results for all patients. Although the flexible working capacity and the ability to quickly add or remove bioreactors may lead to smaller production sizes at times, it can also allow for the facility to capture the largest market share possible. As a result, it is estimated that the plant will be working at 50% capacity during the early years. This will be for production of stem cells to supply the clinical trials and early adopters of this therapy. Eventually, the plant will be running at 90% to meet the demand for this life-changing therapy.

11.1 Profitability Analysis

In order to analyze the profitability of the investment into this stem cell production facility, it was necessary to evaluate the net present value (NPV), internal rate of return (IRR),
and return on investment (ROI). These calculations were explained in *Product and Process Design Principles*. The profitability analysis results can be seen in Appendix D.

11.2 Facility Life

The facility is designed to withstand the changing field of stem cell research. This allows the life of the facility to be slightly longer than the average 5-year life of a biopharmaceutical plant. The facility will be the first of its kind to mass-produce stem cells, yielding enough for 10,000 treatments per year. The need for a plant to be able to produce stem cells on a large scale is a necessity for the commercialization of this therapy, and this facility will capitalize on this need. It can be expected that the number of patients wanting this stem cell therapy treatment will be low in the early years, but increase rapidly once the treatment has been proven as safe and effective. The facility is capable of adjusting for this market expansion, by adding additional reactors. The relatively small size of the reactors allow for little infrastructure change to the facility when new cycles are added to production. Also, the design of the plant and the bioreactor allow for different types of stem cells to be grown, increasing its overall biopharmaceutical market share. This therefore increases the overall life of the plant and decreases pressure to cut costs. Mr. Edward Steve suggested that 10 years would be a safe assumption for this type of biopharmaceutical plant, and thus the profitability analysis was done using a 10-year projection.

11.3 Equipment and Material Costs

The equipment and material costs were determined by first researching the type of equipment used in small-scale production of stem cells. Once determined, various vendors were contacted for information on specific equipment costs. Due to the fact that some of the equipment is explicitly used for small-scale production, and is not available at this time for a large-scale stem cell facility, Mr. Edward Steve suggested using the six-tenths rule in order to most accurately estimate the cost of the larger equipment. Since the bioreactor is unique to the process and has never before been produced commercially, it was necessary to estimate the cost based on the cost of the ATMI Integrity Expansion™ reactor. Finally, some of the equipment in the process is customized to the specific needs of the plant, such as automated robots that
separated a large batch of cells and medium into smaller vials. These exact costs could not be found due to the specialization of the equipment, but were based off already existing equipment that was similar. Bare module factors were factored in to the equipment costs when not provided by vendors, and these values were found in Chapter 22 of Product and Process Control Principles. It was advised that these factors might be high due to differences between the biopharmaceutical industry and a more industrial industry. It was analyzed that using these estimated bare module factors would under-estimate the NPV of the investment, and thus only reflect a more profitable venture. The costs of all of the equipment and materials used in the facility can be found in Appendix D of this report.

11.4 Total Permanent Investment

The total permanent investment of a project includes one-time costs such as site preparations, service facilities, contingencies, cost of the land, and the plant startup. Product and Process Design Principles provided information for investment allocation and profitability analysis. Also, to stay within the scope of this project, all costs were assumed to be included within the first year of production after the design year. These values can be found in Appendix D of this report.

11.5 Working Capital

The working capital of a project measures a facility’s efficiency and is calculated by taking the company’s current assets and subtracting its current liabilities. As shown in Appendix D, the working capital includes cash reserves, inventory, and accounts receivable. For the profitability analysis on this project, these values were measured on a 30 day basis while inventory included 7 days of raw materials and 7 days of product ready for shipment.

11.6 Utilities

Utilities cost $59,355 per year for electricity and water. In order to produce one dose of therapy, 9 L of steam, 331.6 L of water, and 18.0 kWh of electricity are required. The amount of steam and water required for the process was calculated using the SIP and CIP protocol found in
Appendix E. The amount of electricity was found by estimating the usage of the pumps, bioreactors, incubators, refrigerators, lighting, air conditioning, and additional laboratory equipment. It was assumed that these considerations were the primary contributors to electricity usage and others were negligible. The cost of steam is $0.016/L; the cost of water is $0.003/L; the cost of electricity is $0.180/kWh. These numbers were used to calculate the cost of utilities for the facility.

11.7 Fixed Costs

Fixed costs include the cost of operations, maintenance, operating overhead, property taxes and insurance, and other annual expenses. Specifically, these costs include direct wages, salaries, benefits, and operating supplies. There will be a total of 40 employees working at the facility. This number includes engineers and scientists who will work on a salary basis. Additionally, custodians and waste management workers will work on hourly wages. The weight average for hourly wages was determined to be approximately $35 per hour. Percentages used in this analysis were provided by Product and Process Design Principles.

11.8 Other Variable Costs

Variable costs include selling and transfer expenses, direct research, allocated research, administrative expenses, and management incentive compensation. These general expenses combined with the cost of raw materials and utilities yields total variable costs of $72,168,995.

11.9 Depreciation

Total depreciable capital was calculated using the General Depreciation System of the MACRS for a five-year recovery period. Starting from the first year of production, the percentages for depreciation are 20.00%, 32.00%, 19.20%, 11.52%, 11.52%, and 5.76%.
12.0 Conclusions and Recommendations

This proposal explored the options available for the scale-up, purification, and preservation of human embryonic stem cells for a spinal cord injury therapy. There are limited treatments currently available to patients with spinal cord injuries, and regenerative medicine shows a promising solution to this incurable condition. The designed facility is flexible enough to accommodate an increasing demand for this therapy as well as a shift in the type of stem cells needed for different therapies. The bioreactors, based on ATMI’s Xpansion™ system, are customized to meet the need of this proposal. This 2D system allows for large-scale production while mimicking laboratory-scale conditions. The proposed plant can be constructed in two stages; the first stage will produce enough cells for the stages of clinical trials. Once successful, the second stage will be built for maximum capacity production. This facility will follow cGMP and FDA regulations to ensure the safe and successful treatment of patients.

This proposal is the first step in entering and developing this new market space. By analyzing the market and pricing the stem cell therapy at $45,000 per dosage, at maximum capacity, the facility will produce 13,312 dosages (treatment for approximately 10,000 patients) and generate $599,040,000 in revenue annually. By assuming a 50% production capacity in the first year of production and increasing to 90% by year six, the ROI, NPV, and IRR of the proposal are 226.09%, $961,892,600, and 242.81% respectively. Taking this profitability analysis into consideration, it is urged that investors allocate funds toward the further research in the viability of large-scale production in the field of regenerative medicine.
13.0 Acknowledgements

The Regenerative Medicine Team would like to express great thanks to Dr. Tiffany Rau for the project concept and all of the time she has put into guiding our group, answering our questions, and sharing a tremendous amount of knowledge and industry experience. Dr. Rau was able to find time in her busy schedule to meet with us, whether it was during the planned design meetings or late on weekends. She was always available through e-mail and by telephone, and was easily accessible at mutually convenient times. She challenged us to ask questions and made sure we stayed on top of our work. She also provided many references throughout the semester that helped us in the right direction. Although there was a geographic barrier between Dr. Rau and our group, she gave 110% in providing us with all of the support we would need.

We also greatly appreciate our faculty advisor, Dr. Miriam Wattenbarger, for her constant help and encouragement for the duration of our project. Her remaining invested in the project ensured that we also stayed on top of what needed to be done. Dr. Wattenbarger was a useful resource for understanding the culture lab aspects of the report, and anything that was on a lab scale. Dr. Wattenbarger was available to clarify anything that was not clear during the semester.

Thank you to all of the industrial consultants for their input at our weekly meetings. In particular, we greatly appreciate all of the advice and ideas provided to us by Mr. Edward Steve; he has been an invaluable resource with his experience with stem cell manufacturing and reactor design. He helped us a great deal with details and layout of the plant as well, including all of our equipment costs. I would also like to thank Sam Halaby of IPS, who contributed to specific details about the costing of each part of the facility.

Thank you to Dr. Lazzara and Dr. Riggleman for helping us with the mass transfer component of our bioreactor design. They were extremely helpful in thinking about the oxygen diffusion and consumption in the reactors, and conveying the calculations to us in an understandable way.

We would also like to thank Professor Fabiano and Dr. Holleran for all of the help they have provided to us throughout the semester and for instructing us on the principles of design. Professor Fabiano met with us numerous times to keep updated on our project, while providing insight from his industrial experience. He was a great deal of help with our SuperPro Designer.
We would like to thank all of the consultants that met with us during the weekly senior design meetings. There was a wide range of consultants that sat in on our meetings and provided any information and advice that they could.

Lastly, we would like to thank all of the CBE professors from the University of Pennsylvania for teaching us all of the material that pertained to this Senior Design Project. And of course, we would like to thank all of our parents for getting us to this point. We would not have been able to complete this report without the help of everybody acknowledged here.
Appendix A – Protocols

Lab Technician Scale Up of hESCs

Preparation of mTeSR1

mTeSR1 Kit (Stemcell Technologies, 05850) is a highly specialized, serum-free medium used for cell culture of hESCs.

1. Thaw mTeSR1 5X Supplement at room temperature
2. Add 100 mL of thawed mTeSR 5X Supplement to 400 mL mTeSR1 Basal Medium and mix well.

Preparation of Dispase

Dispase (Stemcell Technologies, 07923) is used for passaging hESCs. Dispase at a concentration of 1 mg/mL is ready to use but should be aliquoted and stored at -20°C. (“News Details”, 2012). Matrigel hESC-qualified Matrix (Corning, 354277) should be aliquoted and frozen according to manufacturer specifications.

1. Thaw one aliquot of Matrigel on ice.
2. Dispense 25 mL of DMEM/F-12 dilution medium (Stemcell Technologies, 36254) into a 50 mL conical tube and keep on ice.
3. Add Matrigel to the 50 mL conical tube and mix well.
4. Use the diluted Matrigel to coat tissue culture-treated cultureware. Spread the Matrigel solution evenly across the surface. Coating volumes are as follows:

<table>
<thead>
<tr>
<th>Cultureware</th>
<th>Volume of Matrigel Solution</th>
</tr>
</thead>
<tbody>
<tr>
<td>6-well plate</td>
<td>1 mL/well</td>
</tr>
<tr>
<td>100 mm dish</td>
<td>8 mL/dish</td>
</tr>
<tr>
<td>150 mm dish</td>
<td>22 mL/dish</td>
</tr>
<tr>
<td>T-225 flask</td>
<td>15 mL/flask</td>
</tr>
</tbody>
</table>

5. Incubate at room temperature for at least one-hour prior to use.
6. Gently tilt the cultureware to allow excel Matrigel solution to collect and carefully remove the excess solution.
7. Immediately add an appropriate volume of medium and use to plate hESC.
**Thawing Initial Vial of hESCs (Robins, 2004)**

1. Thaw cells in a 37°C water bath by gently shaking the vial for 30-60 s.
2. Remove the vial from the water bath, sterilize with 70% ethanol, and transfer to a biosafety cabinet.
3. Transfer the contents of the vial to a 15 mL conical tube using a 2 mL pipette.
4. Add 5-7 mL of warm mTeSR1 dropwise into the tube.
5. Centrifuge the tube at 300 x g for 5 minutes at room temperature.
6. Decant the supernatant and gently resuspend the cells in 2 mL of mTeSR1.
7. Transfer the 2 mL of medium containing the cell aggregates to a pre-coated single well of a 6-well plate. Distribute the cells evenly within the well.
8. Culture the cells at 37°C, with 5% CO₂ and 95% humidity.
9. Perform daily medium changes. Observe the cells under a microscope daily. Cells are ready for passaging approximately 5-7 days after thawing.

**Enzymatic Passaging Using Dispase (“Maintenance of Human Pluripotent Stem Cells, 2014”)**

1. Prepare all reagents prior to passaging. Coat new dishes with Matrigel at least 1 hour before passaging. Aliquot sufficient mTeSR, Dispase, and DMEM/F-12 and warm to room temperature.
2. Observe cells under a microscope to visually identify regions of differentiation. Differentiated regions can be removed by scraping with a pipette tip or by aspiration. Scale-up in production was calculated assuming 15% of cells differentiated.
3. Aspirate medium from the well and rinse with DMEM/F-12 (2 mL/well).
4. Add dispase (1 mL/well) at a concentration of 1 mg/mL.
5. Incubate at 37°C for 7 minutes.
6. Aspirate dispase and gently rinse each well 3 times with DMEM/F-12 (2 mL/well).
7. Add DMEM/F-12 or mTeSR1 (2 mL/well).
8. Detach colonies by gently scraping with a cell scraper. Transfer the detached cell aggregates to a 15 mL conical tube. Centrifuge the tube at 300 x g for 5 minutes at room temperature.
9. Decant the supernatant and gently resuspend the cells in mTeSR1 (2 mL per well of cell aggregates collected).
10. Carefully pipette the cell aggregates with a 2 mL pipette to break up the aggregates.
11. Plate the cell aggregates with mTeSR1 onto a new pre-coated plate.

12. Culture the cells at 37°C, with 5% CO₂ and 95% humidity. The cells are passaged every 4-7 days at a split ratio 1:6. The table below specifies the cultureware used as the cells multiply and the appropriate volume of medium to be used.

**Cultureware Used**

<table>
<thead>
<tr>
<th>Timeline</th>
<th>Cultureware</th>
<th>Volume of Medium</th>
</tr>
</thead>
<tbody>
<tr>
<td>Week 1</td>
<td>6-well plate</td>
<td>2 mL/well</td>
</tr>
<tr>
<td>Week 2</td>
<td>6-well plate</td>
<td>2 mL/well</td>
</tr>
<tr>
<td>Week 3</td>
<td>100mm dish</td>
<td>14 mL/dish</td>
</tr>
<tr>
<td>Week 4</td>
<td>150mm dish</td>
<td>38 mL/dish</td>
</tr>
<tr>
<td>Week 5</td>
<td>T-225 cm² flasks</td>
<td>55 mL/flask</td>
</tr>
</tbody>
</table>

**Scale-Up in Production of hESCs**

<table>
<thead>
<tr>
<th>Timeline</th>
<th>Cultureware</th>
<th>Scale</th>
</tr>
</thead>
<tbody>
<tr>
<td>Week 1</td>
<td>1 x 6-well plate</td>
<td>6x10⁵ cells</td>
</tr>
<tr>
<td>Week 2</td>
<td>5 x 6-well plate</td>
<td>3.06x10⁶ cells</td>
</tr>
<tr>
<td>Week 3</td>
<td>4 x 100mm dish</td>
<td>1.56x10⁷ cells</td>
</tr>
<tr>
<td>Week 4</td>
<td>6 x 150mm dish</td>
<td>7.96x10⁷ cells</td>
</tr>
<tr>
<td>Week 5</td>
<td>20 x T-225 cm² flasks</td>
<td>4.06x10⁸ cells</td>
</tr>
</tbody>
</table>

One vial of cells were thawed and grown on Matrigel-coated plates. (1x10⁵ cells/vial) Cells were passaged once a week at the scale indicated. Thirteen vials are required to meet the desired annual production rate (“Maintenance of Human Pluripotent Stem Cells”, 2014).

**Differentiation of hESCs**

*Generation of NSPSCS from hESCs (12 days)* ("Generation of Neural Progenitor Cells”, 2014)

1. Pre-warm STEMdiff Neural Induction Medium (Stemcell Technologies, 06831), Accutase (08920), and DMEM/F-12 (36254) to 37°C.

2. Plate the cells in the small bioreactor.
3. Adjust the medium to a final volume of 2.09 L using STEMdiff Neural Induction Medium supplemented with 10 µM Rock inhibitor Y-27632.

4. Incubate the cells in the bioreactor at 37°C with 5% CO₂ and 95% humidity for 5 days with a daily 3/4-medium change.

5. Flow STEMdiff Neural Induction Medium over the cells to dislodge the neural aggregates from the plates.

6. Collect the neural aggregate suspension and filter through a 37 µm Reversible strainer to filter through single cells.

7. Re-plate neural aggregates.

8. Incubate the cells in the bioreactor at 37°C with 5% CO₂ and 95% humidity for 7 days with a daily full medium change.

9. Remove the media. Wash with 2.09 L DMEM/F-12.

10. Add 2.09 L STEMdiff Neural Rosette Selection Reagent.

11. Incubate the cells in the bioreactor at 37°C with 5% CO₂ and 95% humidity for 1 hour.

12. Remove the Neural Rosette Selection Reagent

**Differentiation of NSPCS into Neurons, Astrocytes, and Oligodendrocytes (5-10 days)** (“Neural Stem Cells & Differentiation Markers”, 2011)

1. Remove the media.

2. Wash with 2.09 L PBS.

3. Add 2.09 mL Complete NeuroCult NS-A Differentiation Medium and begin the continuous media flow cycle.

4. Incubate the cells in the bioreactor at 37°C with 5% CO₂ and 95% humidity. Observe cultures after 5-10 days to determine if cells have differentiated.

**Identification of Differentiated Cells**

*Immunolabeling to Identify Differentiated Cell Types* (“Neural Stem Cells & Differentiation Markers”, 2011)

1. Approximately 2 mL of media containing cells should be removed and plated in each of the wells in the 6-well plate.

2. Remove 90% of the culture medium and add 2 mL of 4% paraformaldehyde in PBS (pH 7.2) to each well.
3. Incubate for 30 minutes at room temperature and remove the paraformaldehyde in a chemical fume hood.
4. Add PBS to the samples and incubate for 5 minutes. Repeat this process two more times.
5. Add 1 mL 0.3% Triton X-100 in PBS to each well and incubate for 5-10 minutes.
6. Remove Triton X-100/PBS and perform 5 minute PBS washes two more times.
7. Prepare a blocking solution of 10% serum and dilute the primary antibody in blocking solution.
8. Add 500 µL to each well and incubate for 2 hours at 37°C.
9. Perform 5 minute PBS washes three more times to remove primary antibody.
10. Dilute secondary antibodies in PBS (1:100) and 2% serum.
11. Add 500 µL to each well and incubate for 30 minutes at 37°C.
12. Perform 5 minute PBS washes three more times to remove secondary antibody. Add distilled water to each well.
13. Visualize immunostaining under a fluorescent microscope.
Appendix B – Calculations

Cell Balance

\[ C_6H_{12}O_6 + p \ C_5H_{10}O_3N_2 + q \ O_2 \rightarrow r \ CH_{1.82}O_{0.84}N_{0.25} + s \ C_3H_6O_3 + t \ NH_3 + u \ CO_2 + v \ H_2O \]

<table>
<thead>
<tr>
<th>Component</th>
<th>Input (g)</th>
<th>Output (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biomass (cells)</td>
<td>2.70x10^-6</td>
<td>2.76</td>
</tr>
<tr>
<td>Glucose</td>
<td>10.61</td>
<td>0.00</td>
</tr>
<tr>
<td>Glutamine</td>
<td>4.46</td>
<td>0.00</td>
</tr>
<tr>
<td>Oxygen</td>
<td>3.09</td>
<td>0.00</td>
</tr>
<tr>
<td>Lactic Acid</td>
<td>0.00</td>
<td>9.55</td>
</tr>
<tr>
<td>Ammonia</td>
<td>0.00</td>
<td>0.66</td>
</tr>
<tr>
<td>Carbon Dioxide</td>
<td>0.00</td>
<td>4.32</td>
</tr>
<tr>
<td>Water</td>
<td>0.00</td>
<td>0.87</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>18.16</strong></td>
<td><strong>18.16</strong></td>
</tr>
</tbody>
</table>

Overall material balance for one cycle of the process; thirteen cycles run each year. Per year, 137.97 g of glucose and 57.95 g of glutamine are consumed; 35.94 g of cells are produced.
Energy Balance within Bioreactor

An energy balance on the cells can be equated to carrying out an energy balance on glucose and glutamine within the bioreactor. Below are the equations for the combustion of glucose and the combustion of glutamine.

\[ C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O \quad \Delta H_c = -2805 \text{ kJ/mol} \]

\[ C_5H_{10}N_2O_3 + 6O_2 \rightarrow 5CO_2 + 5H_2O + N_2 \quad \Delta H_c = -2570 \text{ kJ/mol} \]

Using the amount of each substrate multiplied by the heat of combustion per mole, the heat of combustion for each substance may be calculated. Summing together these values provides the total heat loss. From Bioprocess Engineering: Basic Concepts (Shuler 2001), the assumption can be made that 40% of this energy goes to cell metabolism while the remaining 60% is lost as heat. Sixty percent of the energy divided by the amount of time for the predominant growth in the reactor gives the energy produced. Predominant growth occurs at the end of the reaction; it is averaged over the last four days of reactor time.

\[
\frac{(\Delta H_{\text{c,glucose}}n_{\text{glucose}} + \Delta H_{\text{c,glutamine}}n_{\text{glutamine}})}{\text{growth time}} \times 0.60 = \text{Energy produced}
\]

3-L bioreactor:

\[
\left[ \left( \frac{-2805 \text{ kJ/mol}}{180.16 \text{ g}} \right) \times \left( 0.311 \text{ g glucose} \right) + \left( \frac{-2570 \text{ kJ/mol}}{146.14 \text{ g}} \right) \times \left( 0.130 \text{ g glutamine} \right) \right] \times 0.60 = -4.3 \text{ kJ}
\]

\[
\frac{-4.3 \text{ kJ}}{4 \text{ days}} = -1.1 \frac{\text{ kJ}}{\text{ day}} \approx 0 \text{ kW (negligible)}
\]

17-L bioreactor:

\[
\left[ \left( \frac{-2805 \text{ kJ/mol}}{180.16 \text{ g}} \right) \times \left( 2.492 \text{ g glucose} \right) + \left( \frac{-2570 \text{ kJ/mol}}{146.14 \text{ g}} \right) \times \left( 1.047 \text{ g glutamine} \right) \right] \times 0.60 = -34.3 \text{ kJ}
\]

\[
\frac{-7.1 \text{ kJ}}{4 \text{ days}} = -8.6 \frac{\text{ kJ}}{\text{ day}} \approx 0 \text{ kW (negligible)}
\]

Based on these calculations, a very small heat exchanger would be needed. However, it will not be included for the purpose of the estimates for this process since the energy for each reactor is trivial.
Heat Exchanger

A shell-and-tube heat exchanger was designed to preheat a stream of 18.17 L/min media (flow rate based on pump specification) from storage temperature, 4 °C, to biological temperature, 37 °C. Saturated steam will be used for heating of the media, starting at a temperature of 100 °C and being cooled to 37 °C.

\[
Q = mC_p\Delta T = \left(18.17 \frac{L}{min}\right)\left(\frac{1 m^3}{1000 L}\right)\left(1000 \frac{kg}{m^3}\right)\left(4.1814 \frac{kJ}{kg-K}\right)(37 °C - 4 °C)
= 2507 \frac{kJ}{min} = 41.8 kW
\]

\[
\Delta T_{lm} = \frac{[(100 - 37) - (37 - 4)]}{\ln \left[\frac{100 - 37}{37 - 4}\right]} = 46.4 °C
\]

\[
U_{est} = (120 \frac{BTU}{ft^2 - h - F})\left(\frac{5.678 \frac{W}{m^2 - K}}{1 BTU}\right) = 681 \frac{W}{m^2 - K}
\]

\[
A = \frac{Q}{U_{est} \Delta T_{lm}} = \frac{41.8 kW}{(0.681 \frac{kW}{m^2 - K})(46.4 °C)} = 1.32 m^2
\]

\[
m_{steam} = \frac{Q}{C_p\Delta T} = \frac{41.8 W}{(4.1814 \frac{kJ}{kg-K})(100 °C - 37 °C)} = 0.159 \frac{kg}{s} = 572 kg/hr
\]
Oxygen Transfer

| Gas Flow Rate in Bioreactor | 100 mL/min |
| Flow Area | 1.117 cm$^2$ |
| Rate of O$_2$ Consumption by Cells | 1.70x10$^{-18}$ mol O$_2$ / cell sec |
| Solubility of O$_2$ in Water | 6.716 mg O$_2$ / L H$_2$O |

**Rate of O$_2$ Consumption by Cells**

$$\frac{(1.70 \times 10^{-18} \text{ mol O}_2}{\text{cell sec}}) \left( \frac{\text{cell}}{3.14 \times 10^{-6} \text{ cm}^2} \right) \left( \frac{306 \text{ cm}^2}{\text{plate}} \right) = 1.66 \times 10^{-10} \frac{\text{mol}}{\text{s}} \text{ per plate}$$

**Rate of O$_2$ Delivery to Cells**

$$\left( \frac{0.17 \text{ cm media}}{\text{sec}} \right) \left( \frac{1.12 \text{ cm}^2}{\text{plate}} \right) \left( \frac{2.10 \times 10^{-7} \text{ mol O}_2}{\text{cm}^3 \text{ media}} \right) = 3.91 \times 10^{-8} \frac{\text{mol}}{\text{s}} \text{ per plate}$$

| Rate of O$_2$ Delivery to Cells | 3.91x10$^{-8}$ mol/s |
| Rate of O$_2$ Consumption by Cells | 1.66x10$^{-10}$ mol/s |
| Ratio of O$_2$ Consumed / Delivered | 0.42% per plate |

The cells on each plate consume approximately 0.42% of the oxygen delivered to each plate. Based on this calculation, the oxygen content will never drop below 4%, the minimum oxygen level in which stem cells thrive. The maximum oxygen level will be 20%.
Shear Stress

\[
Re = \frac{\rho v D_H}{\mu} = \frac{(10^{-3}\text{kg/cm}^3)(0.167 \text{ cm/s})(27.14 \text{ cm})}{(0.653 \times 10^{-3}\text{Ns/m}^2)} = 693
\]

\[
\tau_w = \frac{6 \mu Q}{bh^2} = \frac{6(0.653 \times 10^{-3}\text{Ns/m}^2)(0.186 \text{ cm}^3/\text{s})}{(13.96 \text{ cm}^2)(0.16 \text{ cm})^2} = 0.0233 \text{ dyn/cm}^2
\]

The shear stress on the cells due to flowing media is low enough that the stem cells are not negatively impacted. The shear stress calculation assumes the media acts as a Newtonian fluid (it is assumed to be water) and that the plates are infinitely wide. The plates contain dead space, space containing no cells, along the inner and outer radius. This eliminates the potential for high shear stress on the cells at the point where media flows from the plate below to the plate above. Because the area of a cell is minimal compared to the area of a plate, the plates can be assumed to be infinitely wide (Wilkes, 1999). Reynolds number is the ratio of inertial forces (product of media density, media velocity, and plate diameter) to viscous forces (kinematic viscosity). Shear stress is the stress coplanar (product of kinematic viscosity and media velocity) with the cross sectional area (surface area of the plate).

Overall Scale Up

<table>
<thead>
<tr>
<th>Timeline</th>
<th>Cultureware</th>
<th>Scale</th>
</tr>
</thead>
<tbody>
<tr>
<td>Day 0</td>
<td>1 vial</td>
<td>1x10^5 cells (hESCs)</td>
</tr>
<tr>
<td>Day 7</td>
<td>1 x 6-well plate</td>
<td>6x10^5 cells</td>
</tr>
<tr>
<td>Day 14</td>
<td>5 x 6-well plate</td>
<td>3.06x10^6 cells</td>
</tr>
<tr>
<td>Day 21</td>
<td>4 x 100mm dish</td>
<td>1.56x10^7 cells</td>
</tr>
<tr>
<td>Day 28</td>
<td>6 x 150mm dish</td>
<td>7.96x10^7 cells</td>
</tr>
<tr>
<td>Day 35</td>
<td>20 x T-225 cm^2 flasks</td>
<td>4.06x10^8 cells</td>
</tr>
<tr>
<td>Day 47</td>
<td>2 x Small Bioreactor-1</td>
<td>4.06x10^8 cells (NSPCs)</td>
</tr>
<tr>
<td>Day 57</td>
<td>2 x Small Bioreactor-1</td>
<td>4.06x10^8 cells (Neurons)</td>
</tr>
<tr>
<td>Day 73</td>
<td>2 x Small Bioreactor-2</td>
<td>6.40x10^9 cells</td>
</tr>
<tr>
<td>Day 89</td>
<td>4 x Large Bioreactor</td>
<td>1.02x10^11 cells</td>
</tr>
</tbody>
</table>

After 89 days, 2 out of 26 batches will be produced. The batches will be staggered so production time does not exceed one year. (“Maintenance of Human Pluripotent Stem Cells in MTeSR1 and TeSR2”, 2014)
Appendix C – Economic Analysis

The three common methods for calculating profitability are a net present value (NPV) approach, a return on investment (ROI) approach, and an internal rate of return (IRR) approach. All three are analyzed in this report as each presents its own advantages and disadvantages, and all are appropriate in this scenario.

First, we will look at the ROI method. This calculation is found by simply dividing the annual earnings into the capital investment, to find an appropriate percentage. This can also be viewed as an annual interest rate, measuring the relative ratio of investment gains compared to investment costs. This overly simplified and quite useful method also has its drawbacks, however. Little is defined in the calculation of ROI, as there is freedom to choose which variables to include and not include. This makes it the ROI figure somewhat untrustworthy and not viable for comparison. It also assumes fixed annual earnings, which is not the case especially immediately after construction. Lastly, it does not put the percentage reported in the context of the company’s profits at that time, which makes it hard to realize if a larger company would deem the new project worth it. Nonetheless, the ROI of our project in the 3rd year of production is 226.09%.

Next, we will introduce the NPV method. It is usually preferred to the ROI method because it allows for a more in depth analysis and improves on some of the disadvantages of ROI. It takes into account the time value of money, since inflation and other factors change prices over time. The outflows and inflows of cash are netted for each year, and are discounted back to the equivalent price in current year’s dollars. This allows for comparison of money in terms of today’s dollars. The sum of these discounted cash flows during the entire length of the project provides the net present value. Usually, any project that results in a substantially positive NPV will be accepted. The only drawback of this method is that it does not show when the NPV will turn from negative to positive. This means that we will not know the point that we will break even. The NPV of our project at the end of year 10 was calculated to be $961,892,600. This NPV calculation assumes a discount rate of 15%, which was used to bring all of the cash flows back to dollars in to 2014.

The IRR approach is the last one considered in this report. It can supplement the other two techniques to provide a comprehensive economic analysis. It can be found by finding the discount rate that would make the NPV of the project equal to zero. It compares the internal rate
of return to the opportunity cost of capital. One of the few drawbacks to this supplemental method is that it assumes the discount rate is the same over the entire period. For a project like ours, which assumes 10+ years of production, this might not be an accurate assumption. The IRR of our project was 242.81%.

**Sensitivity Analysis**

There are many factors affecting the return on investment for this project. Because stem cell based-therapies for spinal cord injuries have never been commercialized before, it is difficult to predict how many patients will opt for this treatment. Likewise, there is no established price for this type of therapy. A sensitivity analysis will be performed on both the number of patients and the price of the treatment to account for this unpredictable variability. The return on investment is calculated using the third production year.

**Market Size**

To determine the effect of patient base on the ROI, the number of doses per year was modified while keeping all other variables constant. From this analysis, it is seen that at least 680 patients must opt for this treatment every year for the ROI to be positive after year three of production.

<table>
<thead>
<tr>
<th>Number of Patients</th>
<th>IRR</th>
<th>NPV</th>
<th>ROI</th>
</tr>
</thead>
<tbody>
<tr>
<td>13,312</td>
<td>242.81%</td>
<td>$961,892,600</td>
<td>226.09%</td>
</tr>
<tr>
<td>10,000</td>
<td>206.34%</td>
<td>$707,175,600</td>
<td>197.61%</td>
</tr>
<tr>
<td>7,500</td>
<td>171.84%</td>
<td>$514,907,300</td>
<td>168.03%</td>
</tr>
<tr>
<td>5,000</td>
<td>128.79%</td>
<td>$322,638,900</td>
<td>127.01%</td>
</tr>
<tr>
<td>2,500</td>
<td>72.62%</td>
<td>$130,370,600</td>
<td>66.33%</td>
</tr>
<tr>
<td>1,000</td>
<td>24.35%</td>
<td>$15,009,600</td>
<td>13.62%</td>
</tr>
<tr>
<td>680</td>
<td>7.70%</td>
<td>$(9,600,700)</td>
<td>0.00%</td>
</tr>
<tr>
<td>500</td>
<td>-7.41%</td>
<td>$(23,444,000)</td>
<td>-8.11%</td>
</tr>
</tbody>
</table>
Selling Price

To determine the effect of patient base on the ROI, the price of a dose was modified while keeping all other variables constant. From this analysis, it is seen that the cost of one dose must be at least $2,539 every year for the ROI to be positive after year three of production.

<table>
<thead>
<tr>
<th>Product Price</th>
<th>IRR</th>
<th>NPV</th>
<th>ROI</th>
</tr>
</thead>
<tbody>
<tr>
<td>$80,000</td>
<td>317.63%</td>
<td>$1,762,734,300</td>
<td>277.04%</td>
</tr>
<tr>
<td>$70,000</td>
<td>300.62%</td>
<td>$1,544,922,400</td>
<td>266.25%</td>
</tr>
<tr>
<td>$60,000</td>
<td>280.48%</td>
<td>$1,305,110,500</td>
<td>252.97%</td>
</tr>
<tr>
<td>$45,000</td>
<td>242.81%</td>
<td>$961,892,600</td>
<td>226.09%</td>
</tr>
<tr>
<td>$30,000</td>
<td>191.26%</td>
<td>$618,674,800</td>
<td>184.97%</td>
</tr>
<tr>
<td>$20,000</td>
<td>144.90%</td>
<td>$389,862,900</td>
<td>142.85%</td>
</tr>
<tr>
<td>$10,000</td>
<td>82.74%</td>
<td>$161,061,000</td>
<td>77.71%</td>
</tr>
<tr>
<td>$2,539</td>
<td>7.67%</td>
<td>($9,665,600)</td>
<td>0.00%</td>
</tr>
</tbody>
</table>
Appendix D – Profitability Analysis

**General Information**

<table>
<thead>
<tr>
<th>Process Title:</th>
<th>Senior Design</th>
</tr>
</thead>
<tbody>
<tr>
<td>Product:</td>
<td>Stem Cell Therapy</td>
</tr>
<tr>
<td>Plant Site Location:</td>
<td>Northeast</td>
</tr>
<tr>
<td>Site Factor:</td>
<td>1.00</td>
</tr>
<tr>
<td>Operating Hours per Year:</td>
<td>8152</td>
</tr>
<tr>
<td>Operating Days Per Year:</td>
<td>340</td>
</tr>
<tr>
<td>Operating Factor:</td>
<td>0.9306</td>
</tr>
</tbody>
</table>

**Product Information**

This Process will Yield

- 2 dose of Stem Cell Therapy per hour
- 39 dose of Stem Cell Therapy per day
- 13,312 dose of Stem Cell Therapy per year

**Price**

$45,000.00 /dose

**Chronology**

<table>
<thead>
<tr>
<th>Year</th>
<th>Action</th>
<th>Distribution of Permanent Investment</th>
<th>Production Capacity</th>
<th>Depreciation 5 year MACRS</th>
<th>Product Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>2014</td>
<td>Design</td>
<td></td>
<td>0.0%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2015</td>
<td>Research</td>
<td></td>
<td>0.0%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2016</td>
<td>Research</td>
<td></td>
<td>0.0%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2017</td>
<td>Construction</td>
<td>100%</td>
<td>0.0%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2018</td>
<td>Production</td>
<td>0%</td>
<td>45.0%</td>
<td>20.00%</td>
<td>$45,000</td>
</tr>
<tr>
<td>2019</td>
<td>Production</td>
<td>0%</td>
<td>54.0%</td>
<td>32.00%</td>
<td>$45,000</td>
</tr>
<tr>
<td>2020</td>
<td>Production</td>
<td>0%</td>
<td>63.0%</td>
<td>19.20%</td>
<td>$45,000</td>
</tr>
<tr>
<td>2021</td>
<td>Production</td>
<td></td>
<td>72.0%</td>
<td>11.52%</td>
<td>$45,000</td>
</tr>
<tr>
<td>2022</td>
<td>Production</td>
<td></td>
<td>81.0%</td>
<td>11.52%</td>
<td>$45,000</td>
</tr>
<tr>
<td>2023</td>
<td>Production</td>
<td></td>
<td>90.0%</td>
<td>5.76%</td>
<td>$45,000</td>
</tr>
<tr>
<td>2024</td>
<td>Production</td>
<td></td>
<td>90.0%</td>
<td></td>
<td>$45,000</td>
</tr>
<tr>
<td>2025</td>
<td>Production</td>
<td></td>
<td>90.0%</td>
<td></td>
<td>$45,000</td>
</tr>
<tr>
<td>2026</td>
<td>Production</td>
<td></td>
<td>90.0%</td>
<td></td>
<td>$45,000</td>
</tr>
<tr>
<td>2027</td>
<td>Production</td>
<td></td>
<td>90.0%</td>
<td></td>
<td>$45,000</td>
</tr>
</tbody>
</table>
## Equipment Costs

<table>
<thead>
<tr>
<th>Equipment Description</th>
<th>Bare Module Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plates/Dishes and T-Flasks (50)</td>
<td>$36,836</td>
</tr>
<tr>
<td>3 L Bioreactors (5)</td>
<td>$375,000</td>
</tr>
<tr>
<td>17 L Bioreactors (5)</td>
<td>$500,000</td>
</tr>
<tr>
<td>Media Storage Tank</td>
<td>$79,865</td>
</tr>
<tr>
<td>Media Filtration (50)</td>
<td>$36,150</td>
</tr>
<tr>
<td>Small Media Mixing Tank (2)</td>
<td>$32,000</td>
</tr>
<tr>
<td>Vitrification Media Mixing Tank (2)</td>
<td>$10,200</td>
</tr>
<tr>
<td>Recycled Media Filtration (50)</td>
<td>$26,867</td>
</tr>
<tr>
<td>Centrifuge (2)</td>
<td>$17,460</td>
</tr>
<tr>
<td>Pumps (24)</td>
<td>$103,200</td>
</tr>
<tr>
<td>CIP Skid (3)</td>
<td>$750,000</td>
</tr>
<tr>
<td>WFI System (2)</td>
<td>$1,550,000</td>
</tr>
<tr>
<td>USP Treatment Package</td>
<td>$140,000</td>
</tr>
<tr>
<td>Pure Steam Generator</td>
<td>$200,000</td>
</tr>
<tr>
<td>Neuron Media Prep Tank</td>
<td>$94,000</td>
</tr>
<tr>
<td>Differentiation Media #1 Prep Tank</td>
<td>$56,000</td>
</tr>
<tr>
<td>Differentiation Media #2 Prep Tank</td>
<td>$36,000</td>
</tr>
<tr>
<td>Lectin Purification System (2)</td>
<td>$243,777</td>
</tr>
<tr>
<td>ViCell Counter</td>
<td>$50,000</td>
</tr>
<tr>
<td>Neutralization Waste System</td>
<td>$150,000</td>
</tr>
<tr>
<td>Biowaste Inactivation System</td>
<td>$132,000</td>
</tr>
<tr>
<td>Autoclave (6)</td>
<td>$1,200,000</td>
</tr>
<tr>
<td>Dishwasher</td>
<td>$14,765</td>
</tr>
<tr>
<td>Air Compressor</td>
<td>$120,000</td>
</tr>
<tr>
<td>Ventilation Hood System (10)</td>
<td>$286,000</td>
</tr>
<tr>
<td>Biosafety Cabinets (10)</td>
<td>$173,000</td>
</tr>
<tr>
<td>Incubators (10)</td>
<td>$79,000</td>
</tr>
<tr>
<td>Refrigerators/Freezers</td>
<td>$298,000</td>
</tr>
<tr>
<td>500 sq ft Walk-In Freezer</td>
<td>$100,000</td>
</tr>
<tr>
<td>Additional Equipment</td>
<td>$475,649</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>$7,365,769</strong></td>
</tr>
</tbody>
</table>
## Raw Materials

<table>
<thead>
<tr>
<th>Raw Material:</th>
<th>Unit:</th>
<th>Required Amount:</th>
<th>Cost of Raw Material:</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Matrigel</td>
<td>L</td>
<td>0.39 L per year</td>
<td>$46.00 per mL</td>
</tr>
<tr>
<td>2 DMEM/F-12</td>
<td>L</td>
<td>101.47 L per year</td>
<td>$74.00 per L</td>
</tr>
<tr>
<td>3 Dispase</td>
<td>L</td>
<td>9.17 L per year</td>
<td>$380.00 per L</td>
</tr>
<tr>
<td>4 mTeSR1</td>
<td>L</td>
<td>36.80 L per year</td>
<td>$544.00 per L</td>
</tr>
<tr>
<td>5 STEMdiff Neural Induction Medium</td>
<td>L</td>
<td>692.84 L per year</td>
<td>$2,890.00 per L</td>
</tr>
<tr>
<td>6 Rock inhibitor Y27632</td>
<td>mg</td>
<td>2219.15 mg per year</td>
<td>$119.80 per mg</td>
</tr>
<tr>
<td>7 DMEM/F-12</td>
<td>L</td>
<td>54.34 L per year</td>
<td>$74.00 per L</td>
</tr>
<tr>
<td>8 STEMdiff Neural Rosette Selection Reagent</td>
<td>L</td>
<td>54.34 L per year</td>
<td>$350.00 per L</td>
</tr>
<tr>
<td>9 PBS</td>
<td>L</td>
<td>54.34 L per year</td>
<td>$50.00 per L</td>
</tr>
<tr>
<td>10 Complete NeuroCult NS-A Differentiation Medium</td>
<td>L</td>
<td>326.04 L per year</td>
<td>$340.00 per L</td>
</tr>
<tr>
<td>11 Basal Medium</td>
<td>L</td>
<td>1755.00 L per year</td>
<td>$116.00 per L</td>
</tr>
<tr>
<td>12 B27 Supplement</td>
<td>L</td>
<td>35.10 L per year</td>
<td>$860.00 per L</td>
</tr>
<tr>
<td>13 Glutamax</td>
<td>L</td>
<td>351.00 L per year</td>
<td>$310.00 per L</td>
</tr>
<tr>
<td>14 .3 M Fructose</td>
<td>g</td>
<td>4215.64 g per year</td>
<td>$0.32 per g</td>
</tr>
<tr>
<td>15 Liquid Nitrogen</td>
<td>L</td>
<td>278.56 L per year</td>
<td>$0.13 per L</td>
</tr>
<tr>
<td>16 Ethylene Glycol</td>
<td>L</td>
<td>92.66 L per year</td>
<td>$80.70 per L</td>
</tr>
<tr>
<td>17 DMSO</td>
<td>L</td>
<td>92.66 L per year</td>
<td>$86.90 per L</td>
</tr>
<tr>
<td>18 0.5 M Sucrose</td>
<td>kg</td>
<td>17.11 kg per year</td>
<td>$63.10 per kg</td>
</tr>
<tr>
<td>19 Trypsin</td>
<td>L</td>
<td>1300.00 L per year</td>
<td>$73.80 per L</td>
</tr>
<tr>
<td>20 Oxygen (Air)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>21 WFI</td>
<td>L</td>
<td>56215.00 L per year</td>
<td>$0.18 per L</td>
</tr>
<tr>
<td>22 Carbon Dioxide</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>23 Paraformaldehyde</td>
<td>g</td>
<td>1.00 g per year</td>
<td>$80.60 per g</td>
</tr>
<tr>
<td>24 Triton X-100</td>
<td>mL</td>
<td>10.00 mL per year</td>
<td>$2.14 per mL</td>
</tr>
</tbody>
</table>
### Utilities

<table>
<thead>
<tr>
<th>Utility:</th>
<th>Unit:</th>
<th>Required Ratio</th>
<th>Utility Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>High Pressure Steam</td>
<td>lb</td>
<td>0 lb per dose</td>
<td>$0.000E+00 per lb</td>
</tr>
<tr>
<td>Low Pressure Steam</td>
<td>L</td>
<td>9 L per dose</td>
<td>$0.016 per L</td>
</tr>
<tr>
<td>Process Water</td>
<td>L</td>
<td>331.628 L per dose</td>
<td>$3.230E-03 per L</td>
</tr>
<tr>
<td>Cooling Water</td>
<td>lb</td>
<td>0 lb per dose</td>
<td>$0.000E+00 per L</td>
</tr>
<tr>
<td>Electricity</td>
<td>kWh</td>
<td>18 kWh per dose</td>
<td>$0.180 per kWh</td>
</tr>
</tbody>
</table>

Total Weighted Average: $4.459 per dose

### Variable Costs

- **General Expenses:**
  - Selling / Transfer Expenses: 3.00% of Sales
  - Direct Research: 4.80% of Sales
  - Allocated Research: 0.50% of Sales
  - Administrative Expense: 2.00% of Sales
  - Management Incentive Compensation: 1.25% of Sales

### Working Capital

- Accounts Receivable: ⇠ 30 Days
- Cash Reserve: ⇠ 30 Days
- Accounts Payable: ⇠ 30 Days
- Stem Cell Therapy Inventory: ⇠ 7 Days
- Raw Materials: ⇠ 7 Days

### Total Permanent Investment

- Cost of Site Preparations: 5.00% of Total Bare Module Costs
- Cost of Service Facilities: 5.00% of Total Bare Module Costs
- Allocated Costs for utility plants and related facilities: $0
- Cost of Contingencies and Contractor Fees: 18.00% of Direct Permanent Investment
- Cost of Land: 2.00% of Total Depreciable Capital
- Cost of Royalties: $0
- Cost of Plant Start-Up: 10.00% of Total Depreciable Capital

---

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Fixed Costs

Operators per Shift: 20
Direct Wages and Benefits: $35 \$/operator hour
Direct Salaries and Benefits: 15\% of Direct Wages and Benefits
Operating Supplies and Services: 6\% of Direct Wages and Benefits
Technical Assistance to Manufacturing: $0.00 per year, for each Operator per Shift
Control Laboratory: $0.00 per year, for each Operator per Shift

Maintenance

Wages and Benefits: 4.50\% of Total Depreciable Capital
Salaries and Benefits: 25\% of Maintenance Wages and Benefits
Materials and Services: 100\% of Maintenance Wages and Benefits
Maintenance Overhead: 5\% of Maintenance Wages and Benefits

Operating Overhead

General Plant Overhead: 7.10\% of Maintenance and Operation Wages and Benefits
Mechanical Department Services: 2.40\% of Maintenance and Operation Wages and Benefits
Employee Relations Department: 5.90\% of Maintenance and Operation Wages and Benefits
Business Services: 7.40\% of Maintenance and Operation Wages and Benefits

Property Taxes and Insurance

Property Taxes and Insurance: 2\% of Total Depreciable Capital

Straight Line Depreciation

Direct Plant: 8.00\% of Total Depreciable Capital
Allocated Plant: 6.00\%

Other Annual Expenses

Rental Fees (Office and Laboratory Space): $0
Licensing Fees: $0
Miscellaneous: $0

Depletion Allowance

Annual Depletion Allowance: $0
Variable Cost Summary

Variable Costs at 100% Capacity:

**General Expenses**

<table>
<thead>
<tr>
<th>Cost Description</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Selling/Transfer Expenses:</td>
<td>$17,971,200.00</td>
</tr>
<tr>
<td>Direct Research:</td>
<td>$28,753,920.00</td>
</tr>
<tr>
<td>Allocated Research:</td>
<td>$2,995,200.00</td>
</tr>
<tr>
<td>Administrative Expense:</td>
<td>$11,980,800.00</td>
</tr>
<tr>
<td>Management Incentive Compensation:</td>
<td>$7,488,000.00</td>
</tr>
</tbody>
</table>

**Total General Expenses** $ per kg stem cell therapy $69,189,120.00

**Raw Materials** $ per kg stem cell therapy $2,920,519.68

**Byproducts** $0.00 per kg stem cell therapy $

**Utilities** $ per kg stem cell therapy $59,354.99

**Total Variable Costs** $

$72,168,994.67
## Fixed Cost Summary

### Operations

<table>
<thead>
<tr>
<th>Item</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Direct Wages and Benefits</td>
<td>$7,280,000.00</td>
</tr>
<tr>
<td>Direct Salaries and Benefits</td>
<td>$1,092,000.00</td>
</tr>
<tr>
<td>Operating Supplies and Services</td>
<td>$436,800.00</td>
</tr>
<tr>
<td>Technical Assistance to Manufacturing</td>
<td>-</td>
</tr>
<tr>
<td>Control Laboratory</td>
<td>-</td>
</tr>
<tr>
<td><strong>Total Operations</strong></td>
<td><strong>$8,808,800.00</strong></td>
</tr>
</tbody>
</table>

### Maintenance

<table>
<thead>
<tr>
<th>Item</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wages and Benefits</td>
<td>$1,261,744.28</td>
</tr>
<tr>
<td>Salaries and Benefits</td>
<td>$315,436.07</td>
</tr>
<tr>
<td>Materials and Services</td>
<td>$1,261,744.28</td>
</tr>
<tr>
<td>Maintenance Overhead</td>
<td>$63,087.21</td>
</tr>
<tr>
<td><strong>Total Maintenance</strong></td>
<td><strong>$2,902,011.85</strong></td>
</tr>
</tbody>
</table>

### Operating Overhead

<table>
<thead>
<tr>
<th>Item</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>General Plant Overhead</td>
<td>$706,391.81</td>
</tr>
<tr>
<td>Mechanical Department Services</td>
<td>$238,780.33</td>
</tr>
<tr>
<td>Employee Relations Department</td>
<td>$587,001.64</td>
</tr>
<tr>
<td>Business Services</td>
<td>$736,239.35</td>
</tr>
<tr>
<td><strong>Total Operating Overhead</strong></td>
<td><strong>$2,268,413.12</strong></td>
</tr>
</tbody>
</table>

### Property Tax and Insurance

<table>
<thead>
<tr>
<th>Item</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Property Taxes and Insurance</td>
<td>$560,775.24</td>
</tr>
</tbody>
</table>

### Other Annual Expenses

<table>
<thead>
<tr>
<th>Item</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rental Fees:</td>
<td>-</td>
</tr>
<tr>
<td>Licensing Fees:</td>
<td>-</td>
</tr>
<tr>
<td>Miscellaneous</td>
<td>-</td>
</tr>
<tr>
<td><strong>Total Other Annual Expenses</strong></td>
<td><strong>-</strong></td>
</tr>
<tr>
<td><strong>Total Fixed Costs</strong></td>
<td><strong>$14,540,000.21</strong></td>
</tr>
</tbody>
</table>
## Investment Summary

### Bare Module Costs

<table>
<thead>
<tr>
<th>Item</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fabricated Equipment</td>
<td>$3,627,253.46</td>
</tr>
<tr>
<td>Process Machinery</td>
<td>$8,257,917.60</td>
</tr>
<tr>
<td>Spares</td>
<td>$7,299,540.00</td>
</tr>
<tr>
<td>Storage</td>
<td>$663,828.00</td>
</tr>
<tr>
<td>Other Equipment</td>
<td>$1,752,972.40</td>
</tr>
<tr>
<td>Catalysts</td>
<td>-</td>
</tr>
<tr>
<td>Computers, Software, Etc.</td>
<td>-</td>
</tr>
</tbody>
</table>

**Total Bare Module Costs:** $21,601,511.45

### Direct Permanent Investment

<table>
<thead>
<tr>
<th>Item</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cost of Site Preparations</td>
<td>$1,080,075.57</td>
</tr>
<tr>
<td>Cost of Service Facilities</td>
<td>$1,080,075.57</td>
</tr>
<tr>
<td>Allocated Costs for Utility Plants and Related Facilities</td>
<td>-</td>
</tr>
</tbody>
</table>

**Direct Permanent Investment:** $23,761,662.60

### Total Depreciable Capital

*Cost of Contingencies & Contractor Fees* $4,277,099.27

**Total Depreciable Capital:** $28,038,761.86

### Total Permanent Investment

<table>
<thead>
<tr>
<th>Item</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cost of Land</td>
<td>$560,775.24</td>
</tr>
<tr>
<td>Cost of Royalties</td>
<td>-</td>
</tr>
<tr>
<td>Cost of Plant Start-Up</td>
<td>$2,803,876.19</td>
</tr>
</tbody>
</table>

**Total Permanent Investment:** $31,403,413.29

*Site Factor: 1.00*
## Investment Summary

<table>
<thead>
<tr>
<th></th>
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<th>2016</th>
<th>2017</th>
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<td>Product Unit Price</td>
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<td>------</td>
<td>-----------------------------</td>
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<tr>
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<td>-</td>
<td>-</td>
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**Cash Flow Summary**
Profitability Measures

The Internal Rate of Return (IRR) for this project is **242.81%**

The Net Present Value (NPV) of this project in 2014 is **$961,892,600**

**ROI Analysis (Third Production Year)**

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<tr>
<th>Description</th>
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<tr>
<td>Annual Sales</td>
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<tr>
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<td>Net Earnings</td>
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## Sensitivity Analysis

Vary Initial Value by +/-

- **x-axis**: 50%
- **y-axis**: 50%

### Variable Costs

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<td>129.77%</td>
<td>125.68%</td>
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<td>180.81%</td>
<td>177.10%</td>
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<td>203.16%</td>
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<td>242.81%</td>
<td>239.52%</td>
<td>236.23%</td>
<td>232.94%</td>
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<td>257.31%</td>
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<td>292.25%</td>
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<td>286.33%</td>
<td>283.37%</td>
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<td>320.01%</td>
<td>317.23%</td>
<td>314.46%</td>
<td>311.69%</td>
<td>308.92%</td>
<td>306.14%</td>
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</table>
Appendix E – CIP and SIP Procedure

CIP and SIP are common methods used for cleaning tools used in chemical plants. They are easy to use and are cost effective. The pharmaceutical industry uses these methods more than most industries, due to the strict FDA regulations inherent in many of the processes. FDA approval is necessary for all equipment used in each batch, and these standard cleaning procedures further ensure validation. This procedure is the standard CIP procedure that was used to clean all mixing tanks and pipes:

1. Pre-Rinse: Each vessel is cleansed using WFI that is equivalent to half of the volume of the vessel, for about 10 minutes. We want to remove all of the “loosest” material with this initial step.
2. Alkaline Wash: 0.5 M NaOH cleaning solution is sprayed into the vessel for 30 minutes at an amount equal to half of the volume.
3. Post Rinse: Rinse the cleaning solution with WFI (equal to half of the vessel volume) for 10 minutes.
4. Acid Rinse: 5% H₃PO₄ is sprayed into tank for 30 minutes at an amount equal to half of the vessel’s volume. This acid will neutralize the previous base step and remove any mineral deposits.
5. Wash: WFI equal to half of the vessel’s volume is used to wash off the acid solution for 10 minutes.
6. Final Rinse: WFI equal to half of the vessel’s volume is used for 10 minutes to complete a final wash.

Manufacturers of diafiltration and ultrafiltration units use a different procedure for CIP: WFI is flushed through the entire system at 50°C, followed by a wash of NaOCl solution with pH = 10-11 for 60 minutes. Lastly, a final wash of WFI through the system again at 50°C is used.

For the equipment that needs Steam In Place (SIP) before use, water steam at 152°C is sprayed at a volumetric flow rate of 3lb/hr per feet squared for approximately 30 minutes. Once this is completed, all equipment usage is the same, followed by the CIP procedure as listed above.
Appendix F – Stream Reports

Upstream Process

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<th>Stream Name</th>
<th>S-101</th>
<th>S-103</th>
<th>S-105</th>
<th>hESCs</th>
<th>Neurons</th>
<th>Differentiated Cells</th>
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<td>P-7</td>
<td>P-5</td>
<td>P-7</td>
<td>P-10</td>
<td>P-21</td>
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</tr>
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<td>(per batch)</td>
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<td>Temperature (°C)</td>
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<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
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<tr>
<td><strong>Component Flowrates (per batch)</strong></td>
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<td>5.31</td>
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Appendix G – MSDS and Vendor Spec Sheets

All of the MSDS and Vendor Spec Sheets are attached to this report, following the References section. MSDS Sheets were found for all of the chemicals used throughout our process. Vendor Spec Sheets, including prices, are provided for all of the equipment we would need to use in the facility.
References


*Maintenance of Human Pluripotent Stem Cells in MTeSR1 and TeSR2*. N.p.: Stemcell Technologies, 2014. PDF.


*Neural Stem Cells & Differentiation Markers*. Minneapolis: R&D Systems, 2011. PDF


SAFETY DATA SHEET

1. Identification of the substance/mixture and of the company/undertaking

Identification of the substance/preparation

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<th>Product code</th>
<th>A1110501</th>
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<tbody>
<tr>
<td>Product name</td>
<td>STEMPRO® ACCUTASE™ Cell Dissociation Reagent</td>
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Company/Undertaking Identification

| Life Technologies | Life Technologies |
| 5791 Van Allen Way | 5250 Mainway Drive |
| PO Box 6482 | Burlington, ONT |
| Carlsbad, CA 92008 | CANADA L7L 6A4 |
| +1 760 603 7200 | 800/263-6236 |

24 hour Emergency Response:

| 866-536-0631 |
| 301-431-8585 |
| Outside of the U.S. +1-301-431-8585 |

For research use only. Not intended for human or animal diagnostic or therapeutic uses.

2. Hazards identification

GHS - Classification

Signal Word
not hazardous

Health Hazard
not hazardous

Physical Hazards
not hazardous

Principle Routes of Exposure/
Potential Health effects

| Eyes | May cause eye irritation with susceptible persons. |
| Skin | May cause skin irritation in susceptible persons. |
| Inhalation | May be harmful by inhalation. |
| Ingestion | May be harmful if swallowed. |
Specific effects

- Carcinogenic effects: none
- Mutagenic effects: none
- Reproductive toxicity: none
- Sensitization: none

Target Organ Effects: No known effects under normal use conditions.

HMIS

<p>| | |</p>
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<tr>
<td>Reactivity</td>
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</table>

3. Composition/information on ingredients

The product contains no substances which at their given concentration, are considered to be hazardous to health. We recommend handling all chemicals with caution.

4. First aid measures

Skin contact: Rinse with plenty of water. If symptoms arise, call a physician.
Eye contact: Rinse immediately with plenty of water, also under the eyelids, for at least 15 minutes. If symptoms persist, call a physician.
Ingestion: Never give anything by mouth to an unconscious person. If symptoms persist, call a physician. Do not induce vomiting without medical advice.
Inhalation: Move to fresh air. If symptoms persist, call a physician. If not breathing, give artificial respiration.
Notes to physician: Treat symptomatically.

5. Fire-fighting measures

Special protective equipment for firefighters: Wear self-contained breathing apparatus and protective suit.

6. Accidental release measures

Personal precautions: Use personal protective equipment.
Methods for cleaning up: Soak up with inert absorbent material.

Environmental precautions

Prevent further leakage or spillage if safe to do so.

See Section 12 for additional information.

7. Handling and storage
Handling

Always wear recommended Personal Protective Equipment. No special handling advice required.

Storage

Keep in a dry, cool and well-ventilated place.

8. Exposure controls/personal protection

Exposure limits

We are not aware of any national exposure limit.

Engineering measures

Ensure adequate ventilation, especially in confined areas.

Personal protective equipment

Personal Protective Equipment requirements are dependent on the user institution’s risk assessment and are specific to the risk assessment for each laboratory where this material may be used.

Respiratory protection

In case of insufficient ventilation wear suitable respiratory equipment.

Hand protection

Impervious gloves.

Eye protection

Safety glasses with side-shields.

Skin and body protection.

Lightweight protective clothing.

Hygiene measures

Handle in accordance with good industrial hygiene and safety practice.

Environmental exposure controls

Prevent product from entering drains.

9. Physical and chemical properties

General Information

Form

liquid

Appearance

No information available

Odor

No information available

Boiling Point/Range

°C no data available

°F no data available

Melting point/range

°C no data available

°F no data available

Flash point

°C no data available

°F no data available

Autoignition temperature

°C no data available

°F no data available

Oxidizing properties

No information available.

Water solubility

soluble

10. Stability and reactivity

Stability

Stable under normal conditions.

Materials to avoid

No dangerous reaction known under conditions of normal use.

Hazardous decomposition products

None under normal use

Polymerization

Hazardous polymerisation does not occur.

11. Toxicological information

Acute toxicity

...
Principle Routes of Exposure/ Potential Health effects

<table>
<thead>
<tr>
<th>Principle Routes of Exposure</th>
<th>Potential Health effects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eyes</td>
<td>May cause eye irritation with susceptible persons.</td>
</tr>
<tr>
<td>Skin</td>
<td>May cause skin irritation in susceptible persons.</td>
</tr>
<tr>
<td>Inhalation</td>
<td>May be harmful by inhalation.</td>
</tr>
<tr>
<td>Ingestion</td>
<td>May be harmful if swallowed.</td>
</tr>
<tr>
<td>Carcinogenic effects</td>
<td>none</td>
</tr>
<tr>
<td>Mutagenic effects</td>
<td>none</td>
</tr>
<tr>
<td>Reproductive toxicity</td>
<td>none</td>
</tr>
<tr>
<td>Sensitization</td>
<td>none</td>
</tr>
<tr>
<td><strong>Target Organ Effects</strong></td>
<td><strong>No known effects under normal use conditions.</strong></td>
</tr>
</tbody>
</table>

12. Ecological information

- **Ecotoxicity effects**: No information available.
- **Mobility**: No information available.
- **Biodegradation**: Inherently biodegradable
- **Bioaccumulation**: Does not bioaccumulate.

13. Disposal considerations

Dispose of in accordance with local regulations.

14. Transport information

- **IATA**
  - **Proper shipping name**: Not classified as dangerous in the meaning of transport regulations
  - **Hazard class**: none
  - **Subsidiary Class**: none
  - **Packing group**: none
  - **UN-No**: None
15. Regulatory information

U.S. Federal Regulations

SARA 313
This product is not regulated by SARA.

Clean Air Act, Section 112 Hazardous Air Pollutants (HAPs) (see 40 CFR 61)
This product does not contain HAPs.

U.S. State Regulations

California Proposition 65
This product does not contain chemicals listed under Proposition 65

WHMIS Hazard Class
Non-controlled

This product has been classified according to the hazard criteria of the CPR and the MSDS contains all of the information required by the CPR

16. Other information

Reason for Revision (M)SDS sections updated.

For research use only. Not intended for human or animal diagnostic or therapeutic uses.

The above information was acquired by diligent search and/or investigation and the recommendations are based on prudent application of professional judgment. The information shall not be taken as being all inclusive and is to be used only as a guide. All materials and mixtures may present unknown hazards and should be used with caution. Since the Company cannot control the actual methods, volumes, or conditions of use, the Company shall not be held liable for any damages or losses resulting from the handling or from contact with the product as described herein.

THE INFORMATION IN THIS MSDS DOES NOT CONSTITUTE A WARRENTY, EXPRESSED OR IMPLIED, INCLUDING ANY IMPLIED WARRANTY OF MERCHANTABILITY OR FITNESS FOR ANY PARTICULAR PURPOSE.

End of Safety Data Sheet
1. PRODUCT AND COMPANY IDENTIFICATION

1.1 Product identifiers

Product name: Dimethyl sulfoxide

Product Number: D5879
Brand: Sigma-Aldrich
REACH No.: A registration number is not available for this substance as the substance or its uses are exempted from registration, the annual tonnage does not require a registration or the registration is envisaged for a later registration deadline.

CAS-No.: 67-68-5

1.2 Relevant identified uses of the substance or mixture and uses advised against

Identified uses: Laboratory chemicals, Manufacture of substances

1.3 Details of the supplier of the safety data sheet

Company: Sigma-Aldrich
3050 Spruce Street
SAINT LOUIS MO 63103
USA

Telephone: +1 800-325-5832
Fax: +1 800-325-5052

1.4 Emergency telephone number

Emergency Phone #: (314) 776-6555

2. HAZARDS IDENTIFICATION

2.1 Classification of the substance or mixture

GHS Classification in accordance with 29 CFR 1910 (OSHA HCS)
Flammable liquids (Category 4), H227

For the full text of the H-Statements mentioned in this Section, see Section 16.

2.2 GHS Label elements, including precautionary statements

Pictogram: none
Signal word: Warning

Hazard statement(s)
H227: Combustible liquid

Precautionary statement(s)
P210: Keep away from heat/sparks/open flames/hot surfaces. - No smoking.
P280: Wear protective gloves/ protective clothing/ eye protection/ face protection.
P370 + P378: In case of fire: Use dry sand, dry chemical or alcohol-resistant foam for extinction.
P403 + P235: Store in a well-ventilated place. Keep cool.
P501: Dispose of contents/ container to an approved waste disposal plant.

2.3 Hazards not otherwise classified (HNOC) or not covered by GHS - none
3. COMPOSITION/INFORMATION ON INGREDIENTS

3.1 Substances
Chemical characterization: Natural product
Synonyms: DMSO, Methyl sulfoxide

Formula: \( \text{C}_2\text{H}_6\text{OS} \)
Molecular Weight: 78.13 g/mol
CAS-No.: 67-68-5
EC-No.: 200-664-3

Hazardous components

<table>
<thead>
<tr>
<th>Component</th>
<th>Classification</th>
<th>Concentration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dimethyl sulfoxide</td>
<td>Flam. Liq. 4; H227</td>
<td>-</td>
</tr>
</tbody>
</table>

For the full text of the H-Statements mentioned in this Section, see Section 16.

4. FIRST AID MEASURES

4.1 Description of first aid measures

**General advice**
Consult a physician. Show this safety data sheet to the doctor in attendance. Move out of dangerous area.

**If inhaled**
If breathed in, move person into fresh air. If not breathing, give artificial respiration. Consult a physician.

**In case of skin contact**
Wash off with soap and plenty of water. Consult a physician.

**In case of eye contact**
Flush eyes with water as a precaution.

**If swallowed**
Do NOT induce vomiting. Never give anything by mouth to an unconscious person. Rinse mouth with water. Consult a physician.

4.2 Most important symptoms and effects, both acute and delayed
The most important known symptoms and effects are described in the labelling (see section 2.2) and/or in section 11

4.3 Indication of any immediate medical attention and special treatment needed
no data available

5. FIREFIGHTING MEASURES

5.1 Extinguishing media

**Suitable extinguishing media**
For small (incipient) fires, use media such as "alcohol" foam, dry chemical, or carbon dioxide. For large fires, apply water from as far as possible. Use very large quantities (flooding) of water applied as a mist or spray; solid streams of water may be ineffective. Cool all affected containers with flooding quantities of water.

5.2 Special hazards arising from the substance or mixture
Carbon oxides, Sulphur oxides

5.3 Advice for firefighters
Wear self contained breathing apparatus for fire fighting if necessary.

5.4 Further information
Use water spray to cool unopened containers.
6. ACCIDENTAL RELEASE MEASURES

6.1 Personal precautions, protective equipment and emergency procedures
Avoid breathing vapours, mist or gas. Remove all sources of ignition. Beware of vapours accumulating to form explosive concentrations. Vapours can accumulate in low areas. For personal protection see section 8.

6.2 Environmental precautions
Prevent further leakage or spillage if safe to do so. Do not let product enter drains.

6.3 Methods and materials for containment and cleaning up
Contain spillage, and then collect with an electrically protected vacuum cleaner or by wet-brushing and place in container for disposal according to local regulations (see section 13). Keep in suitable, closed containers for disposal.

6.4 Reference to other sections
For disposal see section 13.

7. HANDLING AND STORAGE

7.1 Precautions for safe handling
Avoid inhalation of vapour or mist. Keep away from sources of ignition - No smoking. Take measures to prevent the build up of electrostatic charge. For precautions see section 2.2.

7.2 Conditions for safe storage, including any incompatibilities
Keep container tightly closed in a dry and well-ventilated place. Store under inert gas. hygroscopic

7.3 Specific end use(s)
Apart from the uses mentioned in section 1.2 no other specific uses are stipulated

8. EXPOSURE CONTROLS/PERSONAL PROTECTION

8.1 Control parameters

<table>
<thead>
<tr>
<th>Component</th>
<th>CAS-No.</th>
<th>Value</th>
<th>Control parameters</th>
<th>Basis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dimethyl sulfoxide</td>
<td>67-68-5</td>
<td>TWA</td>
<td>250 ppm</td>
<td>USA. Workplace Environmental Exposure Levels (WEEL)</td>
</tr>
</tbody>
</table>

8.2 Exposure controls

Appropriate engineering controls
Handle in accordance with good industrial hygiene and safety practice. Wash hands before breaks and at the end of workday.

Personal protective equipment

**Eye/face protection**
Safety glasses with side-shields conforming to EN166 Use equipment for eye protection tested and approved under appropriate government standards such as NIOSH (US) or EN 166(EU).

**Skin protection**
Handle with gloves. Gloves must be inspected prior to use. Use proper glove removal technique (without touching glove's outer surface) to avoid skin contact with this product. Dispose of contaminated gloves after use in accordance with applicable laws and good laboratory practices. Wash and dry hands.

Splash contact
Material: Nitrile rubber
Minimum layer thickness: 0.2 mm
Break through time: 38 min
Material tested:Dermatriil® P (KCL 743 / Aldrich Z677388, Size M)

data source: KCL GmbH, D-36124 Eichenzell, phone +49 (0)6659 87300, e-mail sales@kcl.de, test method: EN374
If used in solution, or mixed with other substances, and under conditions which differ from EN 374, contact the supplier of the CE approved gloves. This recommendation is advisory only and must be evaluated by an industrial hygienist and safety officer familiar with the specific situation of anticipated use by our customers. It should not be construed as offering an approval for any specific use scenario.

**Body Protection**
impervious clothing. The type of protective equipment must be selected according to the concentration and amount of the dangerous substance at the specific workplace.

**Respiratory protection**
Where risk assessment shows air-purifying respirators are appropriate use a full-face respirator with multipurpose combination (US) or type ABEK (EN 14387) respirator cartridges as a backup to engineering controls. If the respirator is the sole means of protection, use a full-face supplied air respirator. Use respirators and components tested and approved under appropriate government standards such as NIOSH (US) or CEN (EU).

**Control of environmental exposure**
Prevent further leakage or spillage if safe to do so. Do not let product enter drains.

### 9. PHYSICAL AND CHEMICAL PROPERTIES

#### 9.1 Information on basic physical and chemical properties

| a) Appearance | Form: liquid, clear  
| Colour: colourless |
| b) Odour | no data available |
| c) Odour Threshold | no data available |
| d) pH | no data available |
| e) Melting point/freezing point | Melting point/range: 16 - 19 °C (61 - 66 °F) |
| f) Initial boiling point and boiling range | 189 °C (372 °F) |
| g) Flash point | 87 °C (189 °F) - closed cup |
| h) Evaporation rate | no data available |
| i) Flammability (solid, gas) | no data available |
| j) Upper/lower flammability or explosive limits | Upper explosion limit: 42 % (V)  
| Lower explosion limit: 3.5 % (V) |
| k) Vapour pressure | 0.55 hPa (0.41 mmHg) at 20 °C (68 °F) |
| l) Vapour density | 2.70 - (Air = 1.0) |
| m) Relative density | 1.1 g/mL |
| n) Water solubility | completely miscible |
| o) Partition coefficient: n-octanol/water | log Pow: -2.03 |
| p) Auto-ignition temperature | no data available |
| q) Decomposition temperature | no data available |
| r) Viscosity | no data available |
| s) Explosive properties | no data available |
| t) Oxidizing properties | no data available |

#### 9.2 Other safety information

Relative vapour density: 2.70 - (Air = 1.0)
10. STABILITY AND REACTIVITY

10.1 Reactivity
no data available

10.2 Chemical stability
Stable under recommended storage conditions.

10.3 Possibility of hazardous reactions
no data available

10.4 Conditions to avoid
Heat, flames and sparks.

10.5 Incompatible materials
Acid chlorides, Phosphorus halides, Strong acids, Strong oxidizing agents, Strong reducing agents

10.6 Hazardous decomposition products
Other decomposition products - no data available
In the event of fire: see section 5

11. TOXICOLOGICAL INFORMATION

11.1 Information on toxicological effects

Acute toxicity
LD50 Oral - rat - 14,500 mg/kg
LC50 Inhalation - rat - 4 h - 40250 ppm
LD50 Dermal - rabbit - > 5,000 mg/kg
no data available

Skin corrosion/irritation
no data available

Serious eye damage/eye irritation
no data available

Respiratory or skin sensitisation
no data available

Germ cell mutagenicity
mouse
lymphocyte
Cytogenetic analysis
mouse
lymphocyte
Mutation in mammalian somatic cells.

rat
Cytogenetic analysis

mouse
DNA damage

Carcinogenicity
Carcinogenicity - rat - Oral
Tumorigenic: Equivocal tumorigenic agent by RTECS criteria. Skin and Appendages: Other: Tumors.
Carcinogenicity - mouse - Oral
Tumorigenic: Equivocal tumorigenic agent by RTECS criteria. Leukaemia Skin and Appendages: Other: Tumors.

IARC: No component of this product present at levels greater than or equal to 0.1% is identified as probable, possible or confirmed human carcinogen by IARC.
ACGIH: No component of this product present at levels greater than or equal to 0.1% is identified as a carcinogen or potential carcinogen by ACGIH.

NTP: No component of this product present at levels greater than or equal to 0.1% is identified as a known or anticipated carcinogen by NTP.

OSHA: No component of this product present at levels greater than or equal to 0.1% is identified as a carcinogen or potential carcinogen by OSHA.

**Reproductive toxicity**

Reproductive toxicity - rat - Intraperitoneal
Effects on Fertility: Abortion.

Reproductive toxicity - rat - Intraperitoneal
Effects on Fertility: Post-implantation mortality (e.g., dead and/or resorbed implants per total number of implants).

Reproductive toxicity - rat - Subcutaneous
Effects on Fertility: Post-implantation mortality (e.g., dead and/or resorbed implants per total number of implants).
Effects on Fertility: Litter size (e.g.; # fetuses per litter; measured before birth).

Reproductive toxicity - mouse - Oral
Effects on Fertility: Pre-implantation mortality (e.g., reduction in number of implants per female; total number of implants per corpora lutea). Effects on Embryo or Fetus: Fetotoxicity (except death, e.g., stunted fetus). Specific Developmental Abnormalities: Musculoskeletal system.

Developmental Toxicity - mouse - Intraperitoneal
Effects on Embryo or Fetus: Fetotoxicity (except death, e.g., stunted fetus). Specific Developmental Abnormalities: Musculoskeletal system.

**Specific target organ toxicity**

- **single exposure**
  no data available

- **repeated exposure**
  no data available

**Aspiration hazard**
no data available

**Additional Information**

RTECS: PV6210000
Effects due to ingestion may include; Nausea, Fatigue, Headache

Eyes - Eye disease - Based on Human Evidence
Eyes - Eye disease - Based on Human Evidence

---

### 12. ECOLOGICAL INFORMATION

#### 12.1 Toxicity

Toxicity to fish
- LC50 - Pimephales promelas (fathead minnow) - 34,000 mg/l - 96 h
- LC50 - Oncorhynchus mykiss (rainbow trout) - 35,000 mg/l - 96 h

Toxicity to daphnia and other aquatic invertebrates
- EC50 - Daphnia pulex (Water flea) - 27,500 mg/l

#### 12.2 Persistence and degradability
no data available

#### 12.3 Bioaccumulative potential
no data available

#### 12.4 Mobility in soil
no data available

#### 12.5 Results of PBT and vPvB assessment
PBT/vPvB assessment not available as chemical safety assessment not required/not conducted
12.6 Other adverse effects
no data available

13. DISPOSAL CONSIDERATIONS

13.1 Waste treatment methods

Product
This combustible material may be burned in a chemical incinerator equipped with an afterburner and scrubber. Offer surplus and non-recyclable solutions to a licensed disposal company.

Contaminated packaging
Dispose of as unused product.

14. TRANSPORT INFORMATION

DOT (US)
NA-Number: 1993  Class: NONE  Packing group: III
Proper shipping name: Combustible liquid, n.o.s. (Dimethyl sulfoxide) (Dimethyl sulfoxide)
Marine pollutant: No
Poison Inhalation Hazard: No

IMDG
Not dangerous goods

IATA
Not dangerous goods

15. REGULATORY INFORMATION

REACH No. : A registration number is not available for this substance as the substance or its uses are exempted from registration, the annual tonnage does not require a registration or the registration is envisaged for a later registration deadline.

SARA 302 Components
SARA 302: No chemicals in this material are subject to the reporting requirements of SARA Title III, Section 302.

SARA 313 Components
SARA 313: This material does not contain any chemical components with known CAS numbers that exceed the threshold (De Minimis) reporting levels established by SARA Title III, Section 313.

SARA 311/312 Hazards
Fire Hazard, Chronic Health Hazard

Massachusetts Right To Know Components
No components are subject to the Massachusetts Right to Know Act.

Pennsylvania Right To Know Components

<table>
<thead>
<tr>
<th>Component</th>
<th>CAS-No.</th>
<th>Revision Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dimethyl sulfoxide</td>
<td>67-68-5</td>
<td>2007-03-01</td>
</tr>
</tbody>
</table>

New Jersey Right To Know Components

<table>
<thead>
<tr>
<th>Component</th>
<th>CAS-No.</th>
<th>Revision Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dimethyl sulfoxide</td>
<td>67-68-5</td>
<td>2007-03-01</td>
</tr>
</tbody>
</table>

California Prop. 65 Components
This product does not contain any chemicals known to State of California to cause cancer, birth defects, or any other reproductive harm.

16. OTHER INFORMATION

Full text of H-Statements referred to under sections 2 and 3.

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flam. Liq.</td>
<td>Flammable liquids</td>
</tr>
<tr>
<td>H227</td>
<td>Combustible liquid</td>
</tr>
</tbody>
</table>
HMIS Rating
Health hazard: 0
Chronic Health Hazard: *
Flammability: 2
Physical Hazard 0

NFPA Rating
Health hazard: 0
Fire Hazard: 2
Reactivity Hazard: 0

Further information
Copyright 2014 Sigma-Aldrich Co. LLC. License granted to make unlimited paper copies for internal use only.
The above information is believed to be correct but does not purport to be all inclusive and shall be used only as a
guide. The information in this document is based on the present state of our knowledge and is applicable to the
product with regard to appropriate safety precautions. It does not represent any guarantee of the properties of the
product. Sigma-Aldrich Corporation and its Affiliates shall not be held liable for any damage resulting from handling
or from contact with the above product. See www.sigma-aldrich.com and/or the reverse side of invoice or packing
slip for additional terms and conditions of sale.

Preparation Information
Sigma-Aldrich Corporation
Product Safety – Americas Region
1-800-521-8956

Version: 4.10 Revision Date: 02/21/2014 Print Date: 04/03/2014
Material Safety Data Sheet
Ethylene glycol MSDS

Section 1: Chemical Product and Company Identification

Product Name: Ethylene glycol
Catalog Codes: SLE1072
CAS#: 107-21-1
RTECS: KW2975000
TSCA: TSCA 8(b) inventory: Ethylene glycol
CI#: Not available.
Synonym: 1,2-Dihydroxyethane; 1,2-Ethanediol; 1,2-Ethandiol; Ethylene dihydrate; Glycol alcohol; Monoethylene glycol; Tescol
Chemical Name: Ethylene Glycol
Chemical Formula: HOCH2CH2OH

Contact Information:
Sciencelab.com, Inc.
14025 Smith Rd.
Houston, Texas 77396
US Sales: 1-800-901-7247
International Sales: 1-281-441-4400
Order Online: ScienceLab.com
CHEMTREC (24HR Emergency Telephone), call:
1-800-424-9300
International CHEMTREC, call: 1-703-527-3887
For non-emergency assistance, call: 1-281-441-4400

Section 2: Composition and Information on Ingredients

Composition:

<table>
<thead>
<tr>
<th>Name</th>
<th>CAS #</th>
<th>% by Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ethylene glycol</td>
<td>107-21-1</td>
<td>100</td>
</tr>
</tbody>
</table>

Toxicological Data on Ingredients: Ethylene glycol: ORAL (LD50): Acute: 4700 mg/kg [Rat]. 5500 mg/kg [Mouse]. 6610 mg/kg [Guinea pig]. VAPOR (LC50): Acute: &gt;200 mg/m 4 hours [Rat].

Section 3: Hazards Identification

Potential Acute Health Effects:
Hazardous in case of ingestion. Slightly hazardous in case of skin contact (irritant, permeator), of eye contact (irritant), of inhalation. Severe over-exposure can result in death.

Potential Chronic Health Effects:
CARCINOGENIC EFFECTS: A4 (Not classifiable for human or animal.) by ACGIH. MUTAGENIC EFFECTS: Mutagenic for mammalian somatic cells. Non-mutagenic for bacteria and/or yeast. TERATOGENIC EFFECTS: Not available. DEVELOPMENTAL TOXICITY: Not available. The substance may be toxic to kidneys, liver, central nervous system (CNS). Repeated or prolonged exposure to the substance can produce target organs damage. Repeated exposure to a highly toxic material may produce general deterioration of health by an accumulation in one or many human organs.

Section 4: First Aid Measures
Eye Contact:
Check for and remove any contact lenses. In case of contact, immediately flush eyes with plenty of water for at least 15 minutes. Cold water may be used. Get medical attention if irritation occurs.

Skin Contact:
Wash with soap and water. Cover the irritated skin with an emollient. Get medical attention if irritation develops. Cold water may be used.

Serious Skin Contact: Not available.

Inhalation:
If inhaled, remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Get medical attention immediately.

Serious Inhalation: Not available.

Ingestion:
Do NOT induce vomiting unless directed to do so by medical personnel. Never give anything by mouth to an unconscious person. If large quantities of this material are swallowed, call a physician immediately. Loosen tight clothing such as a collar, tie, belt or waistband.

Serious Ingestion:
Medical Conditions Aggravated by Exposure: Persons with pre-existing kidney, respiratory, eye, or neurological problems might be more sensitive to Ethylene Glycol. Notes to Physician: 1. Support vital functions, correct for dehydration and shock, and manage fluid balance. 2. The currently recommended medical management of Ethylene Glycol poisoning includes elimination of Ethylene Glycol and metabolites. Elimination of Ethylene Glycol may be achieved by the following methods: a. Emptying the stomach by gastric lavage. It is useful if initiated within < 1 of ingestion. b. Correct metabolic acidosis with intravenous administration of sodium bicarbonate, adjusting the administration rate according to repeated and frequent measurement of acid/base status. c. Administer ethanol (orally or by IV (intravenously)) or fomepizole (4-methylpyrazole or Antizol)) therapy by IV as an antidote to inhibit the formation of toxic metabolites. d. If patients are diagnosed and treated early in the course with the above methods, hemodialysis may be avoided if fomepizole or ethanol therapy is effective and has corrected the metabolic acidosis, and no renal failure is present. However, once severe acidosis and renal failure occurred, however, hemodialysis is necessary. It is effective in removing Ethylene Glycol and toxic metabolites, and correcting metabolic acidosis.

Section 5: Fire and Explosion Data

Flammability of the Product: May be combustible at high temperature.

Auto-Ignition Temperature: 398°C (748.4°F)

Flash Points:
CLOSED CUP: 111°C (231.8°F). (Tagliabue.)

Flammable Limits: LOWER: 3.2%

Products of Combustion: These products are carbon oxides (CO, CO2).

Fire Hazards in Presence of Various Substances:
Slightly flammable to flammable in presence of open flames and sparks, of heat. Non-flammable in presence of shocks.

Explosion Hazards in Presence of Various Substances:
Risks of explosion of the product in presence of mechanical impact: Not available. Risks of explosion of the product in presence of static discharge: Not available.

Fire Fighting Media and Instructions:
SMALL FIRE: Use DRY chemical powder. LARGE FIRE: Use water spray, fog or foam. Do not use water jet.

Special Remarks on Fire Hazards: Not available.

Special Remarks on Explosion Hazards:
Explosive decomposition may occur if combined with strong acids or strong bases and subjected to elevated temperatures.

Section 6: Accidental Release Measures
Small Spill:
Dilute with water and mop up, or absorb with an inert dry material and place in an appropriate waste disposal container. Finish cleaning by spreading water on the contaminated surface and dispose of according to local and regional authority requirements.

Large Spill:
Stop leak if without risk. Do not get water inside container. Do not touch spilled material. Use water spray to reduce vapors. Prevent entry into sewers, basements or confined areas; dike if needed. Eliminate all ignition sources. Call for assistance on disposal. Finish cleaning by spreading water on the contaminated surface and allow to evacuate through the sanitary system. Be careful that the product is not present at a concentration level above TLV. Check TLV on the MSDS and with local authorities.

Section 7: Handling and Storage

Precautions:
Keep away from heat. Keep away from sources of ignition. Empty containers pose a fire risk, evaporate the residue under a fume hood. Ground all equipment containing material. Do not ingest. Do not breathe gas/fumes/vapor/spray. Wear suitable protective clothing. If ingested, seek medical advice immediately and show the container or the label. Keep away from incompatibles such as oxidizing agents, acids, alkalis.

Storage: Keep container tightly closed. Keep container in a cool, well-ventilated area. Hygroscopic

Section 8: Exposure Controls/Personal Protection

Engineering Controls:
Provide exhaust ventilation or other engineering controls to keep the airborne concentrations of vapors below their respective threshold limit value. Ensure that eyewash stations and safety showers are proximal to the work-station location.

Personal Protection:
Safety glasses. Synthetic apron. Gloves (impervious). For most conditions, no respiratory protection should be needed. However, if material is heated or sprayed and if atmospheric levels exceed exposure guidelines, use an approved vapor (air purifying) respirator.

Personal Protection in Case of a Large Spill:
Splash goggles. Full suit. Boots. Gloves. Suggested protective clothing might not be sufficient; consult a specialist BEFORE handling this product.

Exposure Limits:
STEL: 120 (mg/m3) [Australia] TWA: 100 (mg/m3) from ACGIH (TLV) [United States] CEIL: 125 (mg/m3) from OSHA (PEL) [United States] CEIL: 50 (ppm) from OSHA (PEL) [United States] TWA: 52 STEL: 104 (mg/m3) [United Kingdom (UK)] Inhalation TWA: 10 (mg/m3) [United Kingdom (UK)] SKIN3 Consult local authorities for acceptable exposure limits.

Section 9: Physical and Chemical Properties

Physical state and appearance: Liquid. (syrupy)
Odor: Odorless.
Taste: Mild sweet
Molecular Weight: 62.07 g/mole
Color: Clear Colorless.
\[\text{pH (1\% soln/water)}\]: Not available.
Boiling Point: 197.6°C (387.7°F)
Melting Point: -13°C (8.6°F)
<table>
<thead>
<tr>
<th><strong>Critical Temperature:</strong></th>
<th>Not available.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Specific Gravity:</strong></td>
<td>1.1088 (Water = 1)</td>
</tr>
<tr>
<td><strong>Vapor Pressure:</strong></td>
<td>.06 mmHg @ 20 C; .092 mmHg at 25 C</td>
</tr>
<tr>
<td><strong>Vapor Density:</strong></td>
<td>2.14 (Air = 1)</td>
</tr>
<tr>
<td><strong>Volatile:</strong></td>
<td>Not available.</td>
</tr>
<tr>
<td><strong>Odor Threshold:</strong></td>
<td>Not available.</td>
</tr>
<tr>
<td><strong>Water/Oil Dist. Coeff.:</strong></td>
<td>The product is more soluble in water; log(oil/water) = -1.4</td>
</tr>
<tr>
<td><strong>Ionicity (in Water):</strong></td>
<td>Not available.</td>
</tr>
<tr>
<td><strong>Dispersion Properties:</strong></td>
<td>See solubility in water, acetone.</td>
</tr>
<tr>
<td><strong>Solubility:</strong></td>
<td>Soluble in cold water, hot water, acetone. Slightly soluble in diethyl ether. Miscible with lower aliphatic alcohols, glycerol, acetic acid, acetone and similar ketones, aldehydes, pyridine, similar coal tar bases. Practically insoluble in benzene and its homologs, chlorinated hydrocarbons, petroleum ether.</td>
</tr>
</tbody>
</table>

### Section 10: Stability and Reactivity Data

<table>
<thead>
<tr>
<th><strong>Stability:</strong></th>
<th>The product is stable.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Instability Temperature:</strong></td>
<td>Not available.</td>
</tr>
<tr>
<td><strong>Conditions of Instability:</strong></td>
<td>Excess heat, incompatible materials.</td>
</tr>
<tr>
<td><strong>Incompatibility with various substances:</strong></td>
<td>Reactive with oxidizing agents, acids, alkalis.</td>
</tr>
<tr>
<td><strong>Corrosivity:</strong></td>
<td>Non-corrosive in presence of glass.</td>
</tr>
<tr>
<td><strong>Special Remarks on Reactivity:</strong></td>
<td>Hygroscopic. Absorbs moisture from the air. Avoid contamination with materials with hydroxyl compounds. Also incompatible with aliphatic amines, isocyanates, chlorosulfonic acid, and oleum</td>
</tr>
<tr>
<td><strong>Special Remarks on Corrosivity:</strong></td>
<td>Not available.</td>
</tr>
<tr>
<td><strong>Polymerization:</strong></td>
<td>Will not occur.</td>
</tr>
</tbody>
</table>

### Section 11: Toxicological Information

<table>
<thead>
<tr>
<th><strong>Routes of Entry:</strong></th>
<th>Absorbed through skin. Ingestion.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Toxicity to Animals:</strong></td>
<td>Acute oral toxicity (LD50): 4700 mg/kg [Rat]. Acute toxicity of the vapor (LC50): &gt;200 mg/m3 4 hours [Rat].</td>
</tr>
<tr>
<td><strong>Chronic Effects on Humans:</strong></td>
<td>CARCINOGENIC EFFECTS: A4 (Not classifiable for human or animal.) by ACGIH. MUTAGENIC EFFECTS: Mutagenic for mammalian somatic cells. Non-mutagenic for bacteria and/or yeast. May cause damage to the following organs: kidneys, liver, central nervous system (CNS).</td>
</tr>
<tr>
<td><strong>Other Toxic Effects on Humans:</strong></td>
<td>Hazardous in case of ingestion. Slightly hazardous in case of skin contact (irritant, permeator), of inhalation.</td>
</tr>
<tr>
<td><strong>Special Remarks on Toxicity to Animals:</strong></td>
<td>Lowest Published Toxic Dose/Conc: TDL [Man] - Route: oral; Dose: 15gm/kg Lethal Dose/Conc 50% Kill LD50 [Rabbit] - Route: dermal; Dose: 9530 ul/kg</td>
</tr>
<tr>
<td><strong>Special Remarks on Chronic Effects on Humans:</strong></td>
<td>May cause adverse reproductive effects and birth defects (teratogenic) based on animal test data. No human data has been reported at this time. May affect genetic material (mutagenic).</td>
</tr>
</tbody>
</table>
Special Remarks on other Toxic Effects on Humans:
Acute Potential Health Effects: Skin: May cause skin irritation. May cause more severe response if skin is abraded. A single prolonged exposure is not likely to result in material being absorbed through skin in harmful amounts. Massive contact with damaged skin may result in absorption of potentially harmful amounts Eyes: Vapors or mist may cause temporary eye irritation (mild temporary conjunctival inflammation) and lacrimation. Corneal injury is unlikely or insignificant. Ingestion: It is rapidly absorbed from the gastrointestinal tract. Oral toxicity is expected to be moderate in humans due to Ethylene Glycol even though tests with animals show a lower degree of toxicity. Excessive exposure (swallowing large amounts) may cause gastrointestinal tract irritation with nausea, vomiting, abdominal discomfort, diarrhea. It can affect behavior/central nervous system within 0.5 to 12 hours after ingestion. A transient inebriation with excitement, stupor, headache, slurred speech, ataxia, somnolence, and euphoria, similar to ethanol intoxication, can occur within the first several hours. As the Ethylene Glycol is metabolized, metabolic acidosis and further central nervous system depression (convulsions, muscle weakness) develop. Serious intoxication may develop to coma associated with hypotonia, hyporeflexia, and less commonly seizures, and meningismus. 12 to 24 hours

<table>
<thead>
<tr>
<th>Section 12: Ecological Information</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Ecotoxicity:</strong></td>
</tr>
<tr>
<td>Ecotoxicity in water (LC50): 41000 mg/l 96 hours [Fish (Trout)]. 46300 mg/l 48 hours [water flea]. 34250 mg/l 96 hours [Fish (bluegill fish)]. 34250 mg/l 72 hours [Fish (Goldfish)].</td>
</tr>
<tr>
<td><strong>BOD5 and COD:</strong> Not available.</td>
</tr>
<tr>
<td><strong>Products of Biodegradation:</strong></td>
</tr>
<tr>
<td>Possibly hazardous short term degradation products are not likely. However, long term degradation products may arise.</td>
</tr>
<tr>
<td><strong>Toxicity of the Products of Biodegradation:</strong> The products of degradation are less toxic than the product itself.</td>
</tr>
<tr>
<td><strong>Special Remarks on the Products of Biodegradation:</strong> Not available.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Section 13: Disposal Considerations</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Waste Disposal:</strong> Waste must be disposed of in accordance with federal, state and local environmental control regulations.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Section 14: Transport Information</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>DOT Classification:</strong> Not a DOT controlled material (United States).</td>
</tr>
<tr>
<td><strong>Identification:</strong> Not applicable.</td>
</tr>
<tr>
<td><strong>Special Provisions for Transport:</strong> Not applicable.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Section 15: Other Regulatory Information</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Federal and State Regulations:</strong></td>
</tr>
<tr>
<td><strong>Other Regulations:</strong></td>
</tr>
</tbody>
</table>
**Other Classifications:**

**WHMIS (Canada):** CLASS D-2A: Material causing other toxic effects (VERY TOXIC).

**DSCL (EEC):**
R22- Harmful if swallowed. S46- If swallowed, seek medical advice immediately and show this container or label.

**HMIS (U.S.A.):**
- Health Hazard: 1
- Fire Hazard: 1
- Reactivity: 0
- Personal Protection: C

**National Fire Protection Association (U.S.A.):**
- Health: 1
- Flammability: 1
- Reactivity: 0
- Specific hazard:

**Protective Equipment:**
Gloves. Lab coat. Not applicable. Safety glasses.

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**Section 16: Other Information**

**References:** Not available.

**Other Special Considerations:** Not available.

**Created:** 10/10/2005 08:18 PM

**Last Updated:** 05/21/2013 12:00 PM

The information above is believed to be accurate and represents the best information currently available to us. However, we make no warranty of merchantability or any other warranty, express or implied, with respect to such information, and we assume no liability resulting from its use. Users should make their own investigations to determine the suitability of the information for their particular purposes. In no event shall ScienceLab.com be liable for any claims, losses, or damages of any third party or for lost profits or any special, indirect, incidental, consequential or exemplary damages, howsoever arising, even if ScienceLab.com has been advised of the possibility of such damages.
Material Safety Data Sheet

mTeSR™1 Basal Medium

1 Product and Company Identification

1.1 Product Name: mTeSR™1 Basal Medium
1.2 Catalog Number: 05851, 05871
1.3 Synonyms: Not Available
1.4 Product Use: Cell Culture
1.5 Manufacturer/Supplier: StemCell Technologies Inc. Suite 400, 570 West 7th Avenue Vancouver, BC V5Z 1B3 Canada
1.6 In Case of Emergency Call: 604-877-0713
1.7 Date Effective: October 30, 2012
1.8 Prepared By: Quality Control

2 Composition / Information on Ingredients

2.1 Component | CAS No. | %W/W
--- | --- | ---
No known hazardous components. | Not Available | Not Available

3 Hazards Identification

3.1 Emergency Overview: This product is a potential irritant to eyes, respiratory system, and skin. This product may also be harmful if ingested. Complete toxicological properties have yet to be determined.
3.2 Routes of Exposure: Absorbed through skin, eye contact, inhalation, and ingestion.
3.3 Potential Health Effects:
   3.3.1 Eye: May cause eye irritation.
   3.3.2 Skin: May cause skin irritation.
   3.3.3 Inhalation: May be harmful if inhaled. Material may be irritating to mucous membranes and upper respiratory tract.
   3.3.4 Ingestion: May be harmful if swallowed.
3.4 Chronic Effects/Carcinogenicity: Not Available
3.5 OSHA Regulatory Status: Not Available

4 First Aid Measures

4.1 Eyes: In case of contact with eyes, flush thoroughly with water. Call a physician.
4.2 Skin: In case of contact with skin, wash the affected area with soap and copious amounts of water. Should irritation occur, contact a physician.
4.3 Ingestion: If swallowed, wash out mouth with water provided person is conscious. Call a physician.
4.4 Inhalation: If inhaled, remove person to fresh air. If breathing becomes difficult, call a physician.
4.5 Puncture Wounds: Wash thoroughly with soap and water. Allow to bleed freely. Call a physician.
4.6 Note to Physician: Not Available

5 Fire Fighting Measures
5.1 Flash Point/Method: Not Available
5.2 Explosive Limits:
   5.2.1 Upper: Not Available
   5.2.2 Lower: Not Available
5.3 Autoignition Temperature: Not Available
5.4 Hazardous Combustion Products: Nature of combustion products not known.
5.5 Conditions of Flammability: Not Available
5.6 Extinguishing Media: Use media appropriate to the surrounding fire.
5.7 Fire Fighting Procedures: Not Available
5.8 Explosion Data:
   5.8.1 Sensitivity to Mechanical Impact: Not Available
   5.8.2 Sensitivity to Static Discharge: Not Available

6 Accidental Release Measures
6.1 Leak and Spill Procedure: Wear chemical-resistant gloves. Absorb spill and place in closed container for disposal. Ventilate and wash area thoroughly after clean-up is complete.

7 Handling and Storage
7.1 Handling: Should be handled by trained personnel observing good laboratory practices. Avoid breathing vapor. Avoid skin contact or swallowing.
7.2 Storage: Stored at 2-8°C.

8 Exposure Controls/Personal Protection
8.1 Engineering Controls: Use with adequate ventilation.
8.2 Personal Protective Equipment:
   8.2.1 Respiratory Protection: This is a laboratory-use product for which no industrial protective equipment has been designated.
   8.2.2 Eye Protection: Safety glasses.
   8.2.3 Skin Protection: Lab coat, latex gloves.
8.3 General Hygiene Considerations: Wash hands after use.
8.4 Exposure Limits:
   8.4.1 ACGIH TLV-TWA: Not Available
   8.4.2 OSHA PEL-TWA: Not Available
9 Physical/Chemical Properties:

9.1 Appearance: Transparent, red fluid
9.2 Odor: None
9.3 Physical State: Liquid
9.4 pH: 7.1 – 7.3
9.5 Boiling Point: Not Available
9.6 Melting Point: Not Available
9.7 Freezing Point: Not Available
9.8 Vapor Pressure: Not Available
9.9 Vapor Density: Not Available
9.10 Specific Gravity: Not Available
9.11 Evaporation Rate: Not Available
9.12 Solubility in Water: Not Available
9.13 Odor Threshold: Not Applicable
9.14 Coefficient of Water/Oil Distribution: Not Available

10 Stability/Reactivity:

10.1 Chemical Stability: Stable
10.2 Conditions to Avoid: Not Available
10.3 Incompatibility (Material to Avoid): Not Available
10.4 Hazardous Decomposition/By-Products: Nature of decomposition products not known.
10.5 Hazardous Polymerization: Not Available

11 Toxicological Information

11.1 Effects of Short-Term Exposure: Not Available
11.2 Effects of Long-Term Exposure: Not Available
11.3 Irritancy of Product: Not Available
11.4 Sensitization to Product: Not Available
11.5 Carcinogenicity: Not Available
11.6 Reproductive Toxicity: Not Available
11.7 Teratogenicity and Embryotoxicity: Not Available
11.8 Mutagenicity: Not Available
11.9 Name of Toxicologically Synergistic Products: Not Available
11.10 LD50 (specify species and route): Not Available
11.11 LC50 (specify species): Not Available

12 Ecological Information

12.1 Not Available

13 Disposal Considerations

13.1 Waste Disposal Method: Disposal should be in accordance with existing practices at your institution. Observe all Federal, Provincial/State and Local Laws.

14 Transport Information

14.1 Transport Canada

14.1.1 PIN No.: Not Available

14.2 U.S. Department of Transportation:

14.2.1 Proper Shipping Name: Not Available

14.2.2 Hazard Class: This substance is not known to be hazardous for transport.

14.2.3 ID. Number: Not Available

14.2.4 Packing Group: Not Available

14.2.5 Label Statement: Not Available

15 Regulatory Information

15.1 WHMIS Classification: Not Available

15.2 Note: This MSDS was prepared according to the Canadian Controlled Products Regulation and contains all the information required by those regulations.

16 Other Information

16.1 Preparation Information: Refer to PIS No. 05850_05870_05875; 05857

16.2 This MSDS has been revised in the following section(s): 9.4, 9.5, 9.7, 16.1, 16.5

16.3 Original Issue Date: July 5, 2010

16.4 Notice: The above information is believed to be correct but does not purport to be all inclusive and shall be used only as a guide. StemCell Technologies Inc., shall not be held liable for any damage resulting from handling or from contact with the product. The information contained in this Material Safety Data Sheet (MSDS) is current as of the Date Prepared shown in Section 1.7 of this document and may be subject to amendment by StemCell Technologies Inc.

16.5 Disclaimer: THIS PRODUCT IS FOR RESEARCH USE ONLY. NOT INTENDED FOR HUMAN OR ANIMAL DIAGNOSTIC OR THERAPEUTIC USES.
1 Product and Company Identification

1.1 Product Name: mTeSR™ 1 5X Supplement
1.2 Catalog Number: 05852
1.3 Synonyms: Not Available
1.4 Product Use: Cell Culture
1.5 Manufacturer/Supplier: STEMCELL Technologies Inc.
    Suite 400, 570 West 7th Avenue
    Vancouver, BC V5Z 1B3 Canada
1.6 In Case of Emergency Call: 604-877-0713
1.7 Date Prepared: October 30, 2012
1.8 Prepared By: Quality Control

2 Composition / Information on Ingredients

2.1 Component |CAS No.| %W/W
Potentially biohazardous material derived from human blood. | Not Available | Not Available

3 Hazards Identification

3.1 Emergency Overview: Contains potentially biohazardous material derived from human blood. As with all human derivatives, universal handling precautions are recommended. This product is a potential irritant to eyes, respiratory system, and skin. This product may also be harmful if ingested. Complete toxicological properties have yet to be determined.

3.2 Routes of Exposure: Absorbed through skin, eye contact, inhalation, and ingestion.

3.3 Potential Health Effects:

3.3.1 Eye: May cause eye irritation.
3.3.2 Skin: May cause skin irritation.
3.3.3 Inhalation: May be harmful if inhaled. Material may be irritating to mucous membranes and upper respiratory tract.
3.3.4 Ingestion: May be harmful if swallowed.

3.4 Chronic Effects/Carcinogenicity: Not Available
3.5 OSHA Regulatory Status: Not Available

4 First Aid Measures

4.1 Eyes: In case of contact with eyes, flush thoroughly with water. Call a physician.
4.2 Skin: In case of contact with skin, wash the affected area with soap and copious amounts of water. Should irritation occur, contact a physician.
4.3 Ingestion: If swallowed, wash out mouth with water provided person is conscious. Call a physician.
4.4 **Inhalation:** If inhaled, remove person to fresh air. If breathing becomes difficult, call a physician.

4.5 **Puncture Wounds:** Wash thoroughly with soap and water. Allow to bleed freely. Call a physician.

4.6 **Note to Physician:** Not Available

---

**5 Fire Fighting Measures**

5.1 **Flash Point/Method:** Not Applicable

5.2 **Explosive Limits:**
   - 5.2.1 Upper: Not Applicable
   - 5.2.2 Lower: Not Applicable

5.3 **Autoignition Temperature:** Not Applicable

5.4 **Hazardous Combustion Products:** Not Applicable

5.5 **Conditions of Flammability:** Not Applicable

5.6 **Extinguishing Media:** Use whatever is appropriate to the surrounding fire.

5.7 **Fire Fighting Procedures:** Not Applicable – No toxic waste in run-off.

5.8 **Explosion Data:**
   - 5.8.1 Sensitivity to Mechanical Impact: Not Applicable
   - 5.8.2 Sensitivity to Static Discharge: Not Applicable

---

**6 Accidental Release Measures**

6.1 **Leak and Spill Procedure:** Wear chemical-resistant gloves. Absorb spill and place in closed container for disposal. Ventilate and wash area thoroughly after clean-up is complete.

---

**7 Handling and Storage**

7.1 **Handling:** Contains potentially biohazardous material derived from human blood. Donors have been tested for hepatitis B surface antigen (HBsAg) and anti-HIV-1 and/or HIV-1 antigen. However, this product should be considered potentially infectious and treated in accordance with universal handling precautions. May cause allergic reaction in sensitized individuals.

7.2 **Storage:** Store at -20°C.

---

**8 Exposure Controls/Personal Protection**

8.1 **Engineering Controls:** Use with adequate ventilation.

8.2 **Personal Protective Equipment:**
   - 8.2.1 Respiratory Protection: This is a laboratory-use product for which no industrial protective equipment has been designated.
   - 8.2.2 Eye Protection: Safety glasses.
   - 8.2.3 Skin Protection: Lab coat, latex gloves.
8.3 General Hygiene Considerations: Wash hands after use.

8.4 Exposure Limits:

8.4.1 ACGIH TLV-TWA: Not Available

8.4.2 OSHA PEL-TWA: Not Available

9 Physical/Chemical Properties:

9.1 Appearance: Light Amber

9.2 Odor: None

9.3 Physical State: Liquid

9.4 pH: 7.3 - 7.7

9.5 Boiling Point: Not Available

9.6 Melting Point: Not Applicable

9.7 Freezing Point: Not Available

9.8 Vapor Pressure: Not Available

9.9 Vapor Density: Not Available

9.10 Specific Gravity: Not Available

9.11 Evaporation Rate: Not Available

9.12 Solubility in Water: Not Available

9.13 Odor Threshold: Not Applicable

9.14 Coefficient of Water/Oil Distribution: Not Available

10 Stability/Reactivity:

10.1 Chemical Stability: Stable

10.2 Conditions to Avoid: Not Applicable

10.3 Incompatibility (Material to Avoid): Not Applicable

10.4 Hazardous Decomposition/By-Products: Nature of decomposition products not known.

10.5 Hazardous Polymerization: Not Applicable

11 Toxicological Information

11.1 Effects of Short-Term Exposure: Not Available

11.2 Effects of Long-Term Exposure: Not Available

11.3 Irritancy of Product: Not Available

11.4 Sensitization to Product: Not Available

11.5 Carcinogenicity: Not Available

11.6 Reproductive Toxicity: Not Available

11.7 Teratogenicity and Embryotoxicity: Not Available
11.8 Mutagenicity: Not Available
11.9 Name of Toxicologically Synergistic Products: Not Available
11.10 LD50 (specify species and route): Not Available
11.11 LC50 (specify species): Not Available

12 Ecological Information
12.1 Not Available

13 Disposal Considerations
13.1 Waste Disposal Method: Disposal should be in accordance with existing practices at your institution. Observe all Federal, Provincial/State and Local Laws.

14 Transport Information
14.1 Transport Canada
14.1.1 PIN No.: Not Available
14.2 U.S. Department of Transportation:
14.2.1 Proper Shipping Name: Not Available
14.2.2 Hazard Class: This substance is not known to be hazardous for transport.
14.2.3 ID. Number: Not Available
14.2.4 Packing Group: Not Available
14.2.5 Label Statement: Not Available

15 Regulatory Information
15.1 WHMIS Classification: D3
15.2 Note: This MSDS was prepared according to the Canadian Controlled Products Regulation and contains all the information required by those regulations.

16 Other Information
16.1 Preparation Information: Refer to PIS No. 05850_05870_05875; 05857
16.2 This MSDS has been revised in the following section(s): 1.1, 1.5, 9.4, 9.5, 9.7, 16.1, 16.5
16.4 Notice: The above information is believed to be correct but does not purport to be all inclusive and shall be used only as a guide. STEMCELL Technologies Inc., shall not be held liable for any damage resulting from handling or from contact with the product. The information contained in this Material Safety Data Sheet (MSDS) is current as of the Date Prepared shown in Section 1.7 of this document and may be subject to amendment by STEMCELL Technologies Inc.
16.5 Disclaimer: THIS PRODUCT IS FOR RESEARCH USE ONLY. NOT INTENDED FOR HUMAN OR ANIMAL DIAGNOSTIC OR THERAPEUTIC USES.
1. Product and Company Identification
   1.1 Product Name: DMEM/F12 1:1, (1X) liquid with 15mM HEPES
   1.2 Catalog Number: 36254
   1.3 Synonyms: Not Available
   1.4 Product Use: Cell Culture
   1.5 Manufacturer/Supplier: STEMCELL Technologies Inc.
   Suite 400, 570 West 7th Avenue
   Vancouver, BC V5Z 1B3
   Canada
   1.6 In Case of Emergency Call: 604-877-0713
   1.7 Date Effective: January 04, 2012
   1.8 Prepared By: Quality Control

2. Composition / Information on Ingredients
   2.1 Component CAS No. %W/W
   No known hazardous components. Not Available Not Available

3. Hazards Identification
   3.1 Emergency Overview: This product is a potential irritant to eyes, respiratory system, and skin. This product may also be harmful if ingested. Complete toxicological properties have yet to be determined.
   3.2 Routes of Exposure: Absorbed through skin, eye contact, inhalation, and ingestion.
   3.3 Potential Health Effects:
      3.3.1 Eye: May cause eye irritation.
      3.3.2 Skin: May cause skin irritation.
      3.3.3 Inhalation: May be harmful if inhaled. Material may be irritating to mucous membranes and upper respiratory tract.
      3.3.4 Ingestion: May be harmful if swallowed.
   3.4 Chronic Effects/Carcinogenicity: Not Available
   3.5 OSHA Regulatory Status: Not Available

4. First Aid Measures
   4.1 Eyes: In case of contact with eyes, flush thoroughly with water. Remove contact lenses, clean before re-use. Call a physician if symptoms develop (redness, itching, etc.).
   4.2 Skin: In case of contact with skin, wash the affected area with soap and copious amounts of water. Should irritation occur, contact a physician.
   4.3 Ingestion: If swallowed, wash out mouth with water provided person is conscious. Call a physician.
   4.4 Inhalation: If inhaled, remove person to fresh air. If breathing becomes difficult, call a physician.
4.5 Puncture Wounds:  Wash thoroughly with soap and water. Allow to bleed freely. Call a physician.

4.6 Note to Physician:  Not Available

5 Fire Fighting Measures

5.1 Flash Point/Method:  Not Available

5.2 Explosive Limits:
   5.2.1 Upper:  Not Available
   5.2.2 Lower:  Not Available

5.3 Autoignition Temperature:  Not Available

5.4 Hazardous Combustion Products:  Nature of combustion products not known.

5.5 Conditions of Flammability:  Not Available

5.6 Extinguishing Media:  Use means appropriate for surrounding materials.

5.7 Fire Fighting Procedures:  Not Available

5.8 Explosion Data:
   5.8.1 Sensitivity to Mechanical Impact:  Not Available
   5.8.2 Sensitivity to Static Discharge:  Not Available

6 Accidental Release Measures

6.1 Leak and Spill Procedure:  Wear chemical-resistant gloves. Absorb spill and place in closed container for disposal. Wash area thoroughly after clean-up is complete.

7 Handling and Storage

7.1 Handling:  Should be handled by trained personnel observing good laboratory practices. Avoid breathing vapor. Avoid skin contact or swallowing.

7.2 Storage:  Stored at 2-8°C.

8 Exposure Controls/Personal Protection

8.1 Engineering Controls:  Use with adequate ventilation.

8.2 Personal Protective Equipment:
   8.2.1 Respiratory Protection:  This is a laboratory-use product for which no industrial protective equipment has been designated.

   8.2.2 Eye Protection:  Safety glasses.

   8.2.3 Skin Protection:  Lab coat, latex gloves.

8.3 General Hygiene Considerations:  Wash hands after use.

8.4 Exposure Limits:
Material Safety Data Sheet

DMEM/F12 1:1, (1X) liquid with 15mM HEPES  
Cat. No: 36254

8.4.1 ACGIH TLV-TWA: Not Available
8.4.2 OSHA PEL-TWA: Not Available

9 Physical/Chemical Properties:
9.1 Appearance: Transparent, red fluid
9.2 Odor: None
9.3 Physical State: Liquid
9.4 pH: Approximately 7.2 – 7.4
9.5 Boiling Point: Not Available
9.6 Melting Point: Not Available
9.7 Freezing Point: Not Available
9.8 Vapor Pressure: Not Available
9.9 Vapor Density: Not Available
9.10 Specific Gravity: Not Available
9.11 Evaporation Rate: Not Available
9.12 Solubility in Water: Not Available
9.13 Odor Threshold: Not Applicable
9.14 Coefficient of Water/Oil Distribution: Not Available

10 Stability/Reactivity:
10.1 Chemical Stability: Stable
10.2 Conditions to Avoid: Strong oxidizers.
10.3 Incompatibility (Material to Avoid): Not Available
10.4 Hazardous Decomposition/By-Products: Nature of decomposition products not known.
10.5 Hazardous Polymerization: Not Available

11 Toxicological Information
11.1 Effects of Short-Term Exposure: Not Available
11.2 Effects of Long-Term Exposure: Not Available
11.3 Irritancy of Product: Not Available
11.4 Sensitization to Product: Not Available
11.5 Carcinogenicity: Not Available
11.6 Reproductive Toxicity: Not Available
11.7 Teratogenicity and Embryotoxicity: Not Available
11.8 Mutagenicity: Not Available
11.9 Name of Toxicologically Synergistic Products: Not Available
11.10 LD50 (specify species and route): Not Available
11.11 LC50 (specify species): Not Available

12 Ecological Information
12.1 Not Available

13 Disposal Considerations
13.1 Waste Disposal Method: Disposal should be in accordance with existing practices at your institution. Observe all Federal, Provincial/State and Local Laws.

14 Transport Information
14.1 Transport Canada
   14.1.1 PIN No.: Not Available
14.2 U.S. Department of Transportation:
   14.2.1 Proper Shipping Name: Not Available
   14.2.2 Hazard Class: This substance is not known to be hazardous for transport.
   14.2.3 ID. Number: Not Available
   14.2.4 Packing Group: Not Available
   14.2.5 Label Statement: Not Available

15 Regulatory Information
15.1 WHMIS Classification: Not Available
15.2 Note: This MSDS was prepared according to the Canadian Controlled Products Regulation and contains all the information required by those regulations.

16 Other Information
16.1 Preparation Information: Refer to PIS No. 36254.
16.2 This MSDS has been revised in the following section(s): 1.5, 9.4, 9.5
16.3 Original Issue Date: May 10, 2005.
16.4 Notice: The above information is believed to be correct but does not purport to be all inclusive and shall be used only as a guide. StemCell Technologies Inc., shall not be held liable for any damage resulting from handling or from contact with the product. The information contained in this Material Safety Data Sheet (MSDS) is current as of the Date Prepared shown in Section 1.7 of this document and may be subject to amendment by StemCell Technologies Inc.
16.5 Disclaimer: THIS PRODUCT IS FOR RESEARCH USE ONLY. NOT USED FOR DIAGNOSTIC OR THERAPEUTIC APPLICATIONS.
1 Product and Company Identification

1.1 Product Name: Dispase (1 U/mL)
1.2 Catalog Number: 07923
1.3 Synonyms: Neutral protease
1.4 Product Use: Tissue dissociation
1.5 Manufacturer/Supplier: STEMCELL Technologies Inc.
   Suite 400, 570 West 7th Avenue
   Vancouver, BC V5Z 1B3
   Canada
1.6 In Case of Emergency Call: 604-877-0713
1.7 Date Effective: October 30, 2012
1.8 Prepared By: Quality Control

2 Composition / Information on Ingredients

2.1 Component CAS No. %W/W
Neutral protease 9001-92-7 Batch specific

3 Hazards Identification

3.1 Emergency Overview: This product is a potential irritant to eyes, respiratory system, and skin. This product may also be harmful if ingested. Complete toxicological properties have yet to be determined.
3.2 Routes of Exposure: Absorbed through skin, eye contact, inhalation, and ingestion.
3.3 Potential Health Effects:
   3.3.1 Eye: May cause eye irritation.
   3.3.2 Skin: May cause skin irritation.
   3.3.3 Inhalation: May be harmful if inhaled. Material may be irritating to mucous membranes and upper respiratory tract.
   3.3.4 Ingestion: May be harmful if swallowed.
3.4 Chronic Effects/Carcinogenicity: Not Available
3.5 OSHA Regulatory Status: Not Available

4 First Aid Measures

4.1 Eyes: In case of contact with eyes, flush thoroughly with water. Call a physician.
4.2 Skin: In case of contact with skin, wash the affected area with soap and copious amounts of water. Should irritation occur, contact a physician.
4.3 Ingestion: If swallowed, wash out mouth with water provided person is conscious. Call a physician.
4.4 Inhalation: If inhaled, remove person to fresh air. If breathing becomes difficult, call a physician.
4.5 Puncture Wounds: Wash thoroughly with soap and water. Allow to bleed freely. Call a physician.
5 Fire Fighting Measures
5.1 Flash Point/Method: Not Available
5.2 Explosive Limits:
   5.2.1 Upper: Not Available
   5.2.2 Lower: Not Available
5.3 Autoignition Temperature: Not Available
5.4 Hazardous Combustion Products: Nature of combustion products not known.
5.5 Conditions of Flammability: Not Available
5.6 Extinguishing Media: Water spray. Carbon dioxide, dry chemical powder or appropriate foam.
5.7 Fire Fighting Procedures: Wear self-contained breathing apparatus and protective clothing to prevent contact with skin and eyes.
5.8 Explosion Data:
   5.8.1 Sensitivity to Mechanical Impact: Not Available
   5.8.2 Sensitivity to Static Discharge: Not Available

6 Accidental Release Measures
6.1 Leak and Spill Procedure: Wear chemical-resistant gloves. Absorb spill and place in closed container for disposal. Wash area thoroughly after clean-up is complete.

7 Handling and Storage
7.1 Handling: Should be handled by trained personnel observing good laboratory practices. Avoid breathing vapor. Avoid contact with eyes, skin, and clothing. Avoid prolonged or repeated exposure.
7.2 Storage: Stored at -20°C.

8 Exposure Controls/Personal Protection
8.1 Engineering Controls: Use with adequate ventilation.
8.2 Personal Protective Equipment:
   8.2.1 Respiratory Protection: This is a laboratory-use product for which no industrial protective equipment has been designated.
   8.2.2 Eye Protection: Safety glasses.
   8.2.3 Skin Protection: Lab coat, latex gloves.
8.3 General Hygiene Considerations: Wash hands after use.
8.4 Exposure Limits:
9 Physical/Chemical Properties:

9.1 Appearance: Transparent red fluid
9.2 Odor: None
9.3 Physical State: Liquid
9.4 pH: 7.2 - 7.5
9.5 Boiling Point: Not Available
9.6 Melting Point: Not Available
9.7 Freezing Point: Not Available
9.8 Vapor Pressure: Not Available
9.9 Vapor Density: Not Available
9.10 Specific Gravity: Not Available
9.11 Evaporation Rate: Not Available
9.12 Solubility in Water: Not Available
9.13 Odor Threshold: Not Applicable
9.14 Coefficient of Water/Oil Distribution: Not Available

10 Stability/Reactivity:

10.1 Chemical Stability: Stable
10.2 Conditions to Avoid: Not Available
10.3 Incompatibility (Material to Avoid): Not Available
10.4 Hazardous Decomposition/By-Products: Nature of decomposition products not known.
10.5 Hazardous Polymerization: Not Available

11 Toxicological Information

11.1 Effects of Short-Term Exposure: Not Available
11.2 Effects of Long-Term Exposure: Not Available
11.3 Irritancy of Product: Not Available
11.4 Sensitization to Product: Not Available
11.5 Carcinogenicity: Not Available
11.6 Reproductive Toxicity: Not Available
11.7 Teratogenicity and Embryotoxicity: Not Available
11.8 Mutagenicity: Not Available
Material Safety Data Sheet

Dispase (1 U/mL)  

11.9 Name of Toxicologically Synergistic Products: Not Available
11.10 LD50 (specify species and route): Not Available
11.11 LC50 (specify species): Not Available

12 Ecological Information
12.1 Not Available

13 Disposal Considerations
13.1 Waste Disposal Method: Disposal should be in accordance with existing practices at your institution. Observe all Federal, Provincial/State and Local Laws.

14 Transport Information
14.1 Transport Canada
14.1.1 PIN No.: Not Available
14.2 U.S. Department of Transportation:
14.2.1 Proper Shipping Name: Not Available
14.2.2 Hazard Class: This substance is not known to be hazardous for transport.
14.2.3 ID. Number: Not Available
14.2.4 Packing Group: Not Available
14.2.5 Label Statement: Not Available

15 Regulatory Information
15.1 WHMIS Classification: Not Available
15.2 Note: This MSDS was prepared according to the Canadian Controlled Products Regulation and contains all the information required by those regulations.

16 Other Information
16.1 Preparation Information: Refer to PIS No. 07923.
16.2 This MSDS has been revised in the following section(s): 1.1, 9.4, 9.5, 9.7, 16.5
16.3 Original Issue Date: February 19, 2008
16.4 Notice: The above information is believed to be correct but does not purport to be all inclusive and shall be used only as a guide. StemCell Technologies Inc., shall not be held liable for any damage resulting from handling or from contact with the product. The information contained in this Material Safety Data Sheet (MSDS) is current as of the Date Prepared shown in Section 1.7 of this document and may be subject to amendment by StemCell Technologies Inc.
16.5 Disclaimer: THIS PRODUCT IS FOR RESEARCH USE ONLY. NOT INTENDED FOR HUMAN OR ANIMAL DIAGNOSTIC OR THERAPEUTIC USES.
1 Product and Company Identification

1.1 Product Name: STEMdiff™ Neural Induction Medium

1.2 Catalogue Number: 05831

1.3 Synonyms: Not Available

1.4 Product Use: Cell Culture

1.5 Manufacturer/Supplier: STEMCELL Technologies Inc.
    Suite 400, 570 West 7th Avenue
    Vancouver, BC V5Z 1B3
    Canada

1.6 In Case of Emergency Call: 604-877-0713

1.7 Date Effective: May 27, 2013

1.8 Prepared By: Quality Control

2 Composition / Information on Ingredients

2.1 Component | CAS No. | %W/W
Potentially biohazardous material derived from human blood. | Not Available | Not Available

3 Hazards Identification

3.1 Emergency Overview: Contains potentially biohazardous material derived from human blood. As with all human derivatives, universal handling precautions are recommended. This product is a potential irritant to eyes, respiratory system, and skin. This product may also be harmful if ingested. Complete toxicological properties have yet to be determined.

3.2 Routes of Exposure: Absorbed through skin, eye contact, inhalation, and ingestion.

3.3 Potential Health Effects:

3.3.1 Eye: May cause eye irritation.

3.3.2 Skin: May cause skin irritation.

3.3.3 Inhalation: May be harmful if inhaled. Material may be irritating to mucous membranes and upper respiratory tract.

3.3.4 Ingestion: May be harmful if swallowed.

3.4 Chronic Effects/Carcinogenicity: Not Available

3.5 OSHA Regulatory Status: Not Available

4 First Aid Measures

4.1 Eyes: In case of contact with eyes, flush thoroughly with water. Call a physician.

4.2 Skin: In case of contact with skin, wash the affected area with soap and copious amounts of water. Should irritation occur, contact a physician.

4.3 Ingestion: If swallowed, wash out mouth with water provided person is conscious. Call a physician.
4.4 Inhalation: If inhaled, remove person to fresh air. If breathing becomes difficult, call a physician.

4.5 Puncture Wounds: Wash thoroughly with soap and water. Allow to bleed freely. Call a physician.

4.6 Note to Physician: Not Available

5 Fire Fighting Measures

5.1 Flash Point/Method: Not Available

5.2 Explosive Limits:

5.2.1 Upper: Not Available

5.2.2 Lower: Not Available

5.3 Autoignition Temperature: Not Available

5.4 Hazardous Combustion Products: Not Available

5.5 Conditions of Flammability: Not Available

5.6 Extinguishing Media: Use whatever is appropriate to the surrounding fire.

5.7 Fire Fighting Procedures: Not Available – No toxic waste in run-off.

5.8 Explosion Data:

5.8.1 Sensitivity to Mechanical Impact: Not Available

5.8.2 Sensitivity to Static Discharge: Not Available

6 Accidental Release Measures

6.1 Leak and Spill Procedure: Wear chemical-resistant gloves. Absorb spill and place in closed container for disposal. Ventilate and wash area thoroughly after clean-up is complete.

7 Handling and Storage

7.1 Handling: Contains material derived from human blood. Donors have been tested for hepatitis B surface antigen (HBsAg) and anti-HIV-1 and/or HIV-1 antigen. However, this product should be considered potentially infectious and treated in accordance with universal handling precautions. May cause allergic reaction in sensitized individuals.

7.2 Storage: Store at -20°C

8 Exposure Controls/Personal Protection

8.1 Engineering Controls: Use with adequate ventilation.

8.2 Personal Protective Equipment:

8.2.1 Respiratory Protection: This is a laboratory-use product for which no industrial protective equipment has been designated.

8.2.2 Eye Protection: Safety glasses.

8.2.3 Skin Protection: Lab coat, latex gloves.

8.3 General Hygiene Considerations: Wash hands after use.
8.4 Exposure Limits:
  8.4.1 ACGIH TLV-TWA: Not Available
  8.4.2 OSHA PEL-TWA: Not Available

9 Physical/Chemical Properties:
  9.1 Appearance: Transparent, red fluid
  9.2 Odor: Not Available
  9.3 Physical State: Liquid
  9.4 pH: 7.2 – 7.4
  9.5 Boiling Point: Not Available
  9.6 Melting Point: Not Available
  9.7 Freezing Point: Not Available
  9.8 Vapor Pressure: Not Available
  9.9 Vapor Density: Not Available
  9.10 Specific Gravity: Not Available
  9.11 Evaporation Rate: Not Available
  9.12 Solubility in Water: Not Available
  9.13 Odor Threshold: Not Applicable
  9.14 Coefficient of Water/Oil Distribution: Not Available

10 Stability/Reactivity:
  10.1 Chemical Stability: Stable
  10.2 Conditions to Avoid: Not Available
  10.3 Incompatibility (Material to Avoid): Not Available
  10.4 Hazardous Decomposition/By-Products: Nature of decomposition products not known.
  10.5 Hazardous Polymerization: Not Available

11 Toxicological Information
  11.1 Effects of Short-Term Exposure: Not Available
  11.2 Effects of Long-Term Exposure: Not Available
  11.3 Irritancy of Product: Not Available
  11.4 Sensitization to Product: Not Available
  11.5 Carcinogenicity: Not Available
  11.6 Reproductive Toxicity: Not Available
  11.7 Teratogenicity and Embryotoxicity: Not Available
  11.8 Mutagenicity: Not Available
Material Safety Data Sheet

STEMdiff™ Neural Induction Medium

Cat. No: 05831

11.9 Name of Toxicologically Synergistic Products: Not Available
11.10 LD50 (specify species and route): Not Available
11.11 LC50 (specify species): Not Available

12 Ecological Information
12.1 Not Available

13 Disposal Considerations
13.1 Waste Disposal Method: Disposal should be in accordance with existing practices at your institution. Observe all Federal, Provincial/State and Local Laws.

14 Transport Information
14.1 Transport Canada
14.1.1 PIN No.: Not Available
14.2 U.S. Department of Transportation:
14.2.1 Proper Shipping Name: Not Available
14.2.2 Hazard Class: This substance is not known to be hazardous for transport.
14.2.3 ID. Number: Not Available
14.2.4 Packing Group: Not Available
14.2.5 Label Statement: Not Available

15 Regulatory Information
15.1 WHMIS Classification: D3
15.2 Note: This MSDS was prepared according to the Canadian Controlled Products Regulation and contains all the information required by those regulations.

16 Other Information
16.1 Preparation Information: Refer to PIS No. 05831
16.2 This MSDS has been revised in the following section(s): Not Applicable
16.3 Original Issue Date: May 27, 2013
16.4 Notice: The above information is believed to be correct but does not purport to be all inclusive and shall be used only as a guide. StemCell Technologies Inc., shall not be held liable for any damage resulting from handling or from contact with the product. The information contained in this Material Safety Data Sheet (MSDS) is current as of the Date Prepared shown in Section 1.7 of this document and may be subject to amendment by StemCell Technologies Inc.

16.5 Disclaimer: THIS PRODUCT IS FOR RESEARCH USE ONLY. NOT INTENDED FOR HUMAN OR ANIMAL DIAGNOSTIC OR THERAPEUTIC USES.
1 Product and Company Identification

1.1 Product Name: Y-27632 (Dihydrochloride)
1.2 Catalog Number: 72302, 72304
1.3 Synonyms: 4-[(1R)-1-amo-noethyl]-N-4-pyridinyl-trans-cyclohexancarboxamide, dihydrochloride
1.4 Product Use: Rho/ROCK pathway inhibitor; inhibits ROCK
1.5 Manufacturer/Supplier: STEMCELL Technologies Inc.
   Suite 400, 570 West 7th Avenue
   Vancouver, BC V5Z 1B3
   Canada
1.6 In Case of Emergency Call: 604-877-0713
1.7 Date Effective: December 5, 2013
1.8 Prepared By: Quality Control

2 Composition / Information on Ingredients

2.1 Component: CAS No. %W/W
Y-27632 (Dihydrochloride) 129830-38-2 100

3 Hazards Identification

3.1 Emergency Overview: This product is harmful if inhaled or swallowed and is harmful in contact with skin. This product may cause eye, skin or respiratory system irritation. The toxicological properties of this product have not been fully evaluated.
3.2 Routes of Exposure: Absorbed through skin, eye contact, inhalation, and ingestion.
3.3 Potential Health Effects:
   3.3.1 Eye: May cause eye irritation.
   3.3.2 Skin: Harmful if absorbed through skin. May cause skin irritation.
   3.3.3 Inhalation: Toxic if inhaled. May cause respiratory tract irritation.
   3.3.4 Ingestion: Harmful if swallowed.
3.4 Chronic Effects/Carcinogenicity: Not Available
3.5 OSHA Regulatory Status: Toxic by inhalation, Harmful by ingestion, Harmful by skin absorption.

4 First Aid Measures

4.1 Eyes: In case of contact with eyes, hold eyelids apart and flush thoroughly with water for at least 20 minutes. Call a physician.
4.2 Skin: In case of contact with skin, wash the affected area immediately with soap and copious amounts of water for at least 20 minutes. Remove contaminated clothing. Call a physician.
4.3 Ingestion: If swallowed, wash out mouth with water provided person is conscious. Call a physician. Do not induce vomiting unless directed to do so by medical personnel.
4.4 Inhalation: If inhaled, remove person to fresh air. If not breathing, give artificial respiration. Call a physician.

4.5 Puncture Wounds: Wash thoroughly with soap and water. Allow to bleed freely. Call a physician.

4.6 Note to Physician: Not Available

5 Fire Fighting Measures

5.1 Flash Point/Method: Not Available

5.2 Explosive Limits:
   5.2.1 Upper: Not Available
   5.2.2 Lower: Not Available

5.3 Autoignition Temperature: Not Available

5.4 Hazardous Combustion Products: Hazardous decomposition products formed under fire conditions: Carbon oxides, nitrogen oxides (NOx), hydrogen chloride gas

5.5 Conditions of Flammability: Not Available

5.6Extinguishing Media: Use alcohol-resistant foam, carbon dioxide, water or dry chemical spray.

5.7 Fire Fighting Procedures: Not Available

5.8 Explosion Data:
   5.8.1 Sensitivity to Mechanical Impact: Not Available
   5.8.2 Sensitivity to Static Discharge: Not Available

6 Accidental Release Measures

6.1 Leak and Spill Procedure: Use personal protective equipment as conditions warrant. Avoid raising and breathing dust and provide adequate ventilation. Take steps to avoid release into the environment if safe to do so. Transfer to a chemical waste container for disposal in accordance with local regulations.

7 Handling and Storage

7.1 Handling: Should be handled by trained personnel observing good laboratory practices. Avoid contact with eyes and skin. Avoid formation of dust and aerosols. Avoid prolonged or repeated exposure. Provide appropriate exhaust ventilation at places where dust is formed.

7.2 Storage: Store at -20°C. Keep container tightly closed.

8 Exposure Controls/Personal Protection

8.1 Engineering Controls: Use mechanical exhaust or laboratory fume hood to avoid exposure.

8.2 Personal Protective Equipment:
   8.2.1 Respiratory Protection: Respirator that meets CAN/CSA Z94.4-93 (R1997) or NIOSH approved respirator, as conditions warrant.
   8.2.2 Eye Protection: Safety glasses.
8.2.3 Skin Protection: Lab coat, compatible chemical-resistant gloves.

8.3 General Hygiene Considerations: Wash hands after use. Facilities storing or utilizing this material should be equipped with an eyewash and a safety shower.

8.4 Exposure Limits:
8.4.1 ACGIH TLV-TWA: Not Available
8.4.2 OSHA PEL-TWA: Not Available

9 Physical/Chemical Properties:
9.1 Appearance: A crystalline solid
9.2 Odor: Not Available
9.3 Physical State: Solid
9.4 pH: Not Available
9.5 Boiling Point: Not Available
9.6 Melting Point: Not Available
9.7 Freezing Point: Not Available
9.8 Vapor Pressure: Not Available
9.9 Vapor Density: Not Available
9.10 Specific Gravity: Not Available
9.11 Evaporation Rate: Not Available
9.12 Solubility in Water: ~10 mg/mL in PBS (pH 7.2); ~5 mg/mL in EtOH; ~20 mg/mL in DMSO; ~30 mg/mL in DMF
9.13 Odor Threshold: Not Available
9.14 Coefficient of Water/Oil Distribution: Not Available

10 Stability/Reactivity:
10.1 Chemical Stability: Stable
10.2 Conditions to Avoid: Not Available
10.3 Incompatibility (Material to Avoid): Strong oxidizing agents
10.4 Hazardous Decomposition/By-Products: Hazardous decomposition products formed under fire conditions - Carbon dioxide, carbon monoxide, nitrogen oxides, hydrogen chloride gas
10.5 Hazardous Polymerization: Will not occur

11 Toxicological Information
11.1 Effects of Short-Term Exposure: Not Available
11.2 Effects of Long-Term Exposure: Not Available
11.3 Irritancy of Product: Not Available
11.4 Sensitization to Product: Not Available
11.5 Carcinogenicity: Not Available
11.6 Reproductive Toxicity: Not Available
11.7 Teratogenicity and Embryotoxicity: Not Available
11.8 Mutagenicity: Not Available
11.9 Name of Toxicologically Synergistic Products: Not Available
11.10 LD50 (specify species and route): Not Available
11.11 LC50 (specify species): Not Available

12 Ecological Information
12.1 Avoid release into the environment. Runoff from fire control or dilution water may cause pollution.

13 Disposal Considerations
13.1 Waste Disposal Method: Disposal should be in accordance with existing practices at your institution. Observe all Federal, Provincial/State and Local Laws.

14 Transport Information
14.1 Transport Canada
14.1.1 PIN No.: Not Available.
14.2 U.S. Department of Transportation:
14.2.1 Proper Shipping Name: Not Available.
14.2.2 Hazard Class: This substance is not known to be hazardous for transport.
14.2.3 ID. Number: Not Available.
14.2.4 Packing Group: Not Available.
14.2.5 Label Statement: Not Available.

15 Regulatory Information
15.1 WHMIS Classification: D1B
15.2 Note: This MSDS was prepared according to the Canadian Controlled Products Regulation and contains all the information required by those regulations.

16 Other Information
16.1 Preparation Information: Refer to PIS No. 72302, 72304
16.2 This MSDS has been revised in the following section(s): Not Applicable
16.3 Original Issue Date: December 5, 2013
16.4 Notice: The above information is believed to be correct but does not purport to be all inclusive and shall be used only as a guide. StemCell Technologies Inc., shall not be held liable for any damage resulting from handling or from contact with the product. The information contained in this Material Safety Data Sheet (MSDS) is current as of the Date Prepared shown in Section 1.7 of this document and may be subject to amendment by StemCell Technologies Inc.
16.5 Disclaimer: THIS PRODUCT IS FOR RESEARCH USE ONLY. NOT INTENDED FOR HUMAN OR ANIMAL DIAGNOSTIC OR THERAPEUTIC USES.
1 Product and Company Identification:

1.1 Product Name: STEMdiff™ Neural Rosette Selection Reagent
1.2 Catalog Number: 05832
1.3 Synonyms: Not Available
1.4 Product Use: Cell culture
1.5 Manufacturer/Supplier: STEMCELL Technologies Inc.
Suite 400, 570 West 7th Avenue
Vancouver, BC V5Z 1B3
Canada
1.6 In Case of Emergency Call: 604-877-0713
1.7 Date Effective: March 22, 2011
1.8 Prepared By: Quality Control

2 Composition / Information on Ingredients

2.1 Component | CAS No.       | %W/W
No known hazardous components | Not Available | Not Available

3 Hazards Identification:

3.1 Emergency Overview: This product is a potential irritant to eyes, respiratory system, and skin. This product may also be harmful if ingested. Complete toxicological properties have yet to be determined.
3.2 Routes of Exposure: Absorbed through skin, eye contact, inhalation, and ingestion.
3.3 Potential Health Effects:

3.3.1 Eye: May cause eye irritation.
3.3.2 Skin: May cause skin irritation.
3.3.3 Inhalation: No toxicity expected from inhalation.
3.3.4 Ingestion: May cause nausea or vomiting.
3.4 Chronic Effects/Carcinogenicity: Not Available
3.5 OSHA Regulatory Status: Not Available

4 First Aid Measures:

4.1 Eyes: In case of contact with eyes, flush thoroughly with water. Call a physician.
4.2 Skin: In case of contact with skin, wash the affected area with soap and copious amounts of water. Should irritation occur, contact a physician.
4.3 Ingestion: If swallowed, wash out mouth with water provided person is conscious. Call a physician.
4.4 Inhalation: If inhaled, remove person to fresh air. If breathing becomes difficult, call a physician.
4.5 Puncture Wounds: Wash thoroughly with soap and water. Allow to bleed freely. Call a physician.
4.6 Note to Physician: Not Available
5 Fire Fighting Measures:

5.1 Flash Point/Method: Not Available

5.2 Explosive Limits:

5.2.1 Upper: Not Available
5.2.2 Lower: Not Available

5.3 Autoignition Temperature: Not Available

5.4 Hazardous Combustion Products: Nature of combustion products not known.

5.5 Conditions of Flammability: Not Available

5.6 Extinguishing Media: Use media appropriate to the surrounding fire.

5.7 Fire Fighting Procedures: Wear self-contained breathing apparatus and protective garments.

5.8 Explosion Data:

5.8.1 Sensitivity to Mechanical Impact: Not Available
5.8.2 Sensitivity to Static Discharge: Not Available

6 Accidental Release Measures:

6.1 Leak and Spill Procedure: Wear chemical-resistant gloves. Absorb spill and place in closed container for disposal. Wash area thoroughly after clean-up is complete.

7 Handling and Storage:

7.1 Handling: Should be handled by trained personnel observing good laboratory practices. Avoid breathing vapor. Avoid skin contact of swallowing.

7.2 Storage: Store at room temperature (15-25°C).

8 Exposure Controls/Personal Protection:

8.1 Engineering Controls: Use with adequate ventilation.

8.2 Personal Protective Equipment:

8.2.1 Respiratory Protection: Protective mask recommended.
8.2.2 Eye Protection: Safety glasses or goggles.
8.2.3 Skin Protection: Lab coat, rubber or chemical resistant gloves.

8.3 General Hygiene Considerations: Wash hands after use.

8.4 Exposure Limits:

8.4.1 ACGIH TLV-TWA: Not Available
8.4.2 OSHA PEL-TWA: Not Available

9 Physical/Chemical Properties:

9.1 Appearance: Clear, red solution
9.2 Odor: None
9.3 Physical State: Liquid
9.4 pH: Approximately 7.2 – 7.5
9.5 Boiling Point: Approximately 100°C
9.6 Melting Point: Not Available
9.7 Freezing Point: Approximately 0°C
9.8 Vapor Pressure: Not Available
9.9 Vapor Density: Not Available
9.10 Specific Gravity: Not Available
9.11 Evaporation Rate: Not Available
9.12 Solubility in Water: Soluble
9.13 Odor Threshold: Not Applicable
9.14 Coefficient of Water/Oil Distribution: Not Available

10 Stability/Reactivity:
10.1 Chemical Stability: Stable
10.2 Conditions to Avoid: Excess heat, flame, and pressure.
10.3 Incompatibility (Material to Avoid): None
10.4 Hazardous Decomposition/By-Products: Not Available
10.5 Hazardous Polymerization: Will not occur.

11 Toxicological Information
11.1 Effects of Short-Term Exposure: Not Available
11.2 Effects of Long-Term Exposure: Not Available
11.3 Irritancy of Product: Not Available
11.4 Sensitization to Product: Not Available
11.5 Carcinogenicity: Not Available
11.6 Reproductive Toxicity: Not Available
11.7 Teratogenicity and Embryotoxicity: Not Available
11.8 Mutagenicity: Not Available
11.9 Name of Toxicologically Synergistic Products: Not Available
11.10 LD50 (specify species and route): Not Available
11.11 LC50 (specify species): Not Available

12 Ecological Information
12.1 Not Available
13 Disposal Considerations

13.1 Waste Disposal Method: Disposal should be in accordance with existing practices at your institution. Observe all Federal, Provincial/State and local laws.

14 Transport Information

14.1 Transport Canada

14.1.1 PIN No.: Not Available

14.2 U.S. Department of Transportation:

14.2.1 Proper Shipping Name: Not Available

14.2.2 Hazard Class: This substance is not known to be hazardous for transport.

14.2.3 ID. Number: Not Available

14.2.4 Packing Group: Not Available

14.2.5 Label Statement: Not Available

15 Regulatory Information

15.1 WHMIS Classification: Not Available

15.2 Note: This MSDS was prepared according to the Canadian Controlled Products Regulation and contains all of the information required by those regulations.

16 Other Information

16.1 Preparation Information: Refer to PIS No.05832

16.2 This MSDS has been revised in the following section(s): Not Applicable

16.3 Original Issue Date: March 22, 2011

16.4 Notice: The above information is believed to be correct but does not purport to be all inclusive and shall be used only as a guide. StemCell Technologies Inc., shall not be held liable for any damage resulting from handling or from contact with the product. The information contained in this Material Safety Data Sheet (MSDS) is current as of the Date Prepared shown in Section 1.7 of this document and may be subject to amendment by StemCell Technologies Inc.

16.5 Disclaimer: THIS PRODUCT IS FOR RESEARCH USE ONLY. NOT USED FOR DIAGNOSTIC OR THERAPEUTIC APPLICATIONS.
Material Safety Data Sheet

Dulbecco’s Phosphate Buffered Saline (DPBS)  
without Calcium Chloride or Magnesium Chloride  
Cat. No: 37350

1 Product and Company Identification

1.1 Product Name: Dulbecco’s Phosphate Buffered Saline (DPBS)  
without Calcium Chloride or Magnesium Chloride

1.2 Catalog Number: 37350

1.3 Synonyms: Not Available

1.4 Product Use: Cell Culture

1.5 Manufacturer/Supplier: StemCell Technologies Inc.  
Suite 400, 570 West 7th Avenue  
Vancouver, BC  V5Z 1B3  
Canada

1.6 In Case of Emergency Call: 604-877-0713

1.7 Date Effective: December 11, 2012

1.8 Prepared By: Quality Control

2 Composition / Information on Ingredients

2.1 Component | CAS No. | %W/W
--- | --- | ---
No known hazardous components. | Not Available | Not Available

3 Hazards Identification

3.1 Emergency Overview: This product is a potential irritant to eyes, respiratory system, and skin.  
This product may also be harmful if ingested. Complete toxicological properties have yet to be determined.

3.2 Routes of Exposure: Absorbed through skin, eye contact, inhalation, and ingestion.

3.3 Potential Health Effects:

3.3.1 Eye: May cause eye irritation.

3.3.2 Skin: May cause skin irritation.

3.3.3 Inhalation: May be harmful if inhaled. Material may be irritating to mucous membranes and upper respiratory tract.

3.3.4 Ingestion: May be harmful if swallowed.

3.4 Chronic Effects/Carcinogenicity: Not Available

3.5 OSHA Regulatory Status: Not Available

4 First Aid Measures

4.1 Eyes: In case of contact with eyes, flush thoroughly with water. Call a physician.

4.2 Skin: In case of contact with skin, wash the affected area with soap and copious amounts of water. Should irritation occur, contact a physician.

4.3 Ingestion: If swallowed, wash out mouth with water provided person is conscious. Call a physician.
4.4 Inhalation: If inhaled, remove person to fresh air. If breathing becomes difficult, call a physician.
4.5 Puncture Wounds: Wash thoroughly with soap and water. Allow to bleed freely. Call a physician.
4.6 Note to Physician: Not Available

5 Fire Fighting Measures

5.1 Flash Point/Method: Not Available
5.2 Explosive Limits:
   5.2.1 Upper: Not Available
   5.2.2 Lower: Not Available
5.3 Autoignition Temperature: Not Available
5.4 Hazardous Combustion Products: Nature of combustion products not known.
5.5 Conditions of Flammability: Not Available
5.6 Extinguishing Media: Use media appropriate to the surrounding fire.
5.7 Fire Fighting Procedures: Not Available
5.8 Explosion Data:
   5.8.1 Sensitivity to Mechanical Impact: Not Available
   5.8.2 Sensitivity to Static Discharge: Not Available

6 Accidental Release Measures

6.1 Leak and Spill Procedure: Wear chemical-resistant gloves. Absorb spill and place in closed container for disposal. Wash area thoroughly after clean-up is complete.

7 Handling and Storage

7.1 Handling: Should be handled by trained personnel observing good laboratory practices. Avoid breathing vapor. Avoid skin contact or swallowing.
7.2 Storage: Store at room temperature (15-25°C).

8 Exposure Controls/Personal Protection

8.1 Engineering Controls: Use with adequate ventilation.
8.2 Personal Protective Equipment:
   8.2.1 Respiratory Protection: This is a laboratory-use product for which no industrial protective equipment has been designated.
   8.2.2 Eye Protection: Safety glasses.
   8.2.3 Skin Protection: Lab coat, latex gloves.
8.3 General Hygiene Considerations: Wash hands after use.
8.4 Exposure Limits:
   8.4.1 ACGIH TLV-TWA: Not Available
Material Safety Data Sheet

Dulbecco’s Phosphate Buffered Saline (DPBS) without Calcium Chloride or Magnesium Chloride

Cat. No: 37350

8.4.2 OSHA PEL-TWA: Not Available

9 Physical/Chemical Properties:

9.1 Appearance: Transparent fluid
9.2 Odor: None
9.3 Physical State: Liquid
9.4 pH: Approximately 7.2 – 7.6
9.5 Boiling Point: Not Available
9.6 Melting Point: Not Available
9.7 Freezing Point: Not Available
9.8 Vapor Pressure: Not Available
9.9 Vapor Density: Not Available
9.10 Specific Gravity: Not Available
9.11 Evaporation Rate: Not Available
9.12 Solubility in Water: Not Available
9.13 Odor Threshold: Not Applicable
9.14 Coefficient of Water/Oil Distribution: Not Available

10 Stability/Reactivity:

10.1 Chemical Stability: Stable
10.2 Conditions to Avoid: Not Available
10.3 Incompatibility (Material to Avoid): Not Available
10.4 Hazardous Decomposition/By-Products: Nature of decomposition products not known.
10.5 Hazardous Polymerization: Not Available

11 Toxicological Information

11.1 Effects of Short-Term Exposure: Not Available
11.2 Effects of Long-Term Exposure: Not Available
11.3 Irritancy of Product: Not Available
11.4 Sensitization to Product: Not Available
11.5 Carcinogenicity: Not Available
11.6 Reproductive Toxicity: Not Available
11.7 Teratogenicity and Embryotoxicity: Not Available
11.8 Mutagenicity: Not Available
11.9 Name of Toxicologically Synergistic Products: Not Available
11.10 LD50 (specify species and route): Not Available
11.11 LC50 (specify species): Not Available

12 Ecological Information
12.1 Not Available

13 Disposal Considerations
13.1 Waste Disposal Method: Disposal should be in accordance with existing practices at your institution. Observe all Federal, Provincial/State and Local Laws.

14 Transport Information
14.1 Transport Canada
14.1.1 PIN No.: Not Available
14.2 U.S. Department of Transportation:
14.2.1 Proper Shipping Name: Not Available
14.2.2 Hazard Class: This substance is not known to be hazardous for transport.
14.2.3 ID. Number: Not Available
14.2.4 Packing Group: Not Available
14.2.5 Label Statement: Not Available

15 Regulatory Information
15.1 WHMIS Classification: Not Available
15.2 Note: This MSDS was prepared according to the Canadian Controlled Products Regulation and contains all the information required by those regulations.

16 Other Information
16.1 Preparation Information: Refer to PIS No. 37350
16.2 This MSDS has been revised in the following section(s): 9.5, 9.7, 16.5
16.3 Original Issue Date: August 26, 2004
16.4 Notice: The above information is believed to be correct but does not purport to be all inclusive and shall be used only as a guide. StemCell Technologies Inc., shall not be held liable for any damage resulting from handling or from contact with the product. The information contained in this Material Safety Data Sheet (MSDS) is current as of the Date Prepared shown in Section 1.7 of this document and may be subject to amendment by StemCell Technologies Inc.
16.5 Disclaimer: THIS PRODUCT IS FOR RESEARCH USE ONLY. NOT INTENDED FOR HUMAN OR ANIMAL DIAGNOSTIC OR THERAPEUTIC USES.
1 Product and Company Identification

1.1 Product Name: NeuroCult™ NS-A Differentiation Supplements (Human)
1.2 Catalog Number: 05754
1.3 Synonyms: None
1.4 Product Use: Cell Culture
1.5 Manufacturer/Supplier: STEMCELL Technologies Inc.
   Suite 400, 570 West 7th Avenue
   Vancouver, BC V5Z 1B3
   Canada
1.6 In Case of Emergency Call: 604-877-0713
1.7 Date Effective: December 07, 2011
1.8 Prepared By: Quality Control

2 Composition / Information on Ingredients

2.1 Component | CAS No. | %W/W
Potentially biohazardous material derived from human blood. | Not Available | Not Available

3 Hazards Identification

3.1 Emergency Overview: Contains potentially biohazardous material derived from human blood. As with all human derivatives, universal handling precautions are recommended. This product is a potential irritant to eyes, respiratory system, and skin. This product may also be harmful if ingested. Complete toxicological properties have yet to be determined.

3.2 Routes of Exposure: Absorbed through skin, eye contact, inhalation, and ingestion.

3.3 Potential Health Effects:

3.3.1 Eye: May cause eye irritation.
3.3.2 Skin: May cause skin irritation.
3.3.3 Inhalation: May be harmful if inhaled. Material may be irritating to mucous membranes and upper respiratory tract.
3.3.4 Ingestion: May be harmful if swallowed.

3.4 Chronic Effects/Carcinogenicity: Not Available.
3.5 OSHA Regulatory Status: Not Available.

4 First Aid Measures

4.1 Eyes: In case of contact with eyes, flush thoroughly with water. Call a physician.
4.2 Skin: In case of contact with skin, wash the affected area with soap and copious amounts of water. Should irritation occur, contact a physician.
4.3 Ingestion: If swallowed, wash out mouth with water provided person is conscious. Call a physician.
4.4 **Inhalation:** If inhaled, remove person to fresh air. If breathing becomes difficult, call a physician.

4.5 **Puncture Wounds:** Wash thoroughly with soap and water. Allow to bleed freely. Call a physician.

4.6 **Note to Physician:** Not Available

---

5 **Fire Fighting Measures**

5.1 **Flash Point/Method:** Not Available

5.2 **Explosive Limits:**

5.2.1 **Upper:** Not Available

5.2.2 **Lower:** Not Available

5.3 **Autoignition Temperature:** Not Available

5.4 **Hazardous Combustion Products:** Not Available

5.5 **Conditions of Flammability:** Not Available

5.6 **Extinguishing Media:** Use whatever is appropriate to the surrounding fire.

5.7 **Fire Fighting Procedures:** Not Available – No toxic waste in run-off.

5.8 **Explosion Data:**

5.8.1 **Sensitivity to Mechanical Impact:** Not Available

5.8.2 **Sensitivity to Static Discharge:** Not Available

---

6 **Accidental Release Measures**

6.1 **Leak and Spill Procedure:** Wear chemical-resistant gloves. Absorb spill and place in closed container for disposal. Ventilate and wash area thoroughly after clean-up is complete.

---

7 **Handling and Storage**

7.1 **Handling:** Contains potentially biohazardous material derived from human blood. Donors have been tested for hepatitis B surface antigen (HBsAg) and anti-HIV-1 and/or HIV-1 antigen. However, this product should be considered potentially infectious and treated in accordance with universal handling precautions. May cause allergic reaction in sensitized individuals.

7.2 **Storage:** Store at -20°C.

---

8 **Exposure Controls/Personal Protection**

8.1 **Engineering Controls:** Use with adequate ventilation.

8.2 **Personal Protective Equipment:**

8.2.1 **Respiratory Protection:** This is a laboratory-use product for which no industrial protective equipment has been designated.

8.2.2 **Eye Protection:** Safety glasses.

8.2.3 **Skin Protection:** Lab coat, latex gloves.

8.3 **General Hygiene Considerations:** Wash hands after use.
8.4 Exposure Limits:
8.4.1 ACGIH TLV-TWA: Not Available
8.4.2 OSHA PEL-TWA: Not Available

9 Physical/Chemical Properties:
9.1 Appearance: Transparent, red
9.2 Odor: None
9.3 Physical State: Liquid
9.4 pH: Not Available
9.5 Boiling Point: Not Available
9.6 Melting Point: Not Applicable
9.7 Freezing Point: Not Available
9.8 Vapor Pressure: Not Available
9.9 Vapor Density: Not Available
9.10 Specific Gravity: Not Available
9.11 Evaporation Rate: Not Available
9.12 Solubility in Water: Not Available
9.13 Odor Threshold: Not Applicable
9.14 Coefficient of Water/Oil Distribution: Not Available

10 Stability/Reactivity:
10.1 Chemical Stability: Stable
10.2 Conditions to Avoid: Not Available
10.3 Incompatibility (Material to Avoid): Not Available
10.4 Hazardous Decomposition/By-Products: Nature of decomposition products not known.
10.5 Hazardous Polymerization: Not Available

11 Toxicological Information
11.1 Effects of Short-Term Exposure: Not Available
11.2 Effects of Long-Term Exposure: Not Available
11.3 Irritancy of Product: Not Available
11.4 Sensitization to Product: Not Available
11.5 Carcinogenicity: Not Available
11.6 Reproductive Toxicity: Not Available
11.7 Teratogenicity and Embryotoxicity: Not Available
11.8 Mutagenicity: Not Available
11.9 Name of Toxicologically Synergistic Products: Not Available
11.10 LD50 (specify species and route): Not Available
11.11 LC50 (specify species): Not Available

12 Ecological Information
12.1 Not Available

13 Disposal Considerations
13.1 Waste Disposal Method: Disposal should be in accordance with existing practices at your institution. Observe all Federal, Provincial/State and Local Laws.

14 Transport Information
14.1 Transport Canada
14.1.1 PIN No.: Not Available
14.2 U.S. Department of Transportation:
14.2.1 Proper Shipping Name: Not Available
14.2.2 Hazard Class: This substance not known to be hazardous for transport.
14.2.3 ID. Number: Not Available
14.2.4 Packing Group: Not Available
14.2.5 Label Statement: Not Available

15 Regulatory Information
15.1 WHMIS Classification: D3
15.2 Note: This MSDS was prepared according to the Canadian Controlled Products Regulation and contains all the information required by those regulations.

16 Other Information
16.1 Preparation Information: Refer to PIS No. 05752.
16.2 This MSDS has been revised in the following section(s): 1.1, 1.5, 9.4, 9.5, 9.7
16.3 Original Issue Date: July 26, 2005.
16.4 Notice: The above information is believed to be correct but does not purport to be all inclusive and shall be used only as a guide. StemCell Technologies Inc., shall not be held liable for any damage resulting from handling or from contact with the product. The information contained in this Material Safety Data Sheet (MSDS) is current as of the Date Prepared shown in Section 1.7 of this document and may be subject to amendment by StemCell Technologies Inc.
16.5 Disclaimer: THIS PRODUCT IS FOR RESEARCH USE ONLY. NOT USED FOR DIAGNOSTIC OR THERAPEUTIC APPLICATIONS.
SAFETY DATA SHEET

1. Identification of the substance/mixture and of the company/undertaking

Identification of the substance/preparation

<table>
<thead>
<tr>
<th>Product code</th>
<th>21103049</th>
</tr>
</thead>
<tbody>
<tr>
<td>Product name</td>
<td>NEUROBASAL™ MED SFM</td>
</tr>
</tbody>
</table>

Company/Undertaking Identification

Life Technologies
5791 Van Allen Way
PO Box 6482
Carlsbad, CA 92008
+1 760 603 7200

Life Technologies
5250 Mainway Drive
Burlington, ONT
CANADA L7L 6A4
800/263-6236

24 hour Emergency Response:

<table>
<thead>
<tr>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>866-536-0631</td>
</tr>
<tr>
<td>301-431-8585</td>
</tr>
<tr>
<td>Outside of the U.S. +1-301-431-8585</td>
</tr>
</tbody>
</table>

For research use only. Not intended for human or animal diagnostic or therapeutic uses.

2. Hazards identification

GHS - Classification

Signal Word
not hazardous

Health Hazard
not hazardous

Physical Hazards
not hazardous

Principle Routes of Exposure/
Potential Health effects

<table>
<thead>
<tr>
<th>Route</th>
<th>Hazard</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eyes</td>
<td>May cause eye irritation with susceptible persons.</td>
</tr>
<tr>
<td>Skin</td>
<td>May cause skin irritation in susceptible persons.</td>
</tr>
<tr>
<td>Inhalation</td>
<td>May be harmful by inhalation.</td>
</tr>
<tr>
<td>Ingestion</td>
<td>May be harmful if swallowed.</td>
</tr>
</tbody>
</table>
### Specific effects

<table>
<thead>
<tr>
<th>Carcinogenic effects</th>
<th>none</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mutagenic effects</td>
<td>none</td>
</tr>
<tr>
<td>Reproductive toxicity</td>
<td>none</td>
</tr>
<tr>
<td>Sensitization</td>
<td>none</td>
</tr>
</tbody>
</table>

**Target Organ Effects**

No known effects under normal use conditions.

### HMIS

<table>
<thead>
<tr>
<th></th>
<th>0</th>
</tr>
</thead>
<tbody>
<tr>
<td>Health</td>
<td></td>
</tr>
<tr>
<td>Flammability</td>
<td></td>
</tr>
<tr>
<td>Reactivity</td>
<td></td>
</tr>
</tbody>
</table>

### 3. Composition/information on ingredients

The product contains no substances which at their given concentration, are considered to be hazardous to health. We recommend handling all chemicals with caution.

### 4. First aid measures

**Skin contact**

Rinse with plenty of water. If symptoms arise, call a physician.

**Eye contact**

Rinse immediately with plenty of water, also under the eyelids, for at least 15 minutes. If symptoms persist, call a physician.

**Ingestion**

Never give anything by mouth to an unconscious person. If symptoms persist, call a physician. Do not induce vomiting without medical advice.

**Inhalation**

Move to fresh air. If symptoms persist, call a physician. If not breathing, give artificial respiration.

**Notes to physician**

Treat symptomatically.

### 5. Fire-fighting measures

**Suitable extinguishing media**


**Special protective equipment for firefighters**

Wear self-contained breathing apparatus and protective suit.

### 6. Accidental release measures

**Personal precautions**

Use personal protective equipment.

**Methods for cleaning up**

Soak up with inert absorbent material.

**Environmental precautions**

Prevent further leakage or spillage if safe to do so.

See Section 12 for additional information.

### 7. Handling and storage
Handling
Always wear recommended Personal Protective Equipment. No special handling advice required.

Storage
Keep in a dry, cool and well-ventilated place.

8. Exposure controls/personal protection

Exposure limits
We are not aware of any national exposure limit.

Engineering measures
Ensure adequate ventilation, especially in confined areas.

Personal protective equipment
Personal Protective Equipment requirements are dependent on the user institution's risk assessment and are specific to the risk assessment for each laboratory where this material may be used.

Respiratory protection
In case of insufficient ventilation wear suitable respiratory equipment.

Hand protection
Impervious gloves.

Eye protection
Safety glasses with side-shields.

Skin and body protection
Lightweight protective clothing.

Hygiene measures
Handle in accordance with good industrial hygiene and safety practice.

Environmental exposure controls
Prevent product from entering drains.

9. Physical and chemical properties

General Information

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Form</td>
<td>liquid</td>
</tr>
<tr>
<td>Appearance</td>
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</tr>
<tr>
<td>Odor</td>
<td>No information available</td>
</tr>
<tr>
<td>Boiling Point/Range</td>
<td>°C no data available</td>
</tr>
<tr>
<td>Melting point/range</td>
<td>°C no data available</td>
</tr>
<tr>
<td>Flash point</td>
<td>°C no data available</td>
</tr>
<tr>
<td>Autoignition temperature</td>
<td>°C no data available</td>
</tr>
<tr>
<td>Oxidizing properties</td>
<td>No information available</td>
</tr>
<tr>
<td>Water solubility</td>
<td>soluble</td>
</tr>
</tbody>
</table>

10. Stability and reactivity

Stability
Stable under normal conditions.

Materials to avoid
No dangerous reaction known under conditions of normal use.

Hazardous decomposition products
None under normal use

polymerization
Hazardous polymerisation does not occur.

11. Toxicological information

Acute toxicity
Principle Routes of Exposure/
Potential Health effects

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Eyes</td>
<td>May cause eye irritation with susceptible persons.</td>
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</tr>
<tr>
<td>Ingestion</td>
<td>May be harmful if swallowed.</td>
</tr>
<tr>
<td>Carcinogenic effects</td>
<td>none</td>
</tr>
<tr>
<td>Mutagenic effects</td>
<td>none</td>
</tr>
<tr>
<td>Reproductive toxicity</td>
<td>none</td>
</tr>
<tr>
<td>Sensitization</td>
<td>none</td>
</tr>
<tr>
<td>Target Organ Effects</td>
<td>No known effects under normal use conditions.</td>
</tr>
</tbody>
</table>

12. Ecological information

| Ecotoxicity effects               | No information available.                        |
| Mobility                          | No information available.                        |
| Biodegradation                    | Inherently biodegradable                         |
| Bioaccumulation                   | Does not bioaccumulate.                         |

13. Disposal considerations

Dispose of in accordance with local regulations.

14. Transport information

<table>
<thead>
<tr>
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<th></th>
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</thead>
<tbody>
<tr>
<td>Proper shipping name</td>
<td>Not classified as dangerous in the meaning of transport regulations</td>
</tr>
<tr>
<td>Hazard class</td>
<td>none</td>
</tr>
<tr>
<td>Subsidiary Class</td>
<td>none</td>
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<tr>
<td>Packing group</td>
<td>none</td>
</tr>
<tr>
<td>UN-No</td>
<td>None</td>
</tr>
</tbody>
</table>
15. Regulatory information

U.S. Federal Regulations

SARA 313
This product is not regulated by SARA.

Clean Air Act, Section 112 Hazardous Air Pollutants (HAPs) (see 40 CFR 61)
This product does not contain HAPs.

U.S. State Regulations

California Proposition 65
This product does not contain chemicals listed under Proposition 65

WHMIS Hazard Class
Non-controlled

This product has been classified according to the hazard criteria of the CPR and the MSDS contains all of the information required by the CPR

16. Other information

Reason for Revision
(M)SDS sections updated.

For research use only. Not intended for human or animal diagnostic or therapeutic uses.

The above information was acquired by diligent search and/or investigation and the recommendations are based on prudent application of professional judgment. The information shall not be taken as being all inclusive and is to be used only as a guide. All materials and mixtures may present unknown hazards and should be used with caution. Since the Company cannot control the actual methods, volumes, or conditions of use, the Company shall not be held liable for any damages or losses resulting from the handling or from contact with the product as described herein. THE INFORMATION IN THIS MSDS DOES NOT CONSTITUTE A WARRENTY, EXPRESSED OR IMPLIED, INCLUDING ANY IMPLIED WARRANTY OF MERCHANTABILITY OR FITNESS FOR ANY PARTICULAR PURPOSE.

End of Safety Data Sheet
SAFETY DATA SHEET

1. Identification of the substance/mixture and of the company/undertaking

Identification of the substance/preparation

<table>
<thead>
<tr>
<th>Product code</th>
<th>35050061</th>
</tr>
</thead>
<tbody>
<tr>
<td>Product name</td>
<td>GLUTAMAX I, 100X</td>
</tr>
</tbody>
</table>

Company/Undertaking Identification

<table>
<thead>
<tr>
<th>Life Technologies</th>
<th>Life Technologies</th>
</tr>
</thead>
<tbody>
<tr>
<td>5791 Van Allen Way</td>
<td>5250 Mainway Drive</td>
</tr>
<tr>
<td>PO Box 6482</td>
<td>Burlingont, ONT</td>
</tr>
<tr>
<td>Carlsbad, CA 92008</td>
<td>CANADA L7L 6A4</td>
</tr>
<tr>
<td>+1 760 603 7200</td>
<td>800/263-6236</td>
</tr>
</tbody>
</table>

24 hour Emergency Response:

| 866-536-0631 |
| 301-431-8585 |
| Outside of the U.S. +1-301-431-8585 |

For in vitro diagnostic use. CAUTION: Not for human or animal therapeutic use.

2. Hazards identification

GHS - Classification

Signal Word
not hazardous

Health Hazard
not hazardous

Physical Hazards
not hazardous

Principle Routes of Exposure/
Potential Health effects

<table>
<thead>
<tr>
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<td>May be harmful if swallowed.</td>
</tr>
</tbody>
</table>

Revision Date: 25-Oct-2012
Product code: 35050061
Product name: GLUTAMAX I, 100X

www.lifetechnologies.com
Sensitization

Accidental release measures

Personal precautions
Use personal protective equipment.

Methods for cleaning up
Soak up with inert absorbent material.

Target Organ Effects
No known effects under normal use conditions.

4. First aid measures

Skin contact
Rinse with plenty of water. If symptoms arise, call a physician.

Eye contact
Rinse immediately with plenty of water, also under the eyelids, for at least 15 minutes. If symptoms persist, call a physician. Do not induce vomiting without medical advice.

Ingestion
Never give anything by mouth to an unconscious person. If symptoms persist, call a physician.

Inhalation
Move to fresh air. If symptoms persist, call a physician. If not breathing, give artificial respiration.

Notes to physician
Treat symptomatically.

5. Fire-fighting measures

Suitable extinguishing media

Special protective equipment for firefighters
Wear self-contained breathing apparatus and protective suit.

3. Composition/information on ingredients

The product contains no substances which at their given concentration, are considered to be hazardous to health. We recommend handling all chemicals with caution.

35050061

25-Oct-2012

www.lifetechnologies.com
Handling
Always wear recommended Personal Protective Equipment. No special handling advice required.

Storage
Keep in a dry, cool and well-ventilated place.

8. Exposure controls/personal protection

Exposure limits
We are not aware of any national exposure limit.

Engineering measures
Ensure adequate ventilation, especially in confined areas.

Personal protective equipment
Personal Protective Equipment requirements are dependent on the user institution’s risk assessment and are specific to the risk assessment for each laboratory where this material may be used.

Respiratory protection
In case of insufficient ventilation wear suitable respiratory equipment.

Hand protection
Impervious gloves.
Eye protection
Safety glasses with side-shields.
Skin and body protection
Lightweight protective clothing.
Hygiene measures
Handle in accordance with good industrial hygiene and safety practice.

Environmental exposure controls
Prevent product from entering drains.

9. Physical and chemical properties

General Information
Form
liquid
Appearance
No information available
Odor
No information available
Boiling Point/Range
°C no data available
°F no data available
Melting point/range
°C no data available
°F no data available
Flash point
°C no data available
°F no data available
Autoignition temperature
°C no data available
°F no data available
Oxidizing properties
No information available.
Water solubility
soluble
pH Range
4.7-6.0

10. Stability and reactivity

Stability
Stable under normal conditions.
Materials to avoid
No dangerous reaction known under conditions of normal use.
Hazardous decomposition products
None under normal use
Polymerization
Hazardous polymerisation does not occur.

11. Toxicological information

Acute toxicity
Principle Routes of Exposure/  
Potential Health effects  

| Eyes       | May cause eye irritation with susceptible persons. |
| Skin      | May cause skin irritation in susceptible persons. |
| Inhalation | May be harmful by inhalation. |
| Ingestion | May be harmful if swallowed. |

| Carcinogenic effects | none |
| Mutagenic effects | none |
| Reproductive toxicity | none |
| Sensitization | none |

Target Organ Effects  
No known effects under normal use conditions.

12. Ecological information

Ecotoxicity effects  
No information available.

Mobility  
No information available.

Biodegradation  
Inherently biodegradable

Bioaccumulation  
Does not bioaccumulate.

13. Disposal considerations

Dispose of in accordance with local regulations.

14. Transport information

IATA  
Proper shipping name  
Not classified as dangerous in the meaning of transport regulations

Hazard class  
none

Subsidiary Class  
none

Packing group  
none

UN-No  
None
15. Regulatory information

U.S. Federal Regulations

SARA 313
This product is not regulated by SARA.

Clean Air Act, Section 112 Hazardous Air Pollutants (HAPs) (see 40 CFR 61)
This product does not contain HAPs.

U.S. State Regulations

California Proposition 65
This product does not contain chemicals listed under Proposition 65

WHMIS Hazard Class
Non-controlled

This product has been classified according to the hazard criteria of the CPR and the MSDS contains all of the information required by the CPR

16. Other information

Reason for Revision
(M)SDS sections updated.

For in vitro diagnostic use. CAUTION: Not for human or animal therapeutic use.

The above information was acquired by diligent search and/or investigation and the recommendations are based on prudent application of professional judgment. The information shall not be taken as being all inclusive and is to be used only as a guide. All materials and mixtures may present unknown hazards and should be used with caution. Since the Company cannot control the actual methods, volumes, or conditions of use, the Company shall not be held liable for any damages or losses resulting from the handling or from contact with the product as described herein. THE INFORMATION IN THIS MSDS DOES NOT CONSTITUTE A WARRENTY, EXPRESSED OR IMPLIED, INCLUDING ANY IMPLIED WARRANTY OF MERCHANTABILITY OR FITNESS FOR ANY PARTICULAR PURPOSE.

End of Safety Data Sheet
# SAFETY DATA SHEET

## 1. Identification of the substance/mixture and of the company/undertaking

### Identification of the substance/preparation

<table>
<thead>
<tr>
<th>Product code</th>
<th>17504044</th>
</tr>
</thead>
<tbody>
<tr>
<td>Product name</td>
<td>B27 Supplement</td>
</tr>
</tbody>
</table>

### Company/Undertaking Identification

<table>
<thead>
<tr>
<th>Life Technologies</th>
<th>Life Technologies</th>
</tr>
</thead>
<tbody>
<tr>
<td>5791 Van Allen Way</td>
<td>5250 Mainway Drive</td>
</tr>
<tr>
<td>PO Box 6482</td>
<td>Burlington, ONT</td>
</tr>
<tr>
<td>Carlsbad, CA 92008</td>
<td>CANADA L7L 6A4</td>
</tr>
<tr>
<td>+1 760 603 7200</td>
<td>800/263-6236</td>
</tr>
</tbody>
</table>

24 hour Emergency Response: 866-536-0631
                                  301-431-8585
                                  Outside of the U.S. +1-301-431-8585

For research use only. Not intended for human or animal diagnostic or therapeutic uses.

## 2. Hazards identification

### GHS - Classification

**Signal Word**
not hazardous

**Health Hazard**
not hazardous

**Physical Hazards**
not hazardous

### Principle Routes of Exposure/
**Potential Health effects**

- **Eyes**: May cause eye irritation with susceptible persons.
- **Skin**: May cause skin irritation in susceptible persons.
- **Inhalation**: May be harmful by inhalation.
- **Ingestion**: May be harmful if swallowed.
6. Accidental release measures

Personal precautions
Use personal protective equipment.

Methods for cleaning up
Soak up with inert absorbent material.

Environmental precautions
Prevent further leakage or spillage if safe to do so.

See Section 12 for additional information.

7. Handling and storage

We recommend handling all chemicals with caution.
Handling
Always wear recommended Personal Protective Equipment. No special handling advice required.

Storage
Keep in a dry, cool and well-ventilated place.

8. Exposure controls/personal protection

Exposure limits

<table>
<thead>
<tr>
<th>Chemical Name</th>
<th>OSHA PEL</th>
<th>OSHA PEL (Ceiling)</th>
<th>ACGIH OEL (TWA)</th>
<th>ACGIH OEL (STEL)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Selenium compounds</td>
<td>none</td>
<td>none</td>
<td>none</td>
<td>none</td>
</tr>
</tbody>
</table>

Engineering measures
Ensure adequate ventilation, especially in confined areas.

Personal protective equipment
Personal Protective Equipment requirements are dependent on the user institution's risk assessment and are specific to the risk assessment for each laboratory where this material may be used.

Respiratory protection
In case of insufficient ventilation wear suitable respiratory equipment.

Hand protection
Impervious gloves.

Eye protection
Safety glasses with side-shields.

Skin and body protection
Lightweight protective clothing.

Hygiene measures
Handle in accordance with good industrial hygiene and safety practice.

Environmental exposure controls
Prevent product from entering drains.

9. Physical and chemical properties

General Information

<table>
<thead>
<tr>
<th>Form</th>
<th>liquid</th>
</tr>
</thead>
<tbody>
<tr>
<td>Appearance</td>
<td>No information available</td>
</tr>
<tr>
<td>Odor</td>
<td>No information available</td>
</tr>
<tr>
<td>Boiling Point/Range</td>
<td>°C no data available</td>
</tr>
<tr>
<td>Melting point/range</td>
<td>°C no data available</td>
</tr>
<tr>
<td>Flash point</td>
<td>°C no data available</td>
</tr>
<tr>
<td>Autoignition temperature</td>
<td>°C no data available</td>
</tr>
<tr>
<td>Oxidizing properties</td>
<td>No information available.</td>
</tr>
<tr>
<td>Water solubility</td>
<td>soluble</td>
</tr>
</tbody>
</table>

10. Stability and reactivity

Stability
Stable under normal conditions.

Materials to avoid
No dangerous reaction known under conditions of normal use.

Hazardous decomposition products
None under normal use

Polymerization
Hazardous polymerisation does not occur.

11. Toxicological information

Acute toxicity
Principle Routes of Exposure/
Potential Health effects

<table>
<thead>
<tr>
<th>Eyes</th>
<th>Skin</th>
<th>Inhalation</th>
<th>Ingestion</th>
</tr>
</thead>
<tbody>
<tr>
<td>May cause eye irritation with susceptible persons.</td>
<td>May cause skin irritation in susceptible persons.</td>
<td>May be harmful by inhalation.</td>
<td>May be harmful if swallowed.</td>
</tr>
</tbody>
</table>

Carcinogenic effects: none
Mutagenic effects: none
Reproductive toxicity: none
Sensitization: none

Target Organ Effects: No known effects under normal use conditions.

12. Ecological information

Ecotoxicity effects: No information available.
Mobility: No information available.
Biodegradation: Inherently biodegradable
Bioaccumulation: Does not bioaccumulate.

13. Disposal considerations

Dispose of in accordance with local regulations.

14. Transport information

IATA

<table>
<thead>
<tr>
<th>Proper shipping name</th>
<th>Hazard class</th>
<th>Subsidiary Class</th>
<th>Packing group</th>
<th>UN-No</th>
</tr>
</thead>
<tbody>
<tr>
<td>Not classified as dangerous in the meaning of transport regulations</td>
<td>none</td>
<td>none</td>
<td>none</td>
<td>None</td>
</tr>
</tbody>
</table>
15. Regulatory information

<table>
<thead>
<tr>
<th>Component</th>
<th>TSCA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Selenium compounds</td>
<td>-</td>
</tr>
<tr>
<td>none ( &lt;0.01 )</td>
<td>-</td>
</tr>
</tbody>
</table>

U.S. Federal Regulations

SARA 313
This product is not regulated by SARA.

Clean Air Act, Section 112 Hazardous Air Pollutants (HAPs) (see 40 CFR 61)
This product does not contain HAPs.

U.S. State Regulations

<table>
<thead>
<tr>
<th>Chemical Name</th>
<th>Massachusetts - RTK</th>
<th>New Jersey - RTK</th>
<th>Pennsylvania - RTK</th>
<th>Illinois - RTK</th>
<th>Rhode Island - RTK</th>
</tr>
</thead>
<tbody>
<tr>
<td>Selenium compounds</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

California Proposition 65
This product does not contain chemicals listed under Proposition 65

WHMIS Hazard Class
Non-controlled

This product has been classified according to the hazard criteria of the CPR and the MSDS contains all of the information required by the CPR

16. Other information

Reason for Revision
(M)SDS sections updated.

For research use only. Not intended for human or animal diagnostic or therapeutic uses.

The above information was acquired by diligent search and/or investigation and the recommendations are based on prudent application of professional judgment. The information shall not be taken as being all inclusive and is to be used only as a guide. All materials and mixtures may present unknown hazards and should be used with caution. Since the Company cannot control the actual methods, volumes, or conditions of use, the Company shall not be held liable for any damages or losses resulting from the handling or from contact with the product as described herein. THE INFORMATION IN THIS MSDS DOES NOT CONSTITUTE A WARRENTY, EXPRESSED OR IMPLIED, INCLUDING ANY IMPLIED WARRANTY OF MERCHANTABILITY OR FITNESS FOR ANY PARTICULAR PURPOSE.

End of Safety Data Sheet
1. PRODUCT AND COMPANY IDENTIFICATION

Product name: Carbon dioxide
Product Number: 295108
Brand: Aldrich
Supplier: Sigma-Aldrich
Supplier address: 3050 Spruce Street, SAINT LOUIS MO 63103, USA
Telephone: +1 800-325-5832
Fax: +1 800-325-5052
Emergency Phone #: (314) 776-6555
Preparation Information: Sigma-Aldrich Corporation
Product Safety - Americas Region
1-800-521-8956

2. HAZARDS IDENTIFICATION

Emergency Overview

OSHA Hazards
Compressed Gas

GHS Classification
Gases under pressure (Liquefied gas)

GHS Label elements, including precautionary statements

Pictogram

Signal word: Warning

Hazard statement(s)
H280 Contains gas under pressure; may explode if heated.

Precautionary statement(s)
P410 + P403 Protect from sunlight. Store in a well-ventilated place.

HMIS Classification
Health hazard: 0
Flammability: 0
Physical hazards: 0

NFPA Rating
Health hazard: 0
Fire: 0
Reactivity Hazard: 0

Potential Health Effects
Inhalation: May be harmful if inhaled. May cause respiratory tract irritation.
Skin: May cause severe frostbite. May be harmful if absorbed through skin. May cause skin irritation.
Eyes: May cause eye irritation.
Ingestion: May be harmful if swallowed.
Aggravated Medical Condition Acts as a simple asphyxiant by displacing air.

3. COMPOSITION/INFORMATION ON INGREDIENTS

<table>
<thead>
<tr>
<th>Formula</th>
<th>CO₂</th>
</tr>
</thead>
<tbody>
<tr>
<td>Molecular Weight</td>
<td>44.01 g/mol</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Component</th>
<th>Concentration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbon dioxide</td>
<td></td>
</tr>
<tr>
<td>CAS-No.</td>
<td>124-38-9</td>
</tr>
<tr>
<td>EC-No.</td>
<td>204-696-9</td>
</tr>
</tbody>
</table>

4. FIRST AID MEASURES

General advice
Consult a physician. Show this safety data sheet to the doctor in attendance. Move out of dangerous area.

If inhaled
If breathed in, move person into fresh air. If not breathing, give artificial respiration. Consult a physician.

In case of skin contact
Wash off with soap and plenty of water. Consult a physician.

In case of eye contact
Flush eyes with water as a precaution.

If swallowed
Never give anything by mouth to an unconscious person. Rinse mouth with water. Consult a physician.

5. FIREFIGHTING MEASURES

Conditions of flammability
Not flammable or combustible.

Suitable extinguishing media
Use water spray, alcohol-resistant foam, dry chemical or carbon dioxide.

Special protective equipment for firefighters
Wear self contained breathing apparatus for fire fighting if necessary.

Hazardous combustion products
Hazardous decomposition products formed under fire conditions. - Carbon oxides

Further information
Use water spray to cool unopened containers.

6. ACCIDENTAL RELEASE MEASURES

Personal precautions
Avoid breathing vapors, mist or gas. Ensure adequate ventilation. Evacuate personnel to safe areas.

Environmental precautions
Do not let product enter drains.

Methods and materials for containment and cleaning up
Clean up promptly by sweeping or vacuum.

7. HANDLING AND STORAGE

Conditions for safe storage
Keep container tightly closed in a dry and well-ventilated place.

Contents under pressure. Avoid heating above: 50°C
8. EXPOSURE CONTROLS/PERSONAL PROTECTION
Components with workplace control parameters

<table>
<thead>
<tr>
<th>Components</th>
<th>CAS-No.</th>
<th>Value Control parameters</th>
<th>Basis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbon dioxide</td>
<td>124-38-9</td>
<td>TWA 5,000 ppm</td>
<td>USA. ACGIH Threshold Limit Values (TLV)</td>
</tr>
<tr>
<td>Remarks</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>STEL 30,000 ppm</td>
<td>USA. ACGIH Threshold Limit Values (TLV)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Asphyxia</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>TWA 10,000 ppm</td>
<td>USA. OSHA - TABLE Z-1 Limits for Air Contaminants - 1910.1000</td>
</tr>
<tr>
<td></td>
<td></td>
<td>18,000 mg/m3</td>
<td>USA. OSHA - TABLE Z-1 Limits for Air Contaminants - 1910.1000</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Exposures under 10,000 ppm to be cited as de minimis.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>STEL 30,000 ppm</td>
<td>USA. OSHA - TABLE Z-1 Limits for Air Contaminants - 1910.1000</td>
</tr>
<tr>
<td></td>
<td></td>
<td>TWA 5,000 ppm</td>
<td>USA. Occupational Exposure Limits (OSHA) - Table Z-1 Limits for Air Contaminants</td>
</tr>
<tr>
<td></td>
<td></td>
<td>9,000 mg/m3</td>
<td>USA. Occupational Exposure Limits (OSHA) - Table Z-1 Limits for Air Contaminants</td>
</tr>
<tr>
<td></td>
<td></td>
<td>The value in mg/m3 is approximate.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>TWA 5,000 ppm</td>
<td>USA. NIOSH Recommended Exposure Limits</td>
</tr>
<tr>
<td></td>
<td></td>
<td>9,000 mg/m3</td>
<td>USA. NIOSH Recommended Exposure Limits</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Normal constituent of air (about 300 ppm).</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>ST 30,000 ppm</td>
<td>USA. NIOSH Recommended Exposure Limits</td>
</tr>
<tr>
<td></td>
<td></td>
<td>54,000 mg/m3</td>
<td>USA. NIOSH Recommended Exposure Limits</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Normal constituent of air (about 300 ppm).</td>
<td></td>
</tr>
</tbody>
</table>

Personal protective equipment

Respiratory protection
Where risk assessment shows air-purifying respirators are appropriate use a full-face respirator with multi-purpose combination (US) or type AXBEK (EN 14387) respirator cartridges as a backup to engineering controls. If the respirator is the sole means of protection, use a full-face supplied air respirator. Use respirators and components tested and approved under appropriate government standards such as NIOSH (US) or CEN (EU).

Hand protection
Handle with gloves. Gloves must be inspected prior to use. Use proper glove removal technique (without touching glove's outer surface) to avoid skin contact with this product. Dispose of contaminated gloves after use in accordance with applicable laws and good laboratory practices. Wash and dry hands.

Full contact
Material: butyl-rubber
Minimum layer thickness: 0.3 mm
Break through time: 480 min
Material tested: Butoject® (KCL 897 / Aldrich Z677647, Size M)

Splash protection
Material: Chloroprene
Minimum layer thickness: 0.6 mm
Break through time: 30 min
Material tested: Campapren® (KCL 722 / Aldrich Z677493, Size M)

data source: KCL GmbH, D-36124 Eichenzell, phone +49 (0)6659 87300, e-mail sales@kcl.de, test method: EN374
If used in solution, or mixed with other substances, and under conditions which differ from EN 374, contact the supplier of the CE approved gloves. This recommendation is advisory only and must be evaluated by an Industrial Hygienist familiar with the specific situation of anticipated use by our customers. It should not be construed as offering an approval for any specific use scenario.
Eye protection
Use equipment for eye protection tested and approved under appropriate government standards such as NIOSH (US) or EN 166(EU).

Skin and body protection
Impervious clothing. The type of protective equipment must be selected according to the concentration and amount of the dangerous substance at the specific workplace.

Hygiene measures
Handle in accordance with good industrial hygiene and safety practice. Wash hands before breaks and at the end of workday.

9. PHYSICAL AND CHEMICAL PROPERTIES

<table>
<thead>
<tr>
<th>Appearance</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Form</td>
<td>Liquefied gas</td>
</tr>
<tr>
<td>Colour</td>
<td>no data available</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Safety data</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>pH</td>
<td>no data available</td>
</tr>
<tr>
<td>Melting point/freezing point</td>
<td>Melting point/range: -78.5 °C (-109.3 ºF) - lit.</td>
</tr>
<tr>
<td>Boiling point</td>
<td>no data available</td>
</tr>
<tr>
<td>Sublimation point</td>
<td>-78.5 °C (-109.3 ºF)</td>
</tr>
<tr>
<td>Flash point</td>
<td>not applicable</td>
</tr>
<tr>
<td>Ignition temperature</td>
<td>no data available</td>
</tr>
<tr>
<td>Auto-ignition  temperature</td>
<td>no data available</td>
</tr>
<tr>
<td>Lower explosion limit</td>
<td>no data available</td>
</tr>
<tr>
<td>Upper explosion limit</td>
<td>no data available</td>
</tr>
<tr>
<td>Vapour pressure</td>
<td>57,249 hPa (42,940 mmHg) at 20 °C (68 °F)</td>
</tr>
<tr>
<td>Density</td>
<td>no data available</td>
</tr>
<tr>
<td>Water solubility</td>
<td>no data available</td>
</tr>
<tr>
<td>Partition coefficient: n-octanol/water</td>
<td>no data available</td>
</tr>
<tr>
<td>Relative vapor density</td>
<td>1.52 (Air = 1.0)</td>
</tr>
<tr>
<td>Odour</td>
<td>no data available</td>
</tr>
<tr>
<td>Odour Threshold</td>
<td>no data available</td>
</tr>
<tr>
<td>Evaporation rate</td>
<td>no data available</td>
</tr>
</tbody>
</table>

10. STABILITY AND REACTIVITY

Chemical stability
Stable under recommended storage conditions.

Possibility of hazardous reactions
No data available

Conditions to avoid
No data available

Materials to avoid
No data available
Hazardous decomposition products
Hazardous decomposition products formed under fire conditions. - Carbon oxides
Other decomposition products - no data available

11. TOXICOLOGICAL INFORMATION

Acute toxicity

**Oral LD50**
no data available

**Inhalation LC50**
no data available

**Dermal LD50**
no data available

**Other information on acute toxicity**
no data available

**Skin corrosion/irritation**
no data available

**Serious eye damage/eye irritation**
no data available

**Respiratory or skin sensitization**
no data available

**Germ cell mutagenicity**
no data available

**Carcinogenicity**

**IARC:** No component of this product present at levels greater than or equal to 0.1% is identified as probable, possible or confirmed human carcinogen by IARC.

**ACGIH:** No component of this product present at levels greater than or equal to 0.1% is identified as a carcinogen or potential carcinogen by ACGIH.

**NTP:** No component of this product present at levels greater than or equal to 0.1% is identified as a known or anticipated carcinogen by NTP.

**OSHA:** No component of this product present at levels greater than or equal to 0.1% is identified as a carcinogen or potential carcinogen by OSHA.

**Reproductive toxicity**
no data available

**Teratogenicity**
no data available

**Specific target organ toxicity - single exposure (Globally Harmonized System)**
no data available

**Specific target organ toxicity - repeated exposure (Globally Harmonized System)**
no data available

**Aspiration hazard**
no data available

**Potential health effects**

**Inhalation** May be harmful if inhaled. May cause respiratory tract irritation.

**Ingestion** May be harmful if swallowed.

**Skin** May cause severe frostbite. May be harmful if absorbed through skin. May cause skin
irritation.  
Eyes
May cause eye irritation.  
Aggravated
Acts as a simple asphyxiant by displacing air.

Medical Condition

Signs and Symptoms of Exposure
Nausea, Dizziness, Headache, Low to medium concentrations of carbon dioxide can affect regulation of blood circulation, affect the acidity of body fluids, respiratory difficulties. At high concentrations: Breathing difficulties, Increased pulse rate, change in body acidity. Very high concentrations can cause: Unconsciousness, death

Synergistic effects
no data available

Additional Information
RTECS: FF6400000

12. ECOLOGICAL INFORMATION

Toxicity
no data available

Persistence and degradability
no data available

Bioaccumulative potential
no data available

Mobility in soil
no data available

PBT and vPvB assessment
no data available

Other adverse effects
no data available

13. DISPOSAL CONSIDERATIONS

Product
Offer surplus and non-recyclable solutions to a licensed disposal company. Contact a licensed professional waste disposal service to dispose of this material.

Contaminated packaging
Dispose of as unused product.

14. TRANSPORT INFORMATION

DOT (US)
UN number: 1013 Class: 2.2
Proper shipping name: Carbon dioxide
Reportable Quantity (RQ):
Marine Pollutant: No
Poison Inhalation Hazard: No

IMDG
UN number: 1013 Class: 2.2
Proper shipping name: CARBON DIOXIDE
Marine Pollutant: No

IATA
UN number: 1013 Class: 2.2
Proper shipping name: Carbon dioxide

15. REGULATORY INFORMATION
OSHA Hazards
Compressed Gas

**SARA 302 Components**
SARA 302: No chemicals in this material are subject to the reporting requirements of SARA Title III, Section 302.

**SARA 313 Components**
SARA 313: This material does not contain any chemical components with known CAS numbers that exceed the threshold (De Minimis) reporting levels established by SARA Title III, Section 313.

**SARA 311/312 Hazards**
Sudden Release of Pressure Hazard

**Massachusetts Right To Know Components**

<table>
<thead>
<tr>
<th>Component</th>
<th>CAS-No.</th>
<th>Revision Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbon dioxide</td>
<td>124-38-9</td>
<td>1993-04-24</td>
</tr>
</tbody>
</table>

**Pennsylvania Right To Know Components**

<table>
<thead>
<tr>
<th>Component</th>
<th>CAS-No.</th>
<th>Revision Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbon dioxide</td>
<td>124-38-9</td>
<td>1993-04-24</td>
</tr>
</tbody>
</table>

**New Jersey Right To Know Components**

<table>
<thead>
<tr>
<th>Component</th>
<th>CAS-No.</th>
<th>Revision Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbon dioxide</td>
<td>124-38-9</td>
<td>1993-04-24</td>
</tr>
</tbody>
</table>

**California Prop. 65 Components**
This product does not contain any chemicals known to State of California to cause cancer, birth defects, or any other reproductive harm.

### 16. OTHER INFORMATION

**Further information**
Copyright 2012 Sigma-Aldrich Co. LLC. License granted to make unlimited paper copies for internal use only. The above information is believed to be correct but does not purport to be all inclusive and shall be used only as a guide. The information in this document is based on the present state of our knowledge and is applicable to the product with regard to appropriate safety precautions. It does not represent any guarantee of the properties of the product. Sigma-Aldrich Corporation and its Affiliates shall not be held liable for any damage resulting from handling or from contact with the above product. See www.sigma-aldrich.com and/or the reverse side of invoice or packing slip for additional terms and conditions of sale.
1. PRODUCT AND COMPANY IDENTIFICATION

1.1 Product identifiers

Product name: D-(+)-Glucose

Product Number: G8270
Brand: Sigma
REACH No.: A registration number is not available for this substance as the substance or its uses are exempted from registration, the annual tonnage does not require a registration or the registration is envisaged for a later registration deadline.

CAS-No.: 50-99-7

1.2 Relevant identified uses of the substance or mixture and uses advised against

Identified uses: Laboratory chemicals, Manufacture of substances

1.3 Details of the supplier of the safety data sheet

Company: Sigma-Aldrich
3050 Spruce Street
SAINT LOUIS MO 63103
USA

Telephone: +1 800-325-5832
Fax: +1 800-325-5052

1.4 Emergency telephone number

Emergency Phone #: (314) 776-6555

2. HAZARDS IDENTIFICATION

2.1 Classification of the substance or mixture

Not a hazardous substance or mixture.

2.2 GHS Label elements, including precautionary statements

Not a hazardous substance or mixture.

2.3 Hazards not otherwise classified (HNOC) or not covered by GHS - none

3. COMPOSITION/INFORMATION ON INGREDIENTS

3.1 Substances

Synonyms: Dextrose

Formula: C₆H₁₂O₆
Molecular Weight: 180.16 g/mol
CAS-No.: 50-99-7
EC-No.: 200-075-1

No ingredients are hazardous according to OSHA criteria.
No components need to be disclosed according to the applicable regulations.
4. FIRST AID MEASURES

4.1 Description of first aid measures

   If inhaled
   If breathed in, move person into fresh air. If not breathing, give artificial respiration.

   In case of skin contact
   Wash off with soap and plenty of water.

   In case of eye contact
   Flush eyes with water as a precaution.

   If swallowed
   Never give anything by mouth to an unconscious person. Rinse mouth with water.

4.2 Most important symptoms and effects, both acute and delayed
The most important known symptoms and effects are described in the labelling (see section 2.2) and/or in section 11

4.3 Indication of any immediate medical attention and special treatment needed
no data available

5. FIREFIGHTING MEASURES

5.1 Extinguishing media

   Suitable extinguishing media
   Use water spray, alcohol-resistant foam, dry chemical or carbon dioxide.

5.2 Special hazards arising from the substance or mixture
Carbon oxides

5.3 Advice for firefighters
   Wear self contained breathing apparatus for fire fighting if necessary.

5.4 Further information
   no data available

6. ACCIDENTAL RELEASE MEASURES

6.1 Personal precautions, protective equipment and emergency procedures
   Avoid dust formation. Avoid breathing vapours, mist or gas.
   For personal protection see section 8.

6.2 Environmental precautions
   Do not let product enter drains.

6.3 Methods and materials for containment and cleaning up
   Sweep up and shovel. Keep in suitable, closed containers for disposal.

6.4 Reference to other sections
   For disposal see section 13.

7. HANDLING AND STORAGE

7.1 Precautions for safe handling
   Provide appropriate exhaust ventilation at places where dust is formed.
   For precautions see section 2.2.

7.2 Conditions for safe storage, including any incompatibilities
   Keep container tightly closed in a dry and well-ventilated place.
   hygroscopic Keep in a dry place.

7.3 Specific end use(s)
   Apart from the uses mentioned in section 1.2 no other specific uses are stipulated
8. EXPOSURE CONTROLS/PERSONAL PROTECTION

8.1 Control parameters

Components with workplace control parameters
Contains no substances with occupational exposure limit values.

8.2 Exposure controls

Appropriate engineering controls
General industrial hygiene practice.

Personal protective equipment

Eye/face protection
Use equipment for eye protection tested and approved under appropriate government standards such as NIOSH (US) or EN 166(EU).

Skin protection
Handle with gloves. Gloves must be inspected prior to use. Use proper glove removal technique (without touching glove's outer surface) to avoid skin contact with this product. Dispose of contaminated gloves after use in accordance with applicable laws and good laboratory practices. Wash and dry hands.

Full contact
Material: Nitrile rubber
Minimum layer thickness: 0.11 mm
Break through time: 480 min
Material tested:Dermatril® (KCL 740 / Aldrich Z677272, Size M)

Splash contact
Material: Nitrile rubber
Minimum layer thickness: 0.11 mm
Break through time: 480 min
Material tested:Dermatril® (KCL 740 / Aldrich Z677272, Size M)

data source: KCL GmbH, D-36124 Eichenzell, phone +49 (0)6659 87300, e-mail sales@kcl.de, test method: EN374

If used in solution, or mixed with other substances, and under conditions which differ from EN 374, contact the supplier of the CE approved gloves. This recommendation is advisory only and must be evaluated by an industrial hygienist and safety officer familiar with the specific situation of anticipated use by our customers. It should not be construed as offering an approval for any specific use scenario.

Body Protection
Choose body protection in relation to its type, to the concentration and amount of dangerous substances, and to the specific workplace., The type of protective equipment must be selected according to the concentration and amount of the dangerous substance at the specific workplace.

Respiratory protection
Respiratory protection is not required. Where protection from nuisance levels of dusts are desired, use type N95 (US) or type P1 (EN 143) dust masks. Use respirators and components tested and approved under appropriate government standards such as NIOSH (US) or CEN (EU).

Control of environmental exposure
Do not let product enter drains.

9. PHYSICAL AND CHEMICAL PROPERTIES

9.1 Information on basic physical and chemical properties

a) Appearance
   Form: crystalline, powder
   Colour: white

b) Odour
   no data available

c) Odour Threshold
   no data available

d) pH
   no data available

e) Melting point/freezing
   Melting point/range: 150 - 152 °C (302 - 306 °F)
point

f) Initial boiling point and boiling range  no data available

g) Flash point  no data available

h) Evaporation rate  no data available

i) Flammability (solid, gas)  no data available

j) Upper/lower flammability or explosive limits  no data available

k) Vapour pressure  no data available

l) Vapour density  no data available

m) Relative density  no data available

n) Water solubility  soluble

o) Partition coefficient: n-octanol/water  no data available

p) Auto-ignition temperature  no data available

q) Decomposition temperature  no data available

r) Viscosity  no data available

s) Explosive properties  no data available

t) Oxidizing properties  no data available

9.2 Other safety information  no data available

10. STABILITY AND REACTIVITY

10.1 Reactivity  no data available

10.2 Chemical stability
Stable under recommended storage conditions.

10.3 Possibility of hazardous reactions  no data available

10.4 Conditions to avoid  no data available

10.5 Incompatible materials
Strong oxidizing agents

10.6 Hazardous decomposition products
Other decomposition products - no data available
In the event of fire: see section 5

11. TOXICOLOGICAL INFORMATION

11.1 Information on toxicological effects

Acute toxicity
LD50 Oral - rat - 25,800 mg/kg

Inhalation: no data available
Dermal: no data available
Skin corrosion/irritation
no data available

Serious eye damage/eye irritation
no data available

Respiratory or skin sensitisation
no data available

Germ cell mutagenicity
mouse
lymphocyte
Mutation in mammalian somatic cells.

Carcinogenicity
IARC: No component of this product present at levels greater than or equal to 0.1% is identified as probable, possible or confirmed human carcinogen by IARC.
ACGIH: No component of this product present at levels greater than or equal to 0.1% is identified as a carcinogen or potential carcinogen by ACGIH.
NTP: No component of this product present at levels greater than or equal to 0.1% is identified as a known or anticipated carcinogen by NTP.
OSHA: No component of this product present at levels greater than or equal to 0.1% is identified as a carcinogen or potential carcinogen by OSHA.

Reproductive toxicity
no data available

Specific target organ toxicity - single exposure
no data available

Specific target organ toxicity - repeated exposure
no data available

Aspiration hazard
no data available

Additional Information
RTECS: LZ6600000
To the best of our knowledge, the chemical, physical, and toxicological properties have not been thoroughly investigated.

12. ECOLOGICAL INFORMATION

12.1 Toxicity
no data available

12.2 Persistence and degradability
no data available

12.3 Bioaccumulative potential
no data available

12.4 Mobility in soil
no data available

12.5 Results of PBT and vPvB assessment
PBT/vPvB assessment not available as chemical safety assessment not required/not conducted

12.6 Other adverse effects
no data available
13. DISPOSAL CONSIDERATIONS

13.1 Waste treatment methods

**Product**
Offer surplus and non-recyclable solutions to a licensed disposal company.

**Contaminated packaging**
Dispose of as unused product.

14. TRANSPORT INFORMATION

**DOT (US)**
Not dangerous goods

**IMDG**
Not dangerous goods

**IATA**
Not dangerous goods

15. REGULATORY INFORMATION

**REACH No.**
A registration number is not available for this substance as the substance or its uses are exempted from registration, the annual tonnage does not require a registration or the registration is envisaged for a later registration deadline.

**SARA 302 Components**
SARA 302: No chemicals in this material are subject to the reporting requirements of SARA Title III, Section 302.

**SARA 313 Components**
SARA 313: This material does not contain any chemical components with known CAS numbers that exceed the threshold (De Minimis) reporting levels established by SARA Title III, Section 313.

**SARA 311/312 Hazards**
No SARA Hazards

**Massachusetts Right To Know Components**
No components are subject to the Massachusetts Right to Know Act.

**Pennsylvania Right To Know Components**

<table>
<thead>
<tr>
<th>Component</th>
<th>CAS-No.</th>
<th>Revision Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Glucose</td>
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**New Jersey Right To Know Components**

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<tr>
<th>Component</th>
<th>CAS-No.</th>
<th>Revision Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Glucose</td>
<td>50-99-7</td>
<td></td>
</tr>
</tbody>
</table>

**California Prop. 65 Components**
This product does not contain any chemicals known to State of California to cause cancer, birth defects, or any other reproductive harm.

16. OTHER INFORMATION

**HMIS Rating**

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<th>Hazard Type</th>
<th>Rating</th>
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<tr>
<td>Chronic Health Hazard</td>
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<td>Flammability:</td>
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<tr>
<td>Physical Hazard</td>
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**NFPA Rating**

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<thead>
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<th>Hazard Type</th>
<th>Rating</th>
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</thead>
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<td>Health hazard:</td>
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<td>Fire Hazard:</td>
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</tr>
<tr>
<td>Reactivity Hazard:</td>
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</table>
Further information
Copyright 2014 Sigma-Aldrich Co. LLC. License granted to make unlimited paper copies for internal use only. The above information is believed to be correct but does not purport to be all inclusive and shall be used only as a guide. The information in this document is based on the present state of our knowledge and is applicable to the product with regard to appropriate safety precautions. It does not represent any guarantee of the properties of the product. Sigma-Aldrich Corporation and its Affiliates shall not be held liable for any damage resulting from handling or from contact with the above product. See www.sigma-aldrich.com and/or the reverse side of invoice or packing slip for additional terms and conditions of sale.

Preparation Information
Sigma-Aldrich Corporation
Product Safety – Americas Region
1-800-521-8956

Version: 4.2 Revision Date: 02/26/2014 Print Date: 03/25/2014
1. PRODUCT AND COMPANY IDENTIFICATION

1.1 Product identifiers

Product name: L-Glutamine

Product Number: G3202
Brand: Aldrich

REACH No.: A registration number is not available for this substance as the substance or its uses are exempted from registration, the annual tonnage does not require a registration or the registration is envisaged for a later registration deadline.

CAS-No.: 56-85-9

1.2 Relevant identified uses of the substance or mixture and uses advised against

Identified uses: Laboratory chemicals, Manufacture of substances

1.3 Details of the supplier of the safety data sheet

Company: Sigma-Aldrich
3050 Spruce Street
SAINT LOUIS MO  63103
USA

Telephone: +1 800-325-5832
Fax: +1 800-325-5052

1.4 Emergency telephone number

Emergency Phone #: (314) 776-6555

2. HAZARDS IDENTIFICATION

2.1 Classification of the substance or mixture

Not a hazardous substance or mixture.

2.2 GHS Label elements, including precautionary statements

Not a hazardous substance or mixture.

2.3 Hazards not otherwise classified (HNOC) or not covered by GHS - none

3. COMPOSITION/INFORMATION ON INGREDIENTS

3.1 Substances

Chemical characterization: Natural product
Synonyms: (S)-2,5-Diamino-5-oxopentanoic acid
L-Glutamic acid 5-amide

Formula: C₅H₁₀N₂O₃ C₅H₁₀N₂O₃
Molecular Weight: 146.14 g/mol
CAS-No.: 56-85-9
EC-No.: 200-292-1

No ingredients are hazardous according to OSHA criteria.
No components need to be disclosed according to the applicable regulations.
4. FIRST AID MEASURES

4.1 Description of first aid measures

If inhaled
If breathed in, move person into fresh air. If not breathing, give artificial respiration.

In case of skin contact
Wash off with soap and plenty of water.

In case of eye contact
Flush eyes with water as a precaution.

If swallowed
Never give anything by mouth to an unconscious person. Rinse mouth with water.

4.2 Most important symptoms and effects, both acute and delayed
The most important known symptoms and effects are described in the labelling (see section 2.2) and/or in section 11

4.3 Indication of any immediate medical attention and special treatment needed
no data available

5. FIREFIGHTING MEASURES

5.1 Extinguishing media

Suitable extinguishing media
Use water spray, alcohol-resistant foam, dry chemical or carbon dioxide.

5.2 Special hazards arising from the substance or mixture
Carbon oxides, nitrogen oxides (NOx)

5.3 Advice for firefighters
Wear self contained breathing apparatus for fire fighting if necessary.

5.4 Further information
no data available

6. ACCIDENTAL RELEASE MEASURES

6.1 Personal precautions, protective equipment and emergency procedures
Avoid dust formation. Avoid breathing vapours, mist or gas.
For personal protection see section 8.

6.2 Environmental precautions
Do not let product enter drains.

6.3 Methods and materials for containment and cleaning up
Sweep up and shovel. Keep in suitable, closed containers for disposal.

6.4 Reference to other sections
For disposal see section 13.

7. HANDLING AND STORAGE

7.1 Precautions for safe handling
Provide appropriate exhaust ventilation at places where dust is formed.
For precautions see section 2.2.

7.2 Conditions for safe storage, including any incompatibilities
Keep container tightly closed in a dry and well-ventilated place.

Keep in a dry place.

7.3 Specific end use(s)
Apart from the uses mentioned in section 1.2 no other specific uses are stipulated
8. EXPOSURE CONTROLS/PERSONAL PROTECTION

8.1 Control parameters

Components with workplace control parameters
Contains no substances with occupational exposure limit values.

8.2 Exposure controls

Appropriate engineering controls
General industrial hygiene practice.

Personal protective equipment

Eye/face protection
Use equipment for eye protection tested and approved under appropriate government standards such as NIOSH (US) or EN 166(EU).

Skin protection
Handle with gloves. Gloves must be inspected prior to use. Use proper glove removal technique (without touching glove's outer surface) to avoid skin contact with this product. Dispose of contaminated gloves after use in accordance with applicable laws and good laboratory practices. Wash and dry hands.

Full contact
Material: Nitrile rubber
Minimum layer thickness: 0.11 mm
Break through time: 480 min
Material tested:Dermatril® (KCL 740 / Aldrich Z677272, Size M)

Splash contact
Material: Nitrile rubber
Minimum layer thickness: 0.11 mm
Break through time: 480 min
Material tested:Dermatril® (KCL 740 / Aldrich Z677272, Size M)

Data source: KCL GmbH, D-36124 Eichenzell, phone +49 (0)6659 87300, e-mail sales@kcl.de, test method: EN374

If used in solution, or mixed with other substances, and under conditions which differ from EN 374, contact the supplier of the CE approved gloves. This recommendation is advisory only and must be evaluated by an industrial hygienist and safety officer familiar with the specific situation of anticipated use by our customers. It should not be construed as offering an approval for any specific use scenario.

Body Protection
Choose body protection in relation to its type, to the concentration and amount of dangerous substances, and to the specific work-place. The type of protective equipment must be selected according to the concentration and amount of the dangerous substance at the specific workplace.

Respiratory protection
Respiratory protection is not required. Where protection from nuisance levels of dusts are desired, use type N95 (US) or type P1 (EN 143) dust masks. Use respirators and components tested and approved under appropriate government standards such as NIOSH (US) or CEN (EU).

Control of environmental exposure
Do not let product enter drains.

9. PHYSICAL AND CHEMICAL PROPERTIES

9.1 Information on basic physical and chemical properties

a) Appearance
   Form: powder
   Colour: white

b) Odour
   no data available

c) Odour Threshold
   no data available

d) pH
   5.0 - 6 at 14.6 g/l at 25 °C (77 °F)

e) Melting point/freezing
   Melting point/range: 185 °C (365 °F) - dec.
f) Initial boiling point and boiling range  
   no data available

g) Flash point  
   no data available

h) Evaporation rate  
   no data available

i) Flammability (solid, gas)  
   no data available

j) Upper/lower flammability or explosive limits  
   no data available

k) Vapour pressure  
   no data available

l) Vapour density  
   no data available

m) Relative density  
   no data available

n) Water solubility  
   14.6 g/l at 20 °C (68 °F) - completely soluble

o) Partition coefficient: n-octanol/water  
   log Pow: -4.609

p) Auto-ignition temperature  
   no data available

q) Decomposition temperature  
   no data available

r) Viscosity  
   no data available

s) Explosive properties  
   no data available

t) Oxidizing properties  
   no data available

9.2 Other safety information  
   no data available

10. STABILITY AND REACTIVITY

10.1 Reactivity  
   no data available

10.2 Chemical stability  
   Stable under recommended storage conditions.

10.3 Possibility of hazardous reactions  
   no data available

10.4 Conditions to avoid  
   no data available

10.5 Incompatible materials  
   Strong oxidizing agents

10.6 Hazardous decomposition products  
   Other decomposition products - no data available
   In the event of fire: see section 5

11. TOXICOLOGICAL INFORMATION

11.1 Information on toxicological effects

Acute toxicity
LD50 Oral - rat - 7,500 mg/kg

Inhalation: no data available

Dermal: no data available

no data available
Skin corrosion/irritation
no data available

Serious eye damage/eye irritation
no data available

Respiratory or skin sensitisation
no data available

Germ cell mutagenicity
no data available

Carcinogenicity
IARC: No component of this product present at levels greater than or equal to 0.1% is identified as probable, possible or confirmed human carcinogen by IARC.

ACGIH: No component of this product present at levels greater than or equal to 0.1% is identified as a carcinogen or potential carcinogen by ACGIH.

NTP: No component of this product present at levels greater than or equal to 0.1% is identified as a known or anticipated carcinogen by NTP.

OSHA: No component of this product present at levels greater than or equal to 0.1% is identified as a carcinogen or potential carcinogen by OSHA.

Reproductive toxicity
no data available

Specific target organ toxicity - single exposure
no data available

Specific target organ toxicity - repeated exposure
no data available

Aspiration hazard
no data available

Additional Information
RTECS: MA2275100

To the best of our knowledge, the chemical, physical, and toxicological properties have not been thoroughly investigated.

12. ECOLOGICAL INFORMATION

12.1 Toxicity
no data available

12.2 Persistence and degradability
no data available

12.3 Bioaccumulative potential
no data available

12.4 Mobility in soil
no data available

12.5 Results of PBT and vPvB assessment
PBT/vPvB assessment not available as chemical safety assessment not required/not conducted

12.6 Other adverse effects
no data available
13. DISPOSAL CONSIDERATIONS

13.1 Waste treatment methods

Product
Offer surplus and non-recyclable solutions to a licensed disposal company.

Contaminated packaging
Dispose of as unused product.

14. TRANSPORT INFORMATION

DOT (US)
Not dangerous goods

IMDG
Not dangerous goods

IATA
Not dangerous goods

15. REGULATORY INFORMATION

REACH No. : A registration number is not available for this substance as the substance or its uses are exempted from registration, the annual tonnage does not require a registration or the registration is envisaged for a later registration deadline.

SARA 302 Components
SARA 302: No chemicals in this material are subject to the reporting requirements of SARA Title III, Section 302.

SARA 313 Components
SARA 313: This material does not contain any chemical components with known CAS numbers that exceed the threshold (De Minimis) reporting levels established by SARA Title III, Section 313.

SARA 311/312 Hazards
No SARA Hazards

Massachusetts Right To Know Components
No components are subject to the Massachusetts Right to Know Act.

Pennsylvania Right To Know Components

<table>
<thead>
<tr>
<th>CAS-No.</th>
<th>Revision Date</th>
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New Jersey Right To Know Components

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<th>Revision Date</th>
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<tr>
<td>56-85-9</td>
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California Prop. 65 Components
This product does not contain any chemicals known to State of California to cause cancer, birth defects, or any other reproductive harm.

16. OTHER INFORMATION

HMIS Rating
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<tr>
<td>Health hazard:</td>
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<td>Chronic Health Hazard:</td>
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<td>Flammability:</td>
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<td>Physical Hazard</td>
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NFPA Rating
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<td>Fire Hazard:</td>
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<tr>
<td>Reactivity Hazard:</td>
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Further information
Copyright 2014 Sigma-Aldrich Co. LLC. License granted to make unlimited paper copies for internal use only. The above information is believed to be correct but does not purport to be all inclusive and shall be used only as a guide. The information in this document is based on the present state of our knowledge and is applicable to the product with regard to appropriate safety precautions. It does not represent any guarantee of the properties of the product. Sigma-Aldrich Corporation and its Affiliates shall not be held liable for any damage resulting from handling or from contact with the above product. See www.sigma-aldrich.com and/or the reverse side of invoice or packing slip for additional terms and conditions of sale.

Preparation Information
Sigma-Aldrich Corporation
Product Safety – Americas Region
1-800-521-8956

Version: 4.3 Revision Date: 02/26/2014 Print Date: 03/25/2014
1. PRODUCT AND COMPANY IDENTIFICATION

Product name : Oxygen
Product Number : 295604
Brand : Aldrich
Supplier : Sigma-Aldrich
3050 Spruce Street
SAINT LOUIS MO 63103
USA
Telephone : +1 800-325-5832
Fax : +1 800-325-5052
Emergency Phone # (For both supplier and manufacturer) : (314) 776-6555
Preparation Information : Sigma-Aldrich Corporation
Product Safety - Americas Region
1-800-521-8956

2. HAZARDS IDENTIFICATION

Emergency Overview

OSHA Hazards
Compressed Gas

GHS Classification
Oxidising gases (Category 1)
Gases under pressure (Compressed gas)

GHS Label elements, including precautionary statements

Pictogram

Signal word Danger

Hazard statement(s)
H270 May cause or intensify fire; oxidiser.
H280 Contains gas under pressure; may explode if heated.

Precautionary statement(s)
P220 Keep/Store away from clothing/ combustible materials.
P410 + P403 Protect from sunlight. Store in a well-ventilated place.

HMIS Classification
Health hazard: 0
Flammability: 0
Physical hazards: 0

NFPA Rating
Health hazard: 0
Fire: 0
Reactivity Hazard: 0
Special hazard: OX

Potential Health Effects
Inhalation May be harmful if inhaled. May cause respiratory tract irritation.
3. COMPOSITION/INFORMATION ON INGREDIENTS

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<th>Concentration</th>
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<td>Index-No.</td>
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4. FIRST AID MEASURES

General advice
Consult a physician. Show this safety data sheet to the doctor in attendance. Move out of dangerous area.

If inhaled
If breathed in, move person into fresh air. If not breathing, give artificial respiration. Consult a physician.

In case of skin contact
Wash off with soap and plenty of water. Consult a physician.

In case of eye contact
Flush eyes with water as a precaution.

If swallowed
Never give anything by mouth to an unconscious person. Rinse mouth with water. Consult a physician.

5. FIREFIGHTING MEASURES

Conditions of flammability
Not flammable or combustible.

Suitable extinguishing media
Use water spray, alcohol-resistant foam, dry chemical or carbon dioxide.

Special protective equipment for firefighters
Wear self-contained breathing apparatus for fire fighting if necessary.

Hazardous combustion products
No data available

Further information
Use water spray to cool unopened containers.

6. ACCIDENTAL RELEASE MEASURES

Personal precautions
Avoid breathing vapors, mist or gas. Ensure adequate ventilation. Evacuate personnel to safe areas.

Environmental precautions
Prevent further leakage or spillage if safe to do so. Do not let product enter drains.

Methods and materials for containment and cleaning up
Contain spillage, and then collect with an electrically protected vacuum cleaner or by wet-brushing and place in container for disposal according to local regulations (see section 13).

7. HANDLING AND STORAGE

Precautions for safe handling
Keep away from sources of ignition - No smoking.

Conditions for safe storage
Keep container tightly closed in a dry and well-ventilated place.
Contents under pressure.

8. EXPOSURE CONTROLS/PERSOAL PROTECTION

Contains no substances with occupational exposure limit values.

**Personal protective equipment**

**Respiratory protection**
Where risk assessment shows air-purifying respirators are appropriate use a full-face respirator with multi-purpose combination (US) or type AXBEK (EN 14387) respirator cartridges as a backup to engineering controls. If the respirator is the sole means of protection, use a full-face supplied air respirator. Use respirators and components tested and approved under appropriate government standards such as NIOSH (US) or CEN (EU).

**Hand protection**
Handle with gloves. Gloves must be inspected prior to use. Use proper glove removal technique (without touching glove’s outer surface) to avoid skin contact with this product. Dispose of contaminated gloves after use in accordance with applicable laws and good laboratory practices. Wash and dry hands.

**Full contact**
Material: butyl-rubber
Minimum layer thickness: 0.3 mm
Break through time: 480 min
Material tested: Butoject® (KCL 897 / Aldrich Z677647, Size M)

**Splash protection**
Material: Chloroprene
Minimum layer thickness: 0.6 mm
Break through time: 30 min
Material tested: Camapren® (KCL 722 / Aldrich Z677493, Size M)

data source: KCL GmbH, D-36124 Eichenzell, phone +49 (0)6659 87300, e-mail sales@kcl.de, test method: EN374

If used in solution, or mixed with other substances, and under conditions which differ from EN 374, contact the supplier of the CE approved gloves. This recommendation is advisory only and must be evaluated by an Industrial Hygienist familiar with the specific situation of anticipated use by our customers. It should not be construed as offering an approval for any specific use scenario.

**Eye protection**
Face shield and safety glasses Use equipment for eye protection tested and approved under appropriate government standards such as NIOSH (US) or EN 166(EU).

**Skin and body protection**
Complete suit protecting against chemicals. The type of protective equipment must be selected according to the concentration and amount of the dangerous substance at the specific workplace.

**Hygiene measures**
Handle in accordance with good industrial hygiene and safety practice. Wash hands before breaks and at the end of workday.

9. PHYSICAL AND CHEMICAL PROPERTIES

**Appearance**
Form: Compressed gas
Colour: colourless

**Safety data**

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>pH</td>
<td>no data available</td>
</tr>
<tr>
<td>Melting point/freezing point</td>
<td>Melting point/range: -218 °C (-360 °F) - lit.</td>
</tr>
<tr>
<td>Boiling point</td>
<td>-183 °C (-297 °F) - lit.</td>
</tr>
<tr>
<td>Flash point</td>
<td>no data available</td>
</tr>
<tr>
<td>Ignition temperature</td>
<td>no data available</td>
</tr>
</tbody>
</table>
10. STABILITY AND REACTIVITY

**Chemical stability**
Stable under recommended storage conditions.

**Possibility of hazardous reactions**
no data available

**Conditions to avoid**
no data available

**Materials to avoid**
Phosphorus, Organic materials, Powdered metals

**Hazardous decomposition products**
no data available

11. TOXICOLOGICAL INFORMATION

**Acute toxicity**

- **Oral LD50**
  no data available

- **Inhalation LC50**
  no data available

- **Dermal LD50**
  no data available

- **Other information on acute toxicity**
  no data available

**Skin corrosion/irritation**
no data available

**Serious eye damage/eye irritation**
no data available

**Respiratory or skin sensitization**
no data available

**Germ cell mutagenicity**
no data available
Carcinogenicity

IARC: No component of this product present at levels greater than or equal to 0.1% is identified as probable, possible or confirmed human carcinogen by IARC.

ACGIH: No component of this product present at levels greater than or equal to 0.1% is identified as a carcinogen or potential carcinogen by ACGIH.

NTP: No component of this product present at levels greater than or equal to 0.1% is identified as a known or anticipated carcinogen by NTP.

OSHA: No component of this product present at levels greater than or equal to 0.1% is identified as a carcinogen or potential carcinogen by OSHA.

Reproductive toxicity

no data available

Teratogenicity

no data available

Specific target organ toxicity - single exposure (Globally Harmonized System)

no data available

Specific target organ toxicity - repeated exposure (Globally Harmonized System)

no data available

Aspiration hazard

no data available

Potential health effects

<table>
<thead>
<tr>
<th>Route</th>
<th>Effect Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inhalation</td>
<td>May be harmful if inhaled. May cause respiratory tract irritation.</td>
</tr>
<tr>
<td>Ingestion</td>
<td>May be harmful if swallowed.</td>
</tr>
<tr>
<td>Skin</td>
<td>May be harmful if absorbed through skin. May cause skin irritation.</td>
</tr>
<tr>
<td>Eyes</td>
<td>May cause eye irritation.</td>
</tr>
</tbody>
</table>

Signs and Symptoms of Exposure

Nausea, Dizziness, Unconsciousness, May be harmful.

Synergistic effects

no data available

Additional Information

RTECS: RS2060000

12. ECOLOGICAL INFORMATION

Toxicity  

no data available

Persistence and degradability

no data available

Bioaccumulative potential

no data available

Mobility in soil

no data available

PBT and vPvB assessment

no data available

Other adverse effects

no data available

13. DISPOSAL CONSIDERATIONS
Product
Burn in a chemical incinerator equipped with an afterburner and scrubber but exert extra care in igniting as this material is highly flammable. Offer surplus and non-recyclable solutions to a licensed disposal company. Contact a licensed professional waste disposal service to dispose of this material.

Contaminated packaging
Dispose of as unused product.

14. TRANSPORT INFORMATION

DOT (US)
UN number: 1072  Class: 2.2 (5.1)
Proper shipping name: Oxygen, compressed
Marine Pollutant: No
Poison Inhalation Hazard: No

IMDG
UN number: 1072  Class: 2.2 (5.1)
Proper shipping name: OXYGEN, COMPRESSED
Marine Pollutant: No
EMS-No: F-C, S-W

IATA
UN number: 1072  Class: 2.2 (5.1)
Proper shipping name: Oxygen, compressed

15. REGULATORY INFORMATION

OSHA Hazards
Compressed Gas

SARA 302 Components
SARA 302: No chemicals in this material are subject to the reporting requirements of SARA Title III, Section 302.

SARA 313 Components
SARA 313: This material does not contain any chemical components with known CAS numbers that exceed the threshold (De Minimis) reporting levels established by SARA Title III, Section 313.

SARA 311/312 Hazards
Sudden Release of Pressure Hazard

Massachusetts Right To Know Components

<table>
<thead>
<tr>
<th>Component</th>
<th>CAS-No.</th>
<th>Revision Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oxygen</td>
<td>7782-44-7</td>
<td>2007-03-01</td>
</tr>
</tbody>
</table>

Pennsylvania Right To Know Components

<table>
<thead>
<tr>
<th>Component</th>
<th>CAS-No.</th>
<th>Revision Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oxygen</td>
<td>7782-44-7</td>
<td>2007-03-01</td>
</tr>
</tbody>
</table>

New Jersey Right To Know Components

<table>
<thead>
<tr>
<th>Component</th>
<th>CAS-No.</th>
<th>Revision Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oxygen</td>
<td>7782-44-7</td>
<td>2007-03-01</td>
</tr>
</tbody>
</table>

California Prop. 65 Components
This product does not contain any chemicals known to State of California to cause cancer, birth defects, or any other reproductive harm.

16. OTHER INFORMATION

Further information
Copyright 2012 Sigma-Aldrich Co. LLC. License granted to make unlimited paper copies for internal use only. The above information is believed to be correct but does not purport to be all inclusive and shall be used only as a guide. The information in this document is based on the present state of our knowledge and is applicable to the product with regard to appropriate safety precautions. It does not represent any guarantee of the properties of the product. Sigma-Aldrich Corporation and its Affiliates shall not be held liable for any damage resulting from handling or from contact with the above product. See www.sigma-aldrich.com and/or the reverse side of invoice or packing slip for additional terms and conditions of sale.
1. PRODUCT AND COMPANY IDENTIFICATION

Product name: Carbon dioxide
Product Number: 295108
Brand: Aldrich
Supplier: Sigma-Aldrich Corporation
3050 Spruce Street
SAINT LOUIS MO 63103 USA
Telephone: +1 800-325-5832
Fax: +1 800-325-5052
Emergency Phone #: (314) 776-6555
Preparation Information: Sigma-Aldrich Corporation
Product Safety - Americas Region
1-800-521-8956

2. HAZARDS IDENTIFICATION

Emergency Overview
OSHA Hazards
Compressed Gas

GHS Classification
Gases under pressure (Liquefied gas)

GHS Label elements, including precautionary statements
Pictogram

Signal word: Warning
Hazard statement(s)
H280 Contains gas under pressure; may explode if heated.

Precautionary statement(s)
P410 + P403 Protect from sunlight. Store in a well-ventilated place.

HMIS Classification
Health hazard: 0
Flammability: 0
Physical hazards: 0

NFPA Rating
Health hazard: 0
Fire: 0
Reactivity Hazard: 0

Potential Health Effects
Inhalation: May be harmful if inhaled. May cause respiratory tract irritation.
Skin: May cause severe frostbite. May be harmful if absorbed through skin. May cause skin irritation.
Eyes: May cause eye irritation.
Ingestion: May be harmful if swallowed.
3. COMPOSITION/INFORMATION ON INGREDIENTS

<table>
<thead>
<tr>
<th>Component</th>
<th>Concentration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbon dioxide</td>
<td></td>
</tr>
<tr>
<td>CAS-No.</td>
<td>124-38-9</td>
</tr>
<tr>
<td>EC-No.</td>
<td>204-696-9</td>
</tr>
</tbody>
</table>

4. FIRST AID MEASURES

**General advice**
Consult a physician. Show this safety data sheet to the doctor in attendance. Move out of dangerous area.

**If inhaled**
If breathed in, move person into fresh air. If not breathing, give artificial respiration. Consult a physician.

**In case of skin contact**
Wash off with soap and plenty of water. Consult a physician.

**In case of eye contact**
Flush eyes with water as a precaution.

**If swallowed**
Never give anything by mouth to an unconscious person. Rinse mouth with water. Consult a physician.

5. FIREFIGHTING MEASURES

**Conditions of flammability**
Not flammable or combustible.

**Suitable extinguishing media**
Use water spray, alcohol-resistant foam, dry chemical or carbon dioxide.

**Special protective equipment for firefighters**
Wear self contained breathing apparatus for fire fighting if necessary.

**Hazardous combustion products**
Hazardous decomposition products formed under fire conditions. - Carbon oxides

**Further information**
Use water spray to cool unopened containers.

6. ACCIDENTAL RELEASE MEASURES

**Personal precautions**
Avoid breathing vapors, mist or gas. Ensure adequate ventilation. Evacuate personnel to safe areas.

**Environmental precautions**
Do not let product enter drains.

**Methods and materials for containment and cleaning up**
Clean up promptly by sweeping or vacuum.

7. HANDLING AND STORAGE

**Conditions for safe storage**
Keep container tightly closed in a dry and well-ventilated place.

Contents under pressure. Avoid heating above: 50°C
8. EXPOSURE CONTROLS/PERSONAL PROTECTION
Components with workplace control parameters

<table>
<thead>
<tr>
<th>Components</th>
<th>CAS-No.</th>
<th>Value</th>
<th>Control parameters</th>
<th>Basis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbon dioxide</td>
<td>124-38-9</td>
<td>TWA</td>
<td>5,000 ppm</td>
<td>USA. ACGIH Threshold Limit Values (TLV)</td>
</tr>
<tr>
<td>Remarks</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>STEL</td>
<td>30,000 ppm USA. ACGIH Threshold Limit Values (TLV)</td>
</tr>
<tr>
<td>Asphyxia</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TWA</td>
<td></td>
<td></td>
<td>10,000 ppm</td>
<td>USA. OSHA - TABLE Z-1 Limits for Air Contaminants - 1910.1000</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>18,000 mg/m³</td>
<td></td>
</tr>
<tr>
<td>Asphyxia</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>STEL</td>
<td></td>
<td></td>
<td>30,000 ppm 54,000 mg/m³</td>
<td>USA. OSHA - TABLE Z-1 Limits for Air Contaminants - 1910.1000</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TWA</td>
<td></td>
<td></td>
<td>5,000 ppm 9,000 mg/m³</td>
<td>USA. Occupational Exposure Limits (OSHA) - Table Z-1 Limits for Air Contaminants</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The value in mg/m³ is approximate.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TWA</td>
<td></td>
<td></td>
<td>5,000 ppm 9,000 mg/m³</td>
<td>USA. NIOSH Recommended Exposure Limits</td>
</tr>
<tr>
<td>Normal constituent of air (about 300 ppm).</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ST</td>
<td>30,000 ppm</td>
<td>54,000 mg/m³</td>
<td>USA. NIOSH Recommended Exposure Limits</td>
<td></td>
</tr>
<tr>
<td>Normal constituent of air (about 300 ppm).</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Personal protective equipment
Respiratory protection
Where risk assessment shows air-purifying respirators are appropriate use a full-face respirator with multi-purpose combination (US) or type AXBEK (EN 14387) respirator cartridges as a backup to engineering controls. If the respirator is the sole means of protection, use a full-face supplied air respirator. Use respirators and components tested and approved under appropriate government standards such as NIOSH (US) or CEN (EU).

Hand protection
Handle with gloves. Gloves must be inspected prior to use. Use proper glove removal technique (without touching glove’s outer surface) to avoid skin contact with this product. Dispose of contaminated gloves after use in accordance with applicable laws and good laboratory practices. Wash and dry hands.

Full contact
Material: butyl-rubber
Minimum layer thickness: 0.3 mm
Break through time: 480 min
Material tested:Butoject® (KCL 897 / Aldrich Z677647, Size M)

Splash protection
Material: Chloroprene
Minimum layer thickness: 0.6 mm
Break through time: 30 min
Material tested:Camapren® (KCL 722 / Aldrich Z677493, Size M)

data source: KCL GmbH, D-36124 Eichenzell, phone +49 (0)6659 87300, e-mail sales@kcl.de, test method: EN374
If used in solution, or mixed with other substances, and under conditions which differ from EN 374, contact the supplier of the CE approved gloves. This recommendation is advisory only and must be evaluated by an Industrial Hygienist familiar with the specific situation of anticipated use by our customers. It should not be construed as offering an approval for any specific use scenario.
Eye protection
Use equipment for eye protection tested and approved under appropriate government standards such as NIOSH (US) or EN 166(EU).

Skin and body protection
Impervious clothing, The type of protective equipment must be selected according to the concentration and amount of the dangerous substance at the specific workplace.

Hygiene measures
Handle in accordance with good industrial hygiene and safety practice. Wash hands before breaks and at the end of workday.

9. PHYSICAL AND CHEMICAL PROPERTIES

Appearance
Form Liquefied gas

Safety data
pH no data available
Melting point/freezing point Melting point/range: -78.5 °C (-109.3 °F) - lit.
Boiling point no data available
Sublimation point -78.5 °C (-109.3 °F)
Flash point not applicable
Ignition temperature no data available
Auto-ignition temperature no data available
Lower explosion limit no data available
Upper explosion limit no data available
Vapour pressure 57,249 hPa (42,940 mmHg) at 20 °C (68 °F)
Density no data available
Water solubility no data available
Partition coefficient: n-octanol/water no data available
Relative vapor density 1.52
- (Air = 1.0)
Odour no data available
Odour Threshold no data available
Evaporation rate no data available

10. STABILITY AND REACTIVITY

Chemical stability
Stable under recommended storage conditions.

Possibility of hazardous reactions
no data available

Conditions to avoid
no data available

Materials to avoid
no data available
Hazardous decomposition products
Hazardous decomposition products formed under fire conditions. - Carbon oxides
Other decomposition products - no data available

11. TOXICOLOGICAL INFORMATION

Acute toxicity

Oral LD50
no data available

Inhalation LC50
no data available

Dermal LD50
no data available

Other information on acute toxicity
no data available

Skin corrosion/irritation
no data available

Serious eye damage/eye irritation
no data available

Respiratory or skin sensitization
no data available

Germ cell mutagenicity
no data available

Carcinogenicity

IARC: No component of this product present at levels greater than or equal to 0.1% is identified as probable, possible or confirmed human carcinogen by IARC.

ACGIH: No component of this product present at levels greater than or equal to 0.1% is identified as a carcinogen or potential carcinogen by ACGIH.

NTP: No component of this product present at levels greater than or equal to 0.1% is identified as a known or anticipated carcinogen by NTP.

OSHA: No component of this product present at levels greater than or equal to 0.1% is identified as a carcinogen or potential carcinogen by OSHA.

Reproductive toxicity
no data available

Teratogenicity
no data available

Specific target organ toxicity - single exposure (Globally Harmonized System)
no data available

Specific target organ toxicity - repeated exposure (Globally Harmonized System)
no data available

Aspiration hazard
no data available

Potential health effects

Inhalation May be harmful if inhaled. May cause respiratory tract irritation.

Ingestion May be harmful if swallowed.

Skin May cause severe frostbite. May be harmful if absorbed through skin. May cause skin
irritation. May cause eye irritation.

Eyes

Aggravated

Medical Condition

Acts as a simple asphyxiant by displacing air.

Signs and Symptoms of Exposure

Nausea, Dizziness, Headache, Low to medium concentrations of carbon dioxide can affect regulation of blood circulation, affect the acidity of body fluids, respiratory difficulties, At high concentrations: Breathing difficulties, Increased pulse rate, change in body acidity, Very high concentrations can cause: Unconsciousness, death

Synergistic effects

no data available

Additional Information

RTECS: FF6400000

12. ECOLOGICAL INFORMATION

Toxicity

no data available

Persistence and degradability

no data available

Bioaccumulative potential

no data available

Mobility in soil

no data available

PBT and vPvB assessment

no data available

Other adverse effects

no data available

13. DISPOSAL CONSIDERATIONS

Product

Offer surplus and non-recyclable solutions to a licensed disposal company. Contact a licensed professional waste disposal service to dispose of this material.

Contaminated packaging

Dispose of as unused product.

14. TRANSPORT INFORMATION

DOT (US)

UN number: 1013  Class: 2.2
Proper shipping name: Carbon dioxide
Reportable Quantity (RQ):
Marine Pollutant: No
Poison Inhalation Hazard: No

IMDG

UN number: 1013  Class: 2.2
Proper shipping name: CARBON DIOXIDE
Marine Pollutant: No

EMS-No: F-C, S-V

IATA

UN number: 1013  Class: 2.2
Proper shipping name: Carbon dioxide

15. REGULATORY INFORMATION
OSHA Hazards
Compressed Gas

SARA 302 Components
SARA 302: No chemicals in this material are subject to the reporting requirements of SARA Title III, Section 302.

SARA 313 Components
SARA 313: This material does not contain any chemical components with known CAS numbers that exceed the threshold (De Minimis) reporting levels established by SARA Title III, Section 313.

SARA 311/312 Hazards
Sudden Release of Pressure Hazard

Massachusetts Right To Know Components
<table>
<thead>
<tr>
<th>Component</th>
<th>CAS-No.</th>
<th>Revision Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbon dioxide</td>
<td>124-38-9</td>
<td>1993-04-24</td>
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</tbody>
</table>

Pennsylvania Right To Know Components
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New Jersey Right To Know Components
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</table>

California Prop. 65 Components
This product does not contain any chemicals known to State of California to cause cancer, birth defects, or any other reproductive harm.

16. OTHER INFORMATION

Further information
Copyright 2012 Sigma-Aldrich Co. LLC. License granted to make unlimited paper copies for internal use only. The above information is believed to be correct but does not purport to be all inclusive and shall be used only as a guide. The information in this document is based on the present state of our knowledge and is applicable to the product with regard to appropriate safety precautions. It does not represent any guarantee of the properties of the product. Sigma-Aldrich Corporation and its Affiliates shall not be held liable for any damage resulting from handling or from contact with the above product. See www.sigma-aldrich.com and/or the reverse side of invoice or packing slip for additional terms and conditions of sale.
1. PRODUCT AND COMPANY IDENTIFICATION

1.1 Product identifiers

Product name: Water
Product Number: W4502
Brand: Sigma
REACH No.: A registration number is not available for this substance as the substance or its uses are exempted from registration, the annual tonnage does not require a registration or the registration is envisaged for a later registration deadline.

CAS-No.: 7732-18-5

1.2 Relevant identified uses of the substance or mixture and uses advised against

Identified uses: Laboratory chemicals, Manufacture of substances

1.3 Details of the supplier of the safety data sheet

Company: Sigma-Aldrich
3050 Spruce Street
SAINT LOUIS MO 63103
USA

Telephone: +1 800-325-5832
Fax: +1 800-325-5052

1.4 Emergency telephone number

Emergency Phone #: (314) 776-6555

2. HAZARDS IDENTIFICATION

2.1 Classification of the substance or mixture

Not a hazardous substance or mixture.

2.2 GHS Label elements, including precautionary statements

Not a hazardous substance or mixture.

2.3 Hazards not otherwise classified (HNOC) or not covered by GHS - none

3. COMPOSITION/INFORMATION ON INGREDIENTS

3.1 Substances

Formula: H₂O
Molecular Weight: 18.02 g/mol
CAS-No.: 7732-18-5
EC-No.: 231-791-2

No ingredients are hazardous according to OSHA criteria. No components need to be disclosed according to the applicable regulations.

4. FIRST AID MEASURES

4.1 Description of first aid measures

If inhaled
If not breathing give artificial respiration
4.2 **Most important symptoms and effects, both acute and delayed**
The most important known symptoms and effects are described in the labelling (see section 2.2) and/or in section 11

4.3 **Indication of any immediate medical attention and special treatment needed**
no data available

---

### 5. FIREFIGHTING MEASURES

5.1 **Extinguishing media**

**Suitable extinguishing media**
Use extinguishing measures that are appropriate to local circumstances and the surrounding environment.

5.2 **Special hazards arising from the substance or mixture**
no data available

5.3 **Advice for firefighters**
no data available

5.4 **Further information**
The product itself does not burn.

---

### 6. ACCIDENTAL RELEASE MEASURES

6.1 **Personal precautions, protective equipment and emergency procedures**
For personal protection see section 8.

6.2 **Environmental precautions**
no data available

6.3 **Methods and materials for containment and cleaning up**
Wipe up with absorbent material (e.g. cloth, fleece).

6.4 **Reference to other sections**
For disposal see section 13.

---

### 7. HANDLING AND STORAGE

7.1 **Precautions for safe handling**
For precautions see section 2.2.

7.2 **Conditions for safe storage, including any incompatibilities**
No special storage conditions required.

7.3 **Specific end use(s)**
Apart from the uses mentioned in section 1.2 no other specific uses are stipulated

---

### 8. EXPOSURE CONTROLS/PERSONAL PROTECTION

8.1 **Control parameters**

**Components with workplace control parameters**
Contains no substances with occupational exposure limit values.

8.2 **Exposure controls**

**Appropriate engineering controls**
Handle in accordance with good industrial hygiene and safety practice.

**Personal protective equipment**

**Skin protection**
Handle with gloves. Gloves must be inspected prior to use. Use proper glove removal technique (without touching glove's outer surface) to avoid skin contact with this product. Dispose of contaminated gloves after use in accordance with applicable laws and good laboratory practices. Wash and dry hands.

- **Full contact**
- **Material: Nitrile rubber**
- **Minimum layer thickness: 0.11 mm**
- **Break through time: 480 min**
Material tested: Dermatril® (KCL 740 / Aldrich Z677272, Size M)
Splash contact
Material: Nitrile rubber
Minimum layer thickness: 0.11 mm
Break through time: 480 min
Material tested: Dermatril® (KCL 740 / Aldrich Z677272, Size M)
data source: KCL GmbH, D-36124 Eichenzell, phone +49 (0)6659 87300, e-mail sales@kcl.de, test method: EN374
If used in solution, or mixed with other substances, and under conditions which differ from EN 374, contact the supplier of the CE approved gloves. This recommendation is advisory only and must be evaluated by an industrial hygienist and safety officer familiar with the specific situation of anticipated use by our customers. It should not be construed as offering an approval for any specific use scenario.

Respiratory protection
No special protective equipment required.

Control of environmental exposure
Prevent product from entering drains.

9. PHYSICAL AND CHEMICAL PROPERTIES

9.1 Information on basic physical and chemical properties

a) Appearance
   Form: liquid
   Colour: colourless
b) Odour
   no data available
c) Odour Threshold
   no data available
d) pH
   6.0 - 8.0 at 25 °C (77 °F)
e) Melting point/freezing point
   0.0 °C (32.0 °F)
f) Initial boiling point and boiling range
   100 °C (212 °F) - lit.
g) Flash point
   not applicable
h) Evaporation rate
   no data available
i) Flammability (solid, gas)
   no data available
j) Upper/lower flammability or explosive limits
   no data available
k) Vapour pressure
   no data available
l) Vapour density
   no data available
m) Relative density
   1.000 g/cm3 at 3.98 °C (39.16 °F)

n) Water solubility
   completely miscible
o) Partition coefficient: n-octanol/water
   no data available
p) Auto-ignition temperature
   no data available
q) Decomposition temperature
   no data available
r) Viscosity
   no data available
s) Explosive properties
   no data available
t) Oxidizing properties
   no data available
9.2 Other safety information
no data available

10. STABILITY AND REACTIVITY

10.1 Reactivity
no data available

10.2 Chemical stability
Stable under recommended storage conditions.

10.3 Possibility of hazardous reactions
no data available

10.4 Conditions to avoid
no data available

10.5 Incompatible materials
no data available

10.6 Hazardous decomposition products
In the event of fire: see section 5

11. TOXICOLOGICAL INFORMATION

11.1 Information on toxicological effects

Acute toxicity
no data available

Inhalation: no data available

Dermal: no data available

no data available

Skin corrosion/irritation
no data available

Serious eye damage/eye irritation
no data available

Respiratory or skin sensitisation
no data available

Germ cell mutagenicity
no data available

Carcinogenicity

IARC: No component of this product present at levels greater than or equal to 0.1% is identified as probable, possible or confirmed human carcinogen by IARC.

ACGIH: No component of this product present at levels greater than or equal to 0.1% is identified as a carcinogen or potential carcinogen by ACGIH.

NTP: No component of this product present at levels greater than or equal to 0.1% is identified as a known or anticipated carcinogen by NTP.

OSHA: No component of this product present at levels greater than or equal to 0.1% is identified as a carcinogen or potential carcinogen by OSHA.

Reproductive toxicity
no data available

no data available

Specific target organ toxicity - single exposure
no data available

Specific target organ toxicity - repeated exposure
no data available
Aspiration hazard
no data available

Additional Information
RTECS: ZC0110000
To the best of our knowledge, the chemical, physical, and toxicological properties have not been thoroughly investigated.

12. ECOLOGICAL INFORMATION

12.1 Toxicity
no data available

12.2 Persistence and degradability
not applicable

12.3 Bioaccumulative potential
no data available

12.4 Mobility in soil
no data available

12.5 Results of PBT and vPvB assessment
PBT/vPvB assessment not available as chemical safety assessment not required/not conducted

12.6 Other adverse effects
no data available

13. DISPOSAL CONSIDERATIONS

13.1 Waste treatment methods

Product
Taking into account local regulations the product may be disposed of as waste water after neutralisation.

14. TRANSPORT INFORMATION

DOT (US)
Not dangerous goods

IMDG
Not dangerous goods

IATA
Not dangerous goods

15. REGULATORY INFORMATION

REACH No.
A registration number is not available for this substance as the substance or its uses are exempted from registration, the annual tonnage does not require a registration or the registration is envisaged for a later registration deadline.

SARA 302 Components
SARA 302: No chemicals in this material are subject to the reporting requirements of SARA Title III, Section 302.

SARA 313 Components
SARA 313: This material does not contain any chemical components with known CAS numbers that exceed the threshold (De Minimis) reporting levels established by SARA Title III, Section 313.

SARA 311/312 Hazards
No SARA Hazards

Massachusetts Right To Know Components
No components are subject to the Massachusetts Right to Know Act.

Pennsylvania Right To Know Components
This product does not contain any chemicals known to State of California to cause cancer, birth defects, or any other reproductive harm.

### 16. OTHER INFORMATION

**HMIS Rating**
- Health hazard: 0
- Chronic Health Hazard: 0
- Flammability: 0
- Physical Hazard: 0

**NFPA Rating**
- Health hazard: 0
- Fire Hazard: 0
- Reactivity Hazard: 0

**Further information**
Copyright 2014 Sigma-Aldrich Co. LLC. License granted to make unlimited paper copies for internal use only. The above information is believed to be correct but does not purport to be all inclusive and shall be used only as a guide. The information in this document is based on the present state of our knowledge and is applicable to the product with regard to appropriate safety precautions. It does not represent any guarantee of the properties of the product. Sigma-Aldrich Corporation and its Affiliates shall not be held liable for any damage resulting from handling or from contact with the above product. See www.sigma-aldrich.com and/or the reverse side of invoice or packing slip for additional terms and conditions of sale.

**Preparation Information**
Sigma-Aldrich Corporation
Product Safety – Americas Region
1-800-521-8956

Version: 5.2 Revision Date: 02/24/2014 Print Date: 03/25/2014
1. PRODUCT AND COMPANY IDENTIFICATION

Product name : Ammonia
Product Number : 294993
Brand : Aldrich
Supplier : Sigma-Aldrich
3050 Spruce Street
SAINT LOUIS MO  63103
USA
Telephone : +1 800-325-5832
Fax : +1 800-325-5052
Emergency Phone # (For both supplier and manufacturer) : (314) 776-6555
Preparation Information : Sigma-Aldrich Corporation
Product Safety - Americas Region
1-800-521-8956

2. HAZARDS IDENTIFICATION

Emergency Overview

OSHA Hazards
Compressed Gas, Target Organ Effect, Corrosive

Target Organs
Lungs, Central nervous system, Liver, Kidney

GHS Classification
Flammable gases (Category 2)
Gases under pressure (Compressed gas)
Acute toxicity, Inhalation (Category 3)
Skin corrosion (Category 1B)
Serious eye damage (Category 1)
Acute aquatic toxicity (Category 1)

GHS Label elements, including precautionary statements

Pictogram

Signal word Danger

Hazard statement(s)
H221 Flammable gas.
H280 Contains gas under pressure; may explode if heated.
H314 Causes severe skin burns and eye damage.
H331 Toxic if inhaled.
H400 Very toxic to aquatic life.

Precautionary statement(s)
P210 Keep away from heat/sparks/open flames/hot surfaces. - No smoking.
P261 Avoid breathing dust/ fume/ gas/ mist/ vapours/ spray.
P273 Avoid release to the environment.
P280 Wear protective gloves/ protective clothing/ eye protection/ face protection.
P305 + P351 + P338 IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if
present and easy to do. Continue rinsing.
P310  Immediately call a POISON CENTER or doctor/physician.
P410 + P403  Protect from sunlight. Store in a well-ventilated place.

HMIS Classification

- **Health hazard:** 3
- **Chronic Health Hazard:** *
- **Flammability:** 0
- **Physical hazards:** 0

NFPA Rating

- **Health hazard:** 3
- **Fire:** 0
- **Reactivity Hazard:** 0

Potential Health Effects

- **Inhalation:** May be harmful if inhaled. Material is extremely destructive to the tissue of the mucous membranes and upper respiratory tract.
- **Skin:** May be harmful if absorbed through skin. Causes skin burns.
- **Eyes:** Causes eye burns.
- **Ingestion:** May be harmful if swallowed.

### 3. COMPOSITION/INFORMATION ON INGREDIENTS

**Formula:** \( \text{H}_3\text{N} \)

**Molecular Weight:** 17.03 g/mol

<table>
<thead>
<tr>
<th>Component</th>
<th>Concentration</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Ammonia, anhydrous</strong></td>
<td></td>
</tr>
<tr>
<td>CAS-No.</td>
<td>7664-41-7</td>
</tr>
<tr>
<td>EC-No.</td>
<td>231-635-3</td>
</tr>
<tr>
<td>Index-No.</td>
<td>007-001-00-5</td>
</tr>
</tbody>
</table>

### 4. FIRST AID MEASURES

**General advice**
Consult a physician. Show this safety data sheet to the doctor in attendance. Move out of dangerous area.

**If inhaled**
If breathed in, move person into fresh air. If not breathing, give artificial respiration. Consult a physician.

**In case of skin contact**
Take off contaminated clothing and shoes immediately. Wash off with soap and plenty of water. Take victim immediately to hospital. Consult a physician.

**In case of eye contact**
Rinse thoroughly with plenty of water for at least 15 minutes and consult a physician. Continue rinsing eyes during transport to hospital.

**If swallowed**
Do NOT induce vomiting. Never give anything by mouth to an unconscious person. Rinse mouth with water. Consult a physician.

### 5. FIREFIGHTING MEASURES

**Conditions of flammability**
Not flammable or combustible.

**Suitable extinguishing media**
Use water spray, alcohol-resistant foam, dry chemical or carbon dioxide.

**Special protective equipment for firefighters**
Wear self contained breathing apparatus for fire fighting if necessary.
Hazardous combustion products
Hazardous decomposition products formed under fire conditions. - nitrogen oxides (NOx)

Further information
Use water spray to cool unopened containers.

6. ACCIDENTAL RELEASE MEASURES

Personal precautions
Wear respiratory protection. Avoid breathing vapors, mist or gas. Ensure adequate ventilation. Remove all sources of ignition. Evacuate personnel to safe areas. Beware of vapours accumulating to form explosive concentrations. Vapours can accumulate in low areas.

Environmental precautions
Prevent further leakage or spillage if safe to do so. Do not let product enter drains. Discharge into the environment must be avoided.

Methods and materials for containment and cleaning up
Contain spillage, and then collect with an electrically protected vacuum cleaner or by wet-brushing and place in container for disposal according to local regulations (see section 13).

7. HANDLING AND STORAGE

Precautions for safe handling
Avoid contact with skin and eyes. Avoid inhalation of vapour or mist. Keep away from sources of ignition - No smoking. Take measures to prevent the build up of electrostatic charge.

Conditions for safe storage
Keep container tightly closed in a dry and well-ventilated place.

8. EXPOSURE CONTROLS/PERSONAL PROTECTION

Components with workplace control parameters

<table>
<thead>
<tr>
<th>Components</th>
<th>CAS-No.</th>
<th>Value</th>
<th>Control parameters</th>
<th>Basis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ammonia, anhydrous</td>
<td>7664-41-7</td>
<td>TWA</td>
<td>25 ppm</td>
<td>USA. ACGIH Threshold Limit Values (TLV)</td>
</tr>
</tbody>
</table>

Remarks
Upper Respiratory Tract irritation Eye damage

<p>| | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>STEL</td>
<td>35 ppm</td>
<td>USA. ACGIH Threshold Limit Values (TLV)</td>
<td></td>
</tr>
</tbody>
</table>

Upper Respiratory Tract irritation Eye damage

<p>| | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>STEL</td>
<td>35 ppm</td>
<td>USA. OSHA - TABLE Z-1 Limits for Air Contaminants - 1910.1000</td>
<td></td>
</tr>
<tr>
<td>TWA</td>
<td>50 ppm</td>
<td>USA. Occupational Exposure Limits (OSHA) - Table Z-1 Limits for Air Contaminants</td>
<td></td>
</tr>
</tbody>
</table>

The value in mg/m³ is approximate.

<p>| | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>TWA</td>
<td>25 ppm</td>
<td>USA. NIOSH Recommended Exposure Limits</td>
<td></td>
</tr>
<tr>
<td>Often used in an aqueous solution.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ST</td>
<td>35 ppm</td>
<td>USA. NIOSH Recommended Exposure Limits</td>
<td></td>
</tr>
<tr>
<td>Often used in an aqueous solution.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Alrich - 294993
Personal protective equipment

Respiratory protection
Where risk assessment shows air-purifying respirators are appropriate use a full-face respirator with multi-purpose combination (US) or type AXBEK (EN 14387) respirator cartridges as a backup to engineering controls. If the respirator is the sole means of protection, use a full-face supplied air respirator. Use respirators and components tested and approved under appropriate government standards such as NIOSH (US) or CEN (EU).

Hand protection
Handle with gloves. Gloves must be inspected prior to use. Use proper glove removal technique (without touching glove’s outer surface) to avoid skin contact with this product. Dispose of contaminated gloves after use in accordance with applicable laws and good laboratory practices. Wash and dry hands.

Full contact
Material: butyl-rubber
Minimum layer thickness: 0.3 mm
Break through time: 480 min
Material tested: Butoject® (KCL 897 / Aldrich Z677647, Size M)

Splash protection
Material: butyl-rubber
Minimum layer thickness: 0.3 mm
Break through time: 480 min
Material tested: Butoject® (KCL 897 / Aldrich Z677647, Size M)

data source: KCL GmbH, D-36124 Eichenzell, phone +49 (0)6659 87300, e-mail sales@kcl.de, test method: EN374
If used in solution, or mixed with other substances, and under conditions which differ from EN 374, contact the supplier of the CE approved gloves. This recommendation is advisory only and must be evaluated by an Industrial Hygienist familiar with the specific situation of anticipated use by our customers. It should not be construed as offering an approval for any specific use scenario.

Eye protection
Tightly fitting safety goggles. Faceshield (8-inch minimum). Use equipment for eye protection tested and approved under appropriate government standards such as NIOSH (US) or EN 166(EU).

Skin and body protection
Complete suit protecting against chemicals, Flame retardant antistatic protective clothing, The type of protective equipment must be selected according to the concentration and amount of the dangerous substance at the specific workplace.

Hygiene measures
Avoid contact with skin, eyes and clothing. Wash hands before breaks and immediately after handling the product.

9. PHYSICAL AND CHEMICAL PROPERTIES

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Appearance</strong></td>
<td></td>
</tr>
<tr>
<td>Form</td>
<td>Compressed gas</td>
</tr>
<tr>
<td>Colour</td>
<td>no data available</td>
</tr>
<tr>
<td><strong>Safety data</strong></td>
<td></td>
</tr>
<tr>
<td>pH</td>
<td>no data available</td>
</tr>
<tr>
<td>Melting point/freezing point</td>
<td>Melting point/range: -78 °C (-108 °F) - lit.</td>
</tr>
<tr>
<td>Boiling point</td>
<td>-33 °C (-27 °F) - lit.</td>
</tr>
<tr>
<td>Flash point</td>
<td>132 °C (270 °F) - closed cup</td>
</tr>
<tr>
<td>Ignition temperature</td>
<td>651 °C (1,204 °F)</td>
</tr>
<tr>
<td>Auto-ignition temperature</td>
<td>no data available</td>
</tr>
<tr>
<td>Lower explosion limit</td>
<td>15 %(V)</td>
</tr>
<tr>
<td>Upper explosion limit</td>
<td>25 %(V)</td>
</tr>
</tbody>
</table>
Vapour pressure 6,402 hPa (4,802 mmHg) at 15.50 °C (59.90 °F)
8,866 hPa (6,650 mmHg) at 21 °C (70 °F)
Density 0.590 g/cm3
Water solubility soluble
Partition coefficient: n-octanol/water no data available
Relative vapor density 0.59 (Air = 1.0)
Odour no data available
Odour Threshold no data available
Evaporation rate no data available

10. STABILITY AND REACTIVITY

Chemical stability
Stable under recommended storage conditions.

Possibility of hazardous reactions
no data available

Conditions to avoid
Heat, flames and sparks. Extremes of temperature and direct sunlight.

Materials to avoid
Oxidizing agents, Iron, Zinc, Copper, Silver/silver oxides, Cadmium/cadmium oxides, Alcohols, acids, Halogens, Aldehydes

Hazardous decomposition products
Hazardous decomposition products formed under fire conditions. - nitrogen oxides (NOx)
Other decomposition products - no data available

11. TOXICOLOGICAL INFORMATION

Acute toxicity

Oral LD50
no data available

Inhalation LC50
LC50 Inhalation - rat - 4 h - 2000 ppm

Dermal LD50
no data available

Other information on acute toxicity
no data available

Skin corrosion/irritation
no data available

Serious eye damage/eye irritation
no data available

Respiratory or skin sensitization
no data available

Germ cell mutagenicity
no data available

Carcinogenicity

IARC: No component of this product present at levels greater than or equal to 0.1% is identified as probable, possible or confirmed human carcinogen by IARC.

ACGIH: No component of this product present at levels greater than or equal to 0.1% is identified as a
carcinogen or potential carcinogen by ACGIH.

NTP: No component of this product present at levels greater than or equal to 0.1% is identified as a known or anticipated carcinogen by NTP.

OSHA: No component of this product present at levels greater than or equal to 0.1% is identified as a carcinogen or potential carcinogen by OSHA.

Reproductive toxicity

no data available

Teratogenicity

no data available

Specific target organ toxicity - single exposure (Globally Harmonized System)

no data available

Specific target organ toxicity - repeated exposure (Globally Harmonized System)

no data available

Aspiration hazard

no data available

Potential health effects

Inhalation May be harmful if inhaled. Material is extremely destructive to the tissue of the mucous membranes and upper respiratory tract.

Ingestion May be harmful if swallowed.

Skin May be harmful if absorbed through skin. Causes skin burns.

Eyes Causes eye burns.

Signs and Symptoms of Exposure

To the best of our knowledge, the chemical, physical, and toxicological properties have not been thoroughly investigated.

Synergistic effects

no data available

Additional Information

RTECS: BO0875000

12. ECOLOGICAL INFORMATION

Toxicity

no data available

Toxicity to daphnia and other aquatic invertebrates

LC50 - Daphnia magna (Water flea) - 25.4 mg/l - 48 h

Persistence and degradability

no data available

Bioaccumulative potential

no data available

Mobility in soil

no data available

PBT and vPvB assessment

no data available

Other adverse effects

An environmental hazard cannot be excluded in the event of unprofessional handling or disposal.

Very toxic to aquatic life.
13. DISPOSAL CONSIDERATIONS

**Product**
Burn in a chemical incinerator equipped with an afterburner and scrubber but exert extra care in igniting as this material is highly flammable. Offer surplus and non-recyclable solutions to a licensed disposal company. Contact a licensed professional waste disposal service to dispose of this material.

**Contaminated packaging**
Dispose of as unused product.

14. TRANSPORT INFORMATION

**DOT (US)**
UN number: 1005  Class: 2.3 (8)
Proper shipping name: Ammonia, anhydrous
Reportable Quantity (RQ): 100 lbs
Marine Pollutant: No
Poison Inhalation Hazard: Hazard zone D

**IMDG**
UN number: 1005  Class: 2.3 (8)
Proper shipping name: AMMONIA, ANHYDROUS
Marine Pollutant: No
EMS-No: F-C, S-U

**IATA**
UN number: 1005  Class: 2.3 (8)
Proper shipping name: Ammonia, anhydrous
IATA Passenger: Not permitted for transport
IATA Cargo: Not permitted for transport

15. REGULATORY INFORMATION

**OSHA Hazards**
Compressed Gas, Target Organ Effect, Corrosive

**SARA 302 Components**
The following components are subject to reporting levels established by SARA Title III, Section 302:

<table>
<thead>
<tr>
<th>Component</th>
<th>CAS-No.</th>
<th>Revision Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ammonia, anhydrous</td>
<td>7664-41-7</td>
<td>2007-03-01</td>
</tr>
</tbody>
</table>

**SARA 313 Components**
The following components are subject to reporting levels established by SARA Title III, Section 313:

<table>
<thead>
<tr>
<th>Component</th>
<th>CAS-No.</th>
<th>Revision Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ammonia, anhydrous</td>
<td>7664-41-7</td>
<td>2007-03-01</td>
</tr>
</tbody>
</table>

**SARA 311/312 Hazards**
Sudden Release of Pressure Hazard, Acute Health Hazard, Chronic Health Hazard

**Massachusetts Right To Know Components**

<table>
<thead>
<tr>
<th>Component</th>
<th>CAS-No.</th>
<th>Revision Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ammonia, anhydrous</td>
<td>7664-41-7</td>
<td>2007-03-01</td>
</tr>
</tbody>
</table>

**Pennsylvania Right To Know Components**

<table>
<thead>
<tr>
<th>Component</th>
<th>CAS-No.</th>
<th>Revision Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ammonia, anhydrous</td>
<td>7664-41-7</td>
<td>2007-03-01</td>
</tr>
</tbody>
</table>

**New Jersey Right To Know Components**

<table>
<thead>
<tr>
<th>Component</th>
<th>CAS-No.</th>
<th>Revision Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ammonia, anhydrous</td>
<td>7664-41-7</td>
<td>2007-03-01</td>
</tr>
</tbody>
</table>

**California Prop. 65 Components**
This product does not contain any chemicals known to State of California to cause cancer, birth defects, or any other reproductive harm.
16. OTHER INFORMATION

Further information
Copyright 2012 Sigma-Aldrich Co. LLC. License granted to make unlimited paper copies for internal use only. The above information is believed to be correct but does not purport to be all inclusive and shall be used only as a guide. The information in this document is based on the present state of our knowledge and is applicable to the product with regard to appropriate safety precautions. It does not represent any guarantee of the properties of the product. Sigma-Aldrich Corporation and its Affiliates shall not be held liable for any damage resulting from handling or from contact with the above product. See www.sigma-aldrich.com and/or the reverse side of invoice or packing slip for additional terms and conditions of sale.
1. PRODUCT AND COMPANY IDENTIFICATION

Product name: L-(+)-Lactic acid
Product Number: L1750
Brand: Sigma
Supplier: Sigma-Aldrich
3050 Spruce Street
SAINT LOUIS MO 63103
USA
Telephone: +1 800-325-5832
Fax: +1 800-325-5052
Emergency Phone # (For both supplier and manufacturer): (314) 776-6555
Preparation Information: Sigma-Aldrich Corporation
Product Safety - Americas Region
1-800-521-8956

2. HAZARDS IDENTIFICATION

Emergency Overview

OSHA Hazards
Irritant

GHS Classification
Acute toxicity, Oral (Category 5)
Acute toxicity, Dermal (Category 5)
Skin irritation (Category 2)
Serious eye damage (Category 1)

GHS Label elements, including precautionary statements

Pictogram

Signal word
Danger

Hazard statement(s)
H303 + H313 May be harmful if swallowed or in contact with skin.
H315 Causes skin irritation.
H318 Causes serious eye damage.

Precautionary statement(s)
P280 Wear protective gloves/ eye protection/ face protection.
P305 + P351 + P338 IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing.

HMIS Classification
Health hazard: 2
Flammability: 1
Physical hazards: 0

NFPA Rating
Health hazard: 2
Fire: 1
Reactivity Hazard: 0
Potential Health Effects

**Inhalation**
May be harmful if inhaled. Causes respiratory tract irritation.

**Skin**
May be harmful if absorbed through skin. Causes skin irritation.

**Eyes**
Causes eye irritation.

**Ingestion**
May be harmful if swallowed.

### 3. COMPOSITION/INFORMATION ON INGREDIENTS

<table>
<thead>
<tr>
<th>Synonyms</th>
<th>(S)-2-Hydroxypropionic acid</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Sarcolactic acid</td>
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<table>
<thead>
<tr>
<th>Formula</th>
<th>C₃H₆O₃</th>
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</thead>
<tbody>
<tr>
<td>Molecular Weight</td>
<td>90.08 g/mol</td>
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<table>
<thead>
<tr>
<th>Component</th>
<th>Concentration</th>
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<td>L-(+)-Lactic acid</td>
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<td>CAS-No.</td>
<td>79-33-4</td>
</tr>
<tr>
<td>EC-No.</td>
<td>201-196-2</td>
</tr>
</tbody>
</table>

### 4. FIRST AID MEASURES

**General advice**
Consult a physician. Show this safety data sheet to the doctor in attendance. Move out of dangerous area.

**If inhaled**
If breathed in, move person into fresh air. If not breathing, give artificial respiration. Consult a physician.

**In case of skin contact**
Take off contaminated clothing and shoes immediately. Wash off with soap and plenty of water. Consult a physician.

**In case of eye contact**
Rinse thoroughly with plenty of water for at least 15 minutes and consult a physician. Continue rinsing eyes during transport to hospital.

**If swallowed**
Do NOT induce vomiting. Never give anything by mouth to an unconscious person. Rinse mouth with water. Consult a physician.

### 5. FIREFIGHTING MEASURES

**Suitable extinguishing media**
Use water spray, alcohol-resistant foam, dry chemical or carbon dioxide.

**Special protective equipment for firefighters**
Wear self-contained breathing apparatus for fire fighting if necessary.

**Hazardous combustion products**
Hazardous decomposition products formed under fire conditions. - Carbon oxides

### 6. ACCIDENTAL RELEASE MEASURES

**Personal precautions**
Use personal protective equipment. Avoid dust formation. Avoid breathing vapors, mist or gas. Ensure adequate ventilation. Evacuate personnel to safe areas. Avoid breathing dust.

**Environmental precautions**
Do not let product enter drains.

**Methods and materials for containment and cleaning up**
Pick up and arrange disposal without creating dust. Sweep up and shovel. Keep in suitable, closed containers for disposal.

### 7. HANDLING AND STORAGE
Precautions for safe handling
Avoid formation of dust and aerosols.
Provide appropriate exhaust ventilation at places where dust is formed. Normal measures for preventive fire protection.

Conditions for safe storage
Keep container tightly closed in a dry and well-ventilated place.
Recommended storage temperature: 2 - 8 °C
hygroscopic

8. EXPOSURE CONTROLS/PERSONAL PROTECTION

Contains no substances with occupational exposure limit values.

Personal protective equipment

Respiratory protection
Where risk assessment shows air-purifying respirators are appropriate use a full-face particle respirator type N100 (US) or type P3 (EN 143) respirator cartridges as a backup to engineering controls. If the respirator is the sole means of protection, use a full-face supplied air respirator. Use respirators and components tested and approved under appropriate government standards such as NIOSH (US) or CEN (EU).

Hand protection
Handle with gloves. Gloves must be inspected prior to use. Use proper glove removal technique (without touching glove’s outer surface) to avoid skin contact with this product. Dispose of contaminated gloves after use in accordance with applicable laws and good laboratory practices. Wash and dry hands.

Eye protection
Face shield and safety glasses Use equipment for eye protection tested and approved under appropriate government standards such as NIOSH (US) or EN 166(EU).

Skin and body protection
Complete suit protecting against chemicals, The type of protective equipment must be selected according to the concentration and amount of the dangerous substance at the specific workplace.

Hygiene measures
Handle in accordance with good industrial hygiene and safety practice. Wash hands before breaks and at the end of workday.

9. PHYSICAL AND CHEMICAL PROPERTIES

Appearance
- Form: solid
- Colour: no data available

Safety data
- pH: 1.2
- Melting point/freezing point: Melting point/range: 53 °C (127 °F)
- Boiling point: no data available
- Flash point: 110 °C (230 °F) - closed cup
- Ignition temperature: no data available
- Autoignition temperature: no data available
- Lower explosion limit: no data available
- Upper explosion limit: no data available
- Vapour pressure: no data available
- Density: 1.200 g/cm³
10. STABILITY AND REACTIVITY

Chemical stability
Stable under recommended storage conditions.

Possibility of hazardous reactions
no data available

Conditions to avoid
Avoid moisture.

Materials to avoid
Strong oxidizing agents

Hazardous decomposition products
Hazardous decomposition products formed under fire conditions. - Carbon oxides
Other decomposition products - no data available

11. TOXICOLOGICAL INFORMATION

Acute toxicity

Oral LD50
LD50 Oral - rat - 3,543 mg/kg

Inhalation LC50
no data available

Dermal LD50
LD50 Dermal - rabbit - > 2,000 mg/kg

Other information on acute toxicity
no data available

Skin corrosion/irritation
no data available

Serious eye damage/eye irritation
no data available

Respiratory or skin sensitization
no data available

Germ cell mutagenicity
no data available

Genotoxicity in vitro - Hamster - ovary
Cytogenetic analysis

Carcinogenicity

IARC: No component of this product present at levels greater than or equal to 0.1% is identified as probable, possible or confirmed human carcinogen by IARC.

ACGIH: No component of this product present at levels greater than or equal to 0.1% is identified as a carcinogen or potential carcinogen by ACGIH.
NTP: No component of this product present at levels greater than or equal to 0.1% is identified as a known or anticipated carcinogen by NTP.

OSHA: No component of this product present at levels greater than or equal to 0.1% is identified as a carcinogen or potential carcinogen by OSHA.

Reproductive toxicity
Reproductive toxicity - mouse - Oral
Maternal Effects: Other effects. Specific Developmental Abnormalities: Musculoskeletal system.

no data available

Teratogenicity
no data available

Specific target organ toxicity - single exposure (Globally Harmonized System)
no data available

Specific target organ toxicity - repeated exposure (Globally Harmonized System)
no data available

Aspiration hazard
no data available

Potential health effects

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Inhalation</td>
<td>May be harmful if inhaled. Causes respiratory tract irritation.</td>
</tr>
<tr>
<td>Ingestion</td>
<td>May be harmful if swallowed.</td>
</tr>
<tr>
<td>Skin</td>
<td>May be harmful if absorbed through skin. Causes skin irritation.</td>
</tr>
<tr>
<td>Eyes</td>
<td>Causes eye irritation.</td>
</tr>
</tbody>
</table>

Signs and Symptoms of Exposure
To the best of our knowledge, the chemical, physical, and toxicological properties have not been thoroughly investigated.

Synergistic effects
no data available

Additional Information
RTECS: OD2800000

12. ECOLOGICAL INFORMATION

Toxicity
Toxicity to daphnia and other aquatic invertebrates
EC50 - Daphnia magna (Water flea) - 180 - 320 mg/l - 48 h
Toxicity to algae
mortality NOEC - Pseudokirchneriella subcapitata - 320 mg/l - 96 h
EC50 - Pseudokirchneriella subcapitata (green algae) - > 2,800 mg/l - 84 h

Persistence and degradability
no data available

Bioaccumulative potential
no data available

Mobility in soil
no data available

PBT and vPvB assessment
no data available

Other adverse effects
no data available
13. DISPOSAL CONSIDERATIONS

Product
Offer surplus and non-recyclable solutions to a licensed disposal company. Contact a licensed professional waste disposal service to dispose of this material.

Contaminated packaging
Dispose of as unused product.

14. TRANSPORT INFORMATION

DOT (US)
Not dangerous goods

IMDG
Not dangerous goods

IATA
Not dangerous goods

15. REGULATORY INFORMATION

OSHA Hazards
Irritant

SARA 302 Components
SARA 302: No chemicals in this material are subject to the reporting requirements of SARA Title III, Section 302.

SARA 313 Components
SARA 313: This material does not contain any chemical components with known CAS numbers that exceed the threshold (De Minimis) reporting levels established by SARA Title III, Section 313.

SARA 311/312 Hazards
Acute Health Hazard

Massachusetts Right To Know Components
No components are subject to the Massachusetts Right to Know Act.

Pennsylvania Right To Know Components

<table>
<thead>
<tr>
<th>Component</th>
<th>CAS-No.</th>
<th>Revision Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>L-(-)-Lactic acid</td>
<td>79-33-4</td>
<td></td>
</tr>
</tbody>
</table>

New Jersey Right To Know Components

<table>
<thead>
<tr>
<th>Component</th>
<th>CAS-No.</th>
<th>Revision Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>L-(-)-Lactic acid</td>
<td>79-33-4</td>
<td></td>
</tr>
</tbody>
</table>

California Prop. 65 Components
This product does not contain any chemicals known to State of California to cause cancer, birth defects, or any other reproductive harm.

16. OTHER INFORMATION

Further information
Copyright 2012 Sigma-Aldrich Co. LLC. License granted to make unlimited paper copies for internal use only. The above information is believed to be correct but does not purport to be all inclusive and shall be used only as a guide. The information in this document is based on the present state of our knowledge and is applicable to the product with regard to appropriate safety precautions. It does not represent any guarantee of the properties of the product. Sigma-Aldrich Corporation and its Affiliates shall not be held liable for any damage resulting from handling or from contact with the above product. See www.sigma-aldrich.com and/or the reverse side of invoice or packing slip for additional terms and conditions of sale.
1. PRODUCT AND COMPANY IDENTIFICATION

Product name : Nitrogen
Product Number : 295574
Brand : Aldrich
Supplier : Sigma-Aldrich
3050 Spruce Street
SAINT LOUIS MO  63103
USA
Telephone : +1 800-325-5832
Fax : +1 800-325-5052
Emergency Phone # (For both supplier and manufacturer) : (314) 776-6555
Preparation Information : Sigma-Aldrich Corporation
Product Safety - Americas Region
1-800-521-8956

2. HAZARDS IDENTIFICATION

Emergency Overview

OSHA Hazards
Compressed Gas

GHS Classification
Gases under pressure (Compressed gas)

GHS Label elements, including precautionary statements

Pictogram

Signal word
Warning

Hazard statement(s)
H280
Contains gas under pressure; may explode if heated.

Precautionary statement(s)
P410 + P403
Protect from sunlight. Store in a well-ventilated place.

HMIS Classification
Health hazard: 0
Flammability: 0
Physical hazards: 0

NFPA Rating
Health hazard: 0
Fire: 0
Reactivity Hazard: 0
Special hazard.: SA

Potential Health Effects

Inhalation
May be harmful if inhaled. May cause respiratory tract irritation.

Ingestion
May be harmful if swallowed.
3. COMPOSITION/INFORMATION ON INGREDIENTS

<table>
<thead>
<tr>
<th>Component</th>
<th>Concentration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nitrogen</td>
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</tr>
<tr>
<td>CAS-No.</td>
<td>7727-37-9</td>
</tr>
<tr>
<td>EC-No.</td>
<td>231-783-9</td>
</tr>
</tbody>
</table>

4. FIRST AID MEASURES

**General advice**
Consult a physician. Show this safety data sheet to the doctor in attendance. Move out of dangerous area.

**If inhaled**
If breathed in, move person into fresh air. If not breathing, give artificial respiration. Consult a physician.

**In case of skin contact**
Wash off with soap and plenty of water. Consult a physician.

**In case of eye contact**
Flush eyes with water as a precaution.

**If swallowed**
Never give anything by mouth to an unconscious person. Rinse mouth with water. Consult a physician.

5. FIREFIGHTING MEASURES

**Suitable extinguishing media**
Use water spray, alcohol-resistant foam, dry chemical or carbon dioxide.

**Special protective equipment for firefighters**
Wear self-contained breathing apparatus for fire fighting if necessary.

**Hazardous combustion products**
Hazardous decomposition products formed under fire conditions. - nitrogen oxides (NOx)

**Further information**
Use water spray to cool unopened containers.

6. ACCIDENTAL RELEASE MEASURES

**Personal precautions**
Avoid breathing vapors, mist or gas. Ensure adequate ventilation. Evacuate personnel to safe areas.

**Environmental precautions**
Do not let product enter drains.

**Methods and materials for containment and cleaning up**
Clean up promptly by sweeping or vacuum.

7. HANDLING AND STORAGE

**Precautions for safe handling**
Normal measures for preventive fire protection.

**Conditions for safe storage**
Keep container tightly closed in a dry and well-ventilated place.

Contents under pressure.
8. EXPOSURE CONTROLS/PERSONAL PROTECTION

Contains no substances with occupational exposure limit values.

Personal protective equipment

Respiratory protection
Where risk assessment shows air-purifying respirators are appropriate use a full-face respirator with multi-purpose combination (US) or type AXBEK (EN 14387) respirator cartridges as a backup to engineering controls. If the respirator is the sole means of protection, use a full-face supplied air respirator. Use respirators and components tested and approved under appropriate government standards such as NIOSH (US) or CEN (EU).

Hand protection
Handle with gloves. Gloves must be inspected prior to use. Use proper glove removal technique (without touching glove's outer surface) to avoid skin contact with this product. Dispose of contaminated gloves after use in accordance with applicable laws and good laboratory practices. Wash and dry hands.

Full contact
Material: butyl-rubber
Minimum layer thickness: 0.3 mm
Break through time: 480 min
Material tested: Butoject® (KCL 897 / Aldrich Z677647, Size M)

Splash protection
Material: Chloroprene
Minimum layer thickness: 0.6 mm
Break through time: 30 min
Material tested: Camapren® (KCL 722 / Aldrich Z677493, Size M)

data source: KCL GmbH, D-36124 Eichenzell, phone +49 (0)6659 87300, e-mail sales@kcl.de, test method: EN374
If used in solution, or mixed with other substances, and under conditions which differ from EN 374, contact the supplier of the CE approved gloves. This recommendation is advisory only and must be evaluated by an Industrial Hygienist familiar with the specific situation of anticipated use by our customers. It should not be construed as offering an approval for any specific use scenario.

Eye protection
Use equipment for eye protection tested and approved under appropriate government standards such as NIOSH (US) or EN 166 (EU).

Skin and body protection
Impervious clothing, The type of protective equipment must be selected according to the concentration and amount of the dangerous substance at the specific workplace.

Hygiene measures
Handle in accordance with good industrial hygiene and safety practice. Wash hands before breaks and at the end of workday.

9. PHYSICAL AND CHEMICAL PROPERTIES

Appearance
Form Compressed gas
Colour colourless

Safety data
pH no data available
Melting point/freezing point Melting point/range: -210 °C (-346 °F) - lit.
Boiling point -196 °C (-321 °F) - lit.
Flash point not applicable
Ignition temperature no data available
Auto-ignition temperature no data available
10. STABILITY AND REACTIVITY

**Chemical stability**
Stable under recommended storage conditions.

**Possibility of hazardous reactions**
no data available

**Conditions to avoid**
no data available

**Materials to avoid**
Strong oxidizing agents

**Hazardous decomposition products**
Hazardous decomposition products formed under fire conditions. - nitrogen oxides (NOx)
Other decomposition products - no data available

11. TOXICOLOGICAL INFORMATION

**Acute toxicity**

**Oral LD50**
no data available

**Inhalation LC50**
no data available

**Dermal LD50**
no data available

**Other information on acute toxicity**
no data available

**Skin corrosion/irritation**
no data available

**Serious eye damage/eye irritation**
no data available

**Respiratory or skin sensitization**
no data available

**Germ cell mutagenicity**
no data available

**Carcinogenicity**

IARC: No component of this product present at levels greater than or equal to 0.1% is identified as probable, possible or confirmed human carcinogen by IARC.
ACGIH: No component of this product present at levels greater than or equal to 0.1% is identified as a carcinogen or potential carcinogen by ACGIH.

NTP: No component of this product present at levels greater than or equal to 0.1% is identified as a known or anticipated carcinogen by NTP.

OSHA: No component of this product present at levels greater than or equal to 0.1% is identified as a carcinogen or potential carcinogen by OSHA.

Reproductive toxicity

no data available

Teratogenicity

no data available

Specific target organ toxicity - single exposure (Globally Harmonized System)
no data available

Specific target organ toxicity - repeated exposure (Globally Harmonized System)
no data available

Aspiration hazard
no data available

Potential health effects

Inhalation May be harmful if inhaled. May cause respiratory tract irritation.
Ingestion May be harmful if swallowed.
Skin May be harmful if absorbed through skin. May cause skin irritation.
Eyes May cause eye irritation.

Signs and Symptoms of Exposure
May be harmful., Nausea, Headache, Vomiting

Synergistic effects
no data available

Additional Information
RTECS: QW9700000

12. ECOLOGICAL INFORMATION

Toxicity
no data available

Persistence and degradability
no data available

Bioaccumulative potential
no data available

Mobility in soil
no data available

PBT and vPvB assessment
no data available

Other adverse effects
no data available

13. DISPOSAL CONSIDERATIONS

Product
Offer surplus and non-recyclable solutions to a licensed disposal company. Contact a licensed professional waste disposal service to dispose of this material.
Contaminated packaging
Dispose of as unused product.

14. TRANSPORT INFORMATION

DOT (US)
UN number: 1066   Class: 2.2
Proper shipping name: Nitrogen, compressed
Marine Pollutant: No
Poison Inhalation Hazard: No

IMDG
UN number: 1066   Class: 2.2
Proper shipping name: NITROGEN, COMPRESSED
Marine Pollutant: No

IATA
UN number: 1066   Class: 2.2
Proper shipping name: Nitrogen, compressed

15. REGULATORY INFORMATION

OSHA Hazards
Compressed Gas

SARA 302 Components
SARA 302: No chemicals in this material are subject to the reporting requirements of SARA Title III, Section 302.

SARA 313 Components
SARA 313: This material does not contain any chemical components with known CAS numbers that exceed the threshold (De Minimis) reporting levels established by SARA Title III, Section 313.

SARA 311/312 Hazards
Sudden Release of Pressure Hazard

Massachusetts Right To Know Components

<table>
<thead>
<tr>
<th>Component</th>
<th>CAS-No.</th>
<th>Revision Date</th>
</tr>
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<tbody>
<tr>
<td>Nitrogen</td>
<td>7727-37-9</td>
<td>2007-03-01</td>
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Pennsylvania Right To Know Components

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New Jersey Right To Know Components

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<th>Revision Date</th>
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</thead>
<tbody>
<tr>
<td>Nitrogen</td>
<td>7727-37-9</td>
<td>2007-03-01</td>
</tr>
</tbody>
</table>

California Prop. 65 Components
This product does not contain any chemicals known to State of California to cause cancer, birth defects, or any other reproductive harm.

16. OTHER INFORMATION

Further information
Copyright 2012 Sigma-Aldrich Co. LLC. License granted to make unlimited paper copies for internal use only. The above information is believed to be correct but does not purport to be all inclusive and shall be used only as a guide. The information in this document is based on the present state of our knowledge and is applicable to the product with regard to appropriate safety precautions. It does not represent any guarantee of the properties of the product. Sigma-Aldrich Corporation and its Affiliates shall not be held liable for any damage resulting from handling or from contact with the above product. See www.sigma-aldrich.com and/or the reverse side of invoice or packing slip for additional terms and conditions of sale.
Material Safety Data Sheet
D-Fructose

ACC# 06165

Section 1 - Chemical Product and Company Identification

<table>
<thead>
<tr>
<th>MSDS Name:</th>
<th>D-Fructose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Product Grade :</td>
<td>SQ</td>
</tr>
<tr>
<td>Catalog Numbers:</td>
<td>23134, 23135</td>
</tr>
<tr>
<td>Synonyms:</td>
<td>D-Fructose</td>
</tr>
</tbody>
</table>
| Company Identification: | Fisher Scientific  
Part of Thermo Fisher Scientific  
THERMO ELECTRON LLS INDIA PVT.LTD.  
Godrej Coliseum, 101A-101B, Somaiya Hospital Road,  
Off Eastern Express Highway, Sion (East), Mumbai-400 022, India |

For information, call: 022 – 6680 3001/2, Call India Toll Free – 1 800 209 7001  
Emergency Number: 022-66803004/14  
For CHEMTREC assistance, call: 800-424-9300 [International]  
For International CHEMTREC assistance, call: 703-527-3887 [International]

Section 2 - Composition, Information on Ingredients

<table>
<thead>
<tr>
<th>CAS#</th>
<th>Chemical Name</th>
<th>Percent</th>
<th>EINECS/ELINCS</th>
</tr>
</thead>
<tbody>
<tr>
<td>57-48-7</td>
<td>D-Fructose</td>
<td>&gt;98</td>
<td>200-333-3</td>
</tr>
</tbody>
</table>

Section 3 - Hazards Identification

EMERGENCY OVERVIEW

Appearance: white crystalline powder.  
Caution! May cause eye irritation. This is expected to be a low hazard for usual industrial handling.  
Target Organs: None.

Potential Health Effects  
Eye: May cause eye irritation.
Skin: Low hazard for usual industrial handling.

Ingestion: Low hazard for usual industrial handling.

Inhalation: Dust is irritating to the respiratory tract. Low hazard for usual industrial handling.

Chronic: No information found.

Section 4 - First Aid Measures

**Eyes:** Flush eyes with plenty of water for at least 15 minutes, occasionally lifting the upper and lower eyelids. If irritation develops, get medical aid.

**Skin:** Flush skin with plenty of water for at least 15 minutes while removing contaminated clothing and shoes. Get medical aid if irritation develops or persists.

**Ingestion:** If victim is conscious and alert, give 2-4 cupfuls of milk or water. Never give anything by mouth to an unconscious person. Get medical aid if irritation or symptoms occur.

**Inhalation:** Remove from exposure and move to fresh air immediately. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Get medical aid if cough or other symptoms appear.

**Notes to Physician:** Treat symptomatically and supportively.

Section 5 - Fire Fighting Measures

**General Information:** As in any fire, wear a self-contained breathing apparatus in pressure-demand, MSHA/NIOSH (approved or equivalent), and full protective gear. During a fire, irritating and highly toxic gases may be generated by thermal decomposition or combustion. Dust from this material can form explosive organic dust cloud.

**Extinguishing Media:** Use water spray, dry chemical, carbon dioxide, or appropriate foam.

**Flash Point:** Not applicable.

**Autoignition Temperature:** Not applicable.

**Explosion Limits, Lower:** Not available.

**Upper:** Not available.

**NFPA Rating:** (estimated) Health: 0; Flammability: 1; Instability: 0

Section 6 - Accidental Release Measures

**General Information:** Use proper personal protective equipment as indicated in
Section 8.
**Spills/Leaks:** Vacuum or sweep up material and place into a suitable disposal container. Clean up spills immediately, observing precautions in the Protective Equipment section. Avoid generating dusty conditions. Provide ventilation.

**Section 7 - Handling and Storage**

**Handling:** Wash thoroughly after handling. Use with adequate ventilation. Minimize dust generation and accumulation. Avoid contact with eyes, skin, and clothing. Keep container tightly closed. Avoid breathing dust.  
**Storage:** Store in a tightly closed container. Store in a cool, dry, well-ventilated area away from incompatible substances.

**Section 8 - Exposure Controls, Personal Protection**

**Engineering Controls:** Use adequate ventilation to keep airborne concentrations low. 

**Exposure Limits**

<table>
<thead>
<tr>
<th>Chemical Name</th>
<th>ACGIH</th>
<th>NIOSH</th>
<th>OSHA - Final PELs</th>
</tr>
</thead>
<tbody>
<tr>
<td>D-Fructose</td>
<td>none listed</td>
<td>none listed</td>
<td>none listed</td>
</tr>
</tbody>
</table>

**OSHA Vacated PELs:** D-Fructose: No OSHA Vacated PELs are listed for this chemical.

**Personal Protective Equipment**

**Eyes:** Wear appropriate protective eyeglasses or chemical safety goggles as described by OSHA's eye and face protection regulations in 29 CFR 1910.133 or European Standard EN166. 

**Skin:** Protective garments not normally required.

**Clothing:** Protective garments not normally required.

**Respirators:** Follow the OSHA respirator regulations found in 29 CFR 1910.134 or European Standard EN 149. Use a NIOSH/MSHA or European Standard EN 149 approved respirator if exposure limits are exceeded or if irritation or other symptoms are experienced.

**Section 9 - Physical and Chemical Properties**

**Physical State:** Crystalline powder
**Appearance:** white  
**Odor:** Not available.  
**pH:** Not available.  
**Vapor Pressure:** Not available.  
**Vapor Density:** Not available.  
**Evaporation Rate:** Not applicable.  
**Viscosity:** Not available.  
**Boiling Point:** Not available.  
**Freezing/Melting Point:** 103-105 deg C (dec)  
**Decomposition Temperature:** 103-105 deg C  
**Solubility:** Freely Soluble.  
**Specific Gravity/Density:** Not available.  
**Molecular Formula:** C_6_H_12_O_6  
**Molecular Weight:** 180.16

---

**Section 10 - Stability and Reactivity**

**Chemical Stability:** Stable at room temperature in closed containers under normal storage and handling conditions.  
**Conditions to Avoid:** Dust generation, moisture, excess heat.  
**Incompatibilities with Other Materials:** Strong oxidizing agents.  
**Hazardous Decomposition Products:** Carbon monoxide, irritating and toxic fumes and gases, carbon dioxide.  
**Hazardous Polymerization:** Has not been reported.

---

**Section 11 - Toxicological Information**

**RTECS#:**  
**CAS# 57-48-7:** LS7120000  
**LD50/LC50:**  
Not available.

**Carcinogenicity:**  
CAS# 57-48-7: Not listed by ACGIH, IARC, NTP, or CA Prop 65.

**Epidemiology:** No information available.  
**Teratogenicity:** No information available.  
**Reproductive Effects:** No information available.  
**Mutagenicity:** No information available.  
**Neurotoxicity:** No information available.  
**Other Studies:**
Section 12 - Ecological Information

No information available.

Section 13 - Disposal Considerations

Chemical waste generators must determine whether a discarded chemical is classified as a hazardous waste. US EPA guidelines for the classification determination are listed in 40 CFR Parts 261.3. Additionally, waste generators must consult state and local hazardous waste regulations to ensure complete and accurate classification.

**RCRA P-Series:** None listed.

**RCRA U-Series:** None listed.

Section 14 - Transport Information

<table>
<thead>
<tr>
<th></th>
<th>US DOT</th>
<th>Canada TDG</th>
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</thead>
<tbody>
<tr>
<td><strong>Shipping Name:</strong></td>
<td>Not Regulated</td>
<td>Not Regulated</td>
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<tr>
<td><strong>Hazard Class:</strong></td>
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<td></td>
</tr>
<tr>
<td><strong>UN Number:</strong></td>
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<tr>
<td><strong>Packing Group:</strong></td>
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</tbody>
</table>

Section 15 - Regulatory Information

**US FEDERAL**

**TSCA**

CAS# 57-48-7 is listed on the TSCA inventory.

**Health & Safety Reporting List**

None of the chemicals are on the Health & Safety Reporting List.

**Chemical Test Rules**

None of the chemicals in this product are under a Chemical Test Rule.

**Section 12b**

None of the chemicals are listed under TSCA Section 12b.

**TSCA Significant New Use Rule**
None of the chemicals in this material have a SNUR under TSCA.

**CERCLA Hazardous Substances and corresponding RQs**
None of the chemicals in this material have an RQ.

**SARA Section 302 Extremely Hazardous Substances**
None of the chemicals in this product have a TPQ.

**Section 313**
No chemicals are reportable under Section 313.

**Clean Air Act:**
This material does not contain any hazardous air pollutants.
This material does not contain any Class 1 Ozone depletors.
This material does not contain any Class 2 Ozone depletors.

**Clean Water Act:**
None of the chemicals in this product are listed as Hazardous Substances under the CWA.
None of the chemicals in this product are listed as Priority Pollutants under the CWA.
None of the chemicals in this product are listed as Toxic Pollutants under the CWA.

**OSHA:**
None of the chemicals in this product are considered highly hazardous by OSHA.

**STATE**
CAS# 57-48-7 is not present on state lists from CA, PA, MN, MA, FL, or NJ.

**California Prop 65**
California No Significant Risk Level: None of the chemicals in this product are listed.

**European/International Regulations**

**European Labeling in Accordance with EC Directives**

**Hazard Symbols:**
Not available.

**Risk Phrases:**

**Safety Phrases:**
S 24/25 Avoid contact with skin and eyes.

**WGK (Water Danger/Protection)**
CAS# 57-48-7: 0

**Canada - DSL/NDSL**
CAS# 57-48-7 is listed on Canada's DSL List.

**Canada - WHMIS**
This product has a WHMIS classification of Not controlled..
This product has been classified in accordance with the hazard criteria of the Controlled Products Regulations and the MSDS contains all of the information required by those regulations.

**Canadian Ingredient Disclosure List**

---

**Section 16 - Additional Information**

**MSDS Creation Date:** 12/12/1997
The information above is believed to be accurate and represents the best information currently available to us. However, we make no warranty of merchantability or any other warranty, express or implied, with respect to such information, and we assume no liability resulting from its use. Users should make their own investigations to determine the suitability of the information for their particular purposes. In no event shall Fisher be liable for any claims, losses, or damages of any third party or for lost profits or any special, indirect, incidental, consequential or exemplary damages, howsoever arising, even if Fisher has been advised of the possibility of such damages.
1. PRODUCT AND COMPANY IDENTIFICATION

Product name : Paraformaldehyde-d₂
Product Number : 394513
Brand : Aldrich
Supplier : Sigma-Aldrich
3050 Spruce Street
SAINT LOUIS MO  63103
USA
Telephone : +1 800-325-5832
Fax : +1 800-325-5052
Emergency Phone # (For both supplier and manufacturer) : (314) 776-6555
Preparation Information : Sigma-Aldrich Corporation
Product Safety - Americas Region
1-800-521-8956

2. HAZARDS IDENTIFICATION

Emergency Overview

OSHA Hazards
Flammable solid, Toxic by inhalation., Harmful by ingestion., Harmful by skin absorption., Skin and respiratory sensitiser

GHS Classification
Flammable solids (Category 2)
Acute toxicity, Oral (Category 4)
Acute toxicity, Inhalation (Category 4)
Acute toxicity, Dermal (Category 4)
Respiratory sensitisation (Category 1)
Skin sensitisation (Category 1)

GHS Label elements, including precautionary statements

Pictogram

Signal word Danger

Hazard statement(s)
H228 Flammable solid.
H302 + H312 + H332 Harmful if swallowed, in contact with skin or if inhaled
H317 May cause an allergic skin reaction.
H334 May cause allergy or asthma symptoms or breathing difficulties if inhaled.

Precautionary statement(s)
P210 Keep away from heat/sparks/open flames/hot surfaces. - No smoking.
P261 Avoid breathing dust/ fume/ gas/ mist/ vapours/ spray.
P280 Wear protective gloves/ protective clothing.
P342 + P311 If experiencing respiratory symptoms: Call a POISON CENTER or doctor/ physician.

HMIS Classification
Health hazard: 2
Chronic Health Hazard: *
Flammability: 2
Physical hazards: 2

NFPA Rating
Health hazard: 2
Fire: 2
Reactivity Hazard: 2

Potential Health Effects
Inhalation: Toxic if inhaled. May cause respiratory tract irritation.
Skin: Harmful if absorbed through skin. May cause skin irritation.
Eyes: May cause eye irritation.
Ingestion: Harmful if swallowed.

3. COMPOSITION/INFORMATION ON INGREDIENTS

Synonyms: Dideuteroparaformaldehyde
Formaldehyde-d2 polymer
Formaldehyde-d2 polymer

Formula: CD₂O
Molecular Weight: 32.04 g/mol

<table>
<thead>
<tr>
<th>Component</th>
<th>Concentration</th>
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</thead>
<tbody>
<tr>
<td>Paraformaldehyde-d2</td>
<td></td>
</tr>
<tr>
<td>CAS-No.</td>
<td>32008-59-6</td>
</tr>
</tbody>
</table>

4. FIRST AID MEASURES

General advice
Consult a physician. Show this safety data sheet to the doctor in attendance. Move out of dangerous area.

If inhaled
If breathed in, move person into fresh air. If not breathing, give artificial respiration. Consult a physician.

In case of skin contact
Wash off with soap and plenty of water. Consult a physician.

In case of eye contact
Flush eyes with water as a precaution.

If swallowed
Do NOT induce vomiting. Never give anything by mouth to an unconscious person. Rinse mouth with water. Consult a physician.

5. FIREFIGHTING MEASURES

Suitable extinguishing media
Use water spray, alcohol-resistant foam, dry chemical or carbon dioxide.

Special protective equipment for firefighters
Wear self contained breathing apparatus for fire fighting if necessary.

Hazardous combustion products
Hazardous decomposition products formed under fire conditions. - Carbon oxides

Further information
Use water spray to cool unopened containers.

6. ACCIDENTAL RELEASE MEASURES

Personal precautions
Use personal protective equipment. Avoid dust formation. Avoid breathing vapours, mist or gas. Ensure adequate ventilation. Remove all sources of ignition. Evacuate personnel to safe areas. Avoid breathing dust.
Environmental precautions
Prevent further leakage or spillage if safe to do so. Do not let product enter drains.

Methods and materials for containment and cleaning up
Sweep up and shovel. Contain spillage, and then collect with an electrically protected vacuum cleaner or by wet-brushing and transfer to a container for disposal according to local regulations (see section 13). Keep in suitable, closed containers for disposal. Contain spillage, pick up with an electrically protected vacuum cleaner or by wet-brushing and transfer to a container for disposal according to local regulations (see section 13).

7. HANDLING AND STORAGE

Precautions for safe handling
Avoid contact with skin and eyes. Avoid formation of dust and aerosols. Provide appropriate exhaust ventilation at places where dust is formed. Keep away from sources of ignition - No smoking. Take measures to prevent the build up of electrostatic charge.

Conditions for safe storage
Store in cool place. Keep container tightly closed in a dry and well-ventilated place. Store under inert gas. hygroscopic

8. EXPOSURE CONTROLS/PERSONAL PROTECTION

Contains no substances with occupational exposure limit values.

Personal protective equipment

Respiratory protection
Where risk assessment shows air-purifying respirators are appropriate use a full-face particle respirator type N100 (US) or type P3 (EN 143) respirator cartridges as a backup to engineering controls. If the respirator is the sole means of protection, use a full-face supplied air respirator. Use respirators and components tested and approved under appropriate government standards such as NIOSH (US) or CEN (EU).

Hand protection
Handle with gloves. Gloves must be inspected prior to use. Use proper glove removal technique (without touching glove’s outer surface) to avoid skin contact with this product. Dispose of contaminated gloves after use in accordance with applicable laws and good laboratory practices. Wash and dry hands.

Eye protection
Face shield and safety glasses Use equipment for eye protection tested and approved under appropriate government standards such as NIOSH (US) or EN 166(EU).

Skin and body protection
Complete suit protecting against chemicals. Flame retardant antistatic protective clothing, The type of protective equipment must be selected according to the concentration and amount of the dangerous substance at the specific workplace.

Hygiene measures
Handle in accordance with good industrial hygiene and safety practice. Wash hands before breaks and at the end of workday.

9. PHYSICAL AND CHEMICAL PROPERTIES

Appearance
Form powder
Colour white

Safety data
pH no data available
Melting point/range: 170 °C (338 °F) - dec.
Boiling point no data available
Flash point: 70 °C (158 °F) - closed cup

Flammability (solid, gas): The substance or mixture is a flammable solid with the category 2.

Ignition temperature: no data available

Auto-ignition temperature: no data available

Lower explosion limit: no data available

Upper explosion limit: no data available

Vapour pressure: no data available

Density: no data available

Water solubility: no data available

Partition coefficient: n-octanol/water: no data available

Relative vapour density: no data available

Odour: no data available

Odour Threshold: no data available

Evaporation rate: no data available

10. STABILITY AND REACTIVITY

Chemical stability
Stable under recommended storage conditions.

Possibility of hazardous reactions
no data available

Conditions to avoid
Heat, flames and sparks. Extremes of temperature and direct sunlight.

Materials to avoid
Strong oxidizing agents

Hazardous decomposition products
Hazardous decomposition products formed under fire conditions. - Carbon oxides
Other decomposition products - no data available

11. TOXICOLOGICAL INFORMATION

Acute toxicity

Oral LD50
no data available

Inhalation LC50
no data available

Dermal LD50
no data available

Other information on acute toxicity

Skin corrosion/irritation
no data available

Serious eye damage/eye irritation

Respiratory or skin sensitisation
May cause allergic respiratory and skin reactions
no data available
Germ cell mutagenicity

Carcinogenicity

IARC: No component of this product present at levels greater than or equal to 0.1% is identified as probable, possible or confirmed human carcinogen by IARC.

ACGIH: No component of this product present at levels greater than or equal to 0.1% is identified as a carcinogen or potential carcinogen by ACGIH.

NTP: No component of this product present at levels greater than or equal to 0.1% is identified as a known or anticipated carcinogen by NTP.

OSHA: No component of this product present at levels greater than or equal to 0.1% is identified as a carcinogen or potential carcinogen by OSHA.

Reproductive toxicity

Teratogenicity

Specific target organ toxicity - single exposure (Globally Harmonized System)
no data available

Specific target organ toxicity - repeated exposure (Globally Harmonized System)
no data available

Aspiration hazard
no data available

Potential health effects

Inhalation: Toxic if inhaled. May cause respiratory tract irritation.

Ingestion: Harmful if swallowed.

Skin: Harmful if absorbed through skin. May cause skin irritation.

Eyes: May cause eye irritation.

Signs and Symptoms of Exposure
burning sensation, Cough, wheezing, laryngitis, Shortness of breath, Headache, Nausea, Vomiting

Synergistic effects
no data available

Additional Information
RTECS: Not available

12. ECOLOGICAL INFORMATION

Toxicity
no data available

Persistence and degradability
no data available

Bioaccumulative potential
no data available

Mobility in soil
no data available

PBT and vPvB assessment
no data available

Other adverse effects
no data available

13. DISPOSAL CONSIDERATIONS

Product
Burn in a chemical incinerator equipped with an afterburner and scrubber but exert extra care in igniting as this material is highly flammable. Offer surplus and non-recyclable solutions to a licensed disposal company. Contact a licensed professional waste disposal service to dispose of this material.
**Contaminated packaging**
Dispose of as unused product.

### 14. TRANSPORT INFORMATION

**DOT (US)**
- UN number: 2213  Class: 4.1  Packing group: III
- Proper shipping name: Paraformaldehyde
- Marine pollutant: No
- Poison Inhalation Hazard: No

**IMDG**
- UN number: 2213  Class: 4.1  Packing group: III  EMS-No: F-A, S-G
- Proper shipping name: PARAFORMALDEHYDE
- Marine pollutant: No

**IATA**
- UN number: 2213  Class: 4.1  Packing group: III
- Proper shipping name: Paraformaldehyde

### 15. REGULATORY INFORMATION

**OSHA Hazards**
Flammable solid, Toxic by inhalation., Harmful by ingestion., Harmful by skin absorption., Skin and respiratory sensitiser

**SARA 302 Components**
SARA 302: No chemicals in this material are subject to the reporting requirements of SARA Title III, Section 302.

**SARA 313 Components**
SARA 313: This material does not contain any chemical components with known CAS numbers that exceed the threshold (De Minimis) reporting levels established by SARA Title III, Section 313.

**SARA 311/312 Hazards**
Fire Hazard, Acute Health Hazard

**Massachusetts Right To Know Components**

<table>
<thead>
<tr>
<th>Component</th>
<th>CAS-No.</th>
<th>Revision Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Paraformaldehyde-d2</td>
<td>32008-59-6</td>
<td>1993-04-24</td>
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</table>

**Pennsylvania Right To Know Components**

<table>
<thead>
<tr>
<th>Component</th>
<th>CAS-No.</th>
<th>Revision Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Paraformaldehyde-d2</td>
<td>32008-59-6</td>
<td>1993-04-24</td>
</tr>
</tbody>
</table>

**New Jersey Right To Know Components**

<table>
<thead>
<tr>
<th>Component</th>
<th>CAS-No.</th>
<th>Revision Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Paraformaldehyde-d2</td>
<td>32008-59-6</td>
<td>1993-04-24</td>
</tr>
</tbody>
</table>

**California Prop. 65 Components**
This product does not contain any chemicals known to State of California to cause cancer, birth defects, or any other reproductive harm.

### 16. OTHER INFORMATION

**Further information**
Copyright 2013 Sigma-Aldrich Co. LLC. License granted to make unlimited paper copies for internal use only.
The above information is believed to be correct but does not purport to be all inclusive and shall be used only as a guide. The information in this document is based on the present state of our knowledge and is applicable to the product with regard to appropriate safety precautions. It does not represent any guarantee of the properties of the product. Sigma-Aldrich Corporation and its Affiliates shall not be held liable for any damage resulting from handling or from contact with the above product. See www.sigma-aldrich.com and/or the reverse side of invoice or packing slip for additional terms and conditions of sale.
Material Safety Data Sheet
Sucrose MSDS

Section 1: Chemical Product and Company Identification

<table>
<thead>
<tr>
<th>Product Name: Sucrose</th>
<th>Contact Information:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Catalog Codes: SLS4048, SLS3253, SLS1036</td>
<td>Sciencelab.com, Inc.</td>
</tr>
<tr>
<td>CAS#: 57-50-1</td>
<td>14025 Smith Rd.</td>
</tr>
<tr>
<td>RTECS: WN6500000</td>
<td>Houston, Texas 77396</td>
</tr>
<tr>
<td>TSCA: TSCA 8(b) inventory: Sucrose</td>
<td>US Sales: 1-800-901-7247</td>
</tr>
<tr>
<td>CI#: Not available.</td>
<td>International Sales: 1-281-441-4400</td>
</tr>
<tr>
<td>Synonym: beta-D-Fructofuranosyl-alpha-D-glucopyranoside</td>
<td>CHEMTREC (24HR Emergency Telephone), call:</td>
</tr>
<tr>
<td>Chemical Name: Sucrose</td>
<td>1-800-424-9300</td>
</tr>
<tr>
<td>Chemical Formula: C12H22O11</td>
<td>International CHEMTREC, call: 1-703-527-3887</td>
</tr>
<tr>
<td></td>
<td>For non-emergency assistance, call: 1-281-441-4400</td>
</tr>
</tbody>
</table>

Section 2: Composition and Information on Ingredients

<table>
<thead>
<tr>
<th>Name</th>
<th>CAS #</th>
<th>% by Weight</th>
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<tbody>
<tr>
<td>Sucrose</td>
<td>57-50-1</td>
<td>100</td>
</tr>
</tbody>
</table>

Toxicological Data on Ingredients: Not applicable.

Section 3: Hazards Identification

Potential Acute Health Effects: Slightly hazardous in case of skin contact (irritant), of eye contact (irritant), of ingestion, of inhalation.

Potential Chronic Health Effects:
CARCINOGENIC EFFECTS: A4 (Not classifiable for human or animal.) by ACGIH. MUTAGENIC EFFECTS: Mutagenic for bacteria and/or yeast. TERATOGENIC EFFECTS: Not available. DEVELOPMENTAL TOXICITY: Not available. Repeated or prolonged exposure is not known to aggravate medical condition.

Section 4: First Aid Measures

Eye Contact:
Check for and remove any contact lenses. In case of contact, immediately flush eyes with plenty of water for at least 15 minutes. Cold water may be used. Get medical attention if irritation occurs.
Skin Contact: Wash with soap and water. Cover the irritated skin with an emollient. Get medical attention if irritation develops. Cold water may be used.

Serious Skin Contact: Not available.

Inhalation: If inhaled, remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Get medical attention.

Serious Inhalation: Not available.

Ingestion: Do NOT induce vomiting unless directed to do so by medical personnel. Never give anything by mouth to an unconscious person. Loosen tight clothing such as a collar, tie, belt or waistband. Get medical attention if symptoms appear.

Serious Ingestion: Not available.

Section 5: Fire and Explosion Data

Flammability of the Product: May be combustible at high temperature.

Auto-Ignition Temperature: Not available.

Flash Points: CLOSED CUP: Higher than 93.3°C (200°F).

Flammable Limits: Not available.

Products of Combustion: These products are carbon oxides (CO, CO2).

Fire Hazards in Presence of Various Substances: Slightly flammable to flammable in presence of heat.

Explosion Hazards in Presence of Various Substances:
- Risks of explosion of the product in presence of mechanical impact: Not available.
- Risks of explosion of the product in presence of static discharge: Not available.

Fire Fighting Media and Instructions:
- SMALL FIRE: Use DRY chemical powder. LARGE FIRE: Use water spray, fog or foam. Do not use water jet.

Special Remarks on Fire Hazards: Not available.

Special Remarks on Explosion Hazards: Not available.

Section 6: Accidental Release Measures

Small Spill: Use appropriate tools to put the spilled solid in a convenient waste disposal container. Finish cleaning by spreading water on the contaminated surface and dispose of according to local and regional authority requirements.

Large Spill: Use a shovel to put the material into a convenient waste disposal container. Finish cleaning by spreading water on the contaminated surface and allow to evacuate through the sanitary system. Be careful that the product is not present at a concentration level above TLV. Check TLV on the MSDS and with local authorities.

Section 7: Handling and Storage

Precautions: Keep locked up. Keep away from heat. Keep away from sources of ignition. Empty containers pose a fire risk, evaporate the residue under a fume hood. Ground all equipment containing material. Do not ingest. Do not breathe dust. Wear suitable protective clothing. If ingested, seek medical advice immediately and show the container or the label. Keep away from incompatibles such as oxidizing agents, acids.
**Section 8: Exposure Controls/Personal Protection**

**Engineering Controls:**
Use process enclosures, local exhaust ventilation, or other engineering controls to keep airborne levels below recommended exposure limits. If user operations generate dust, fume or mist, use ventilation to keep exposure to airborne contaminants below the exposure limit.

**Personal Protection:**
Safety glasses. Lab coat. Vapor and dust respirator. Be sure to use an approved/certified respirator or equivalent. Gloves. Suggested protective clothing might not be sufficient; consult a specialist BEFORE handling this product.

**Personal Protection in Case of a Large Spill:**
Splash goggles. Full suit. Vapor and dust respirator. Boots. Gloves. A self contained breathing apparatus should be used to avoid inhalation of the product. Suggested protective clothing might not be sufficient; consult a specialist BEFORE handling this product.

**Exposure Limits:**
TWA: 15 (mg/m³) from OSHA (PEL) [United States] Inhalation Total. TWA: 10 (mg/m³) from ACGIH (TLV) [United States] [1999] Inhalation Total. TWA: 10 (mg/m³) from NIOSH Inhalation Total. TWA: 5 (mg/m³) from NIOSH Inhalation Respirable. TWA: 5 (mg/m³) from OSHA (PEL) [United States] Inhalation Respirable.3 Consult local authorities for acceptable exposure limits.

**Section 9: Physical and Chemical Properties**

**Physical state and appearance:** Solid. (Crystalline granules solid.)

**Odor:** Characteristic Carmel to Odorless.

**Taste:** Sweet.

**Molecular Weight:** 342.3 g/mole

**Color:** White.

**pH (1% soln/water):** Not available.

**Boiling Point:** Not available.

**Melting Point:** 186°C (366.8°F)

**Critical Temperature:** Not available.

**Specific Gravity:** 1.587 (Water = 1)

**Vapor Pressure:** Not applicable.

**Vapor Density:** Not available.

**Volatility:** Not available.

**Odor Threshold:** Not available.

**Water/Oil Dist. Coeff.:** The product is more soluble in water; log(oil/water) = -3.7

**Ionicity (in Water):** Not available.

**Dispersion Properties:** See solubility in water, methanol.

**Solubility:**
Easily soluble in cold water. Partially soluble in methanol. Insoluble in diethyl ether.

**Section 10: Stability and Reactivity Data**
Stability: The product is stable.

Instability Temperature: Not available.

Conditions of Instability: Excess heat, incompatible materials

Incompatibility with various substances: Reactive with oxidizing agents, acids.

Corrosivity: Not available.

Special Remarks on Reactivity: Reactive with sulfuric acid, nitric acid, and oxidizers.

Special Remarks on Corrosivity: Not available.

Polymerization: Will not occur.

---

Section 11: Toxicological Information

Routes of Entry: Inhalation. Ingestion.

Toxicity to Animals: Acute oral toxicity (LD50): 29700 mg/kg [Rat].

Chronic Effects on Humans:
CARCINOGENIC EFFECTS: A4 (Not classifiable for human or animal.) by ACGIH. MUTAGENIC EFFECTS: Mutagenic for bacteria and/or yeast.

Other Toxic Effects on Humans: Slightly hazardous in case of skin contact (irritant), of ingestion, of inhalation.

Special Remarks on Toxicity to Animals: Not available.

Special Remarks on Chronic Effects on Humans:
No adverse reproductive affects have been found in humans. However at extremely high oral doses of 683,000 mg/kg given to rats during pregnancy showed some effects on newborn (growth, developmental anomalies of central nervous system). Passes through the placental barrier in human.

Special Remarks on other Toxic Effects on Humans:
Acute Potential Health Effects: Skin: May cause skin irritation. Low hazard for usual industrial handling. Eyes: Dust may cause mechanical irritation. Inhalation: Excessive inhalation may cause minor respiratory irritation. Ingestion: Ingestion of large amounts may cause gastrointestinal (digestive) tract irritation. Expected to be a low ingestion hazard. Chronic Potential Health Effects: no information.

Section 12: Ecological Information

Ecotoxicity: Not available.

BOD5 and COD: Not available.

Products of Biodegradation:
Possibly hazardous short term degradation products are not likely. However, long term degradation products may arise.

Toxicity of the Products of Biodegradation: The product itself and its products of degradation are not toxic.

Special Remarks on the Products of Biodegradation: Not available.

Section 13: Disposal Considerations

Waste Disposal:
Waste must be disposed of in accordance with federal, state and local environmental control regulations.

Section 14: Transport Information
DOT Classification: Not a DOT controlled material (United States).

Identification: Not applicable.

Special Provisions for Transport: Not applicable.

### Section 15: Other Regulatory Information

**Federal and State Regulations:**
Rhode Island RTK hazardous substances: Sucrose Pennsylvania RTK: Sucrose Minnesota: Sucrose Massachusetts RTK:
Sucrose Tennessee: Sucrose TSCA 8(b) inventory: Sucrose

**Other Regulations:** EINECS: This product is on the European Inventory of Existing Commercial Chemical Substances.

**Other Classifications:**

WHMIS (Canada): Not controlled under WHMIS (Canada).

DSCL (EEC):
This product is not classified according to the EU regulations. S24/25- Avoid contact with skin and eyes.

HMIS (U.S.A.):

- Health Hazard: 1
- Fire Hazard: 1
- Reactivity: 0
- Personal Protection: X

National Fire Protection Association (U.S.A.):

- Health: 1
- Flammability: 1
- Reactivity: 0
- Specific hazard:

Protective Equipment:
Gloves. Lab coat. Vapor and dust respirator. Be sure to use an approved/certified respirator or equivalent. Safety glasses.

### Section 16: Other Information

**References:** Not available.

**Other Special Considerations:** Not available.

**Created:** 10/10/2005 08:28 PM

**Last Updated:** 05/21/2013 12:00 PM

The information above is believed to be accurate and represents the best information currently available to us. However, we make no warranty of merchantability or any other warranty, express or implied, with respect to such information, and we assume no liability resulting from its use. Users should make their own investigations to determine the suitability of the information for their particular purposes. In no event shall ScienceLab.com be liable for any claims, losses, or damages of any third party or for lost profits or any special, indirect, incidental, consequential or exemplary damages, howsoever arising, even if ScienceLab.com has been advised of the possibility of such damages.
1. PRODUCT AND COMPANY IDENTIFICATION

1.1 Product identifiers

Product name: Triton™ X-100
Product Number: X100
Brand: Sigma-Aldrich
REACH No.: A registration number is not available for this substance as the substance or its uses are exempted from registration, the annual tonnage does not require a registration or the registration is envisaged for a later registration deadline.
CAS-No.: 9002-93-1

1.2 Relevant identified uses of the substance or mixture and uses advised against

Identified uses: Laboratory chemicals, Manufacture of substances

1.3 Details of the supplier of the safety data sheet

Company: Sigma-Aldrich
3050 Spruce Street
SAINT LOUIS MO  63103
USA
Telephone: +1 800-325-5832
Fax: +1 800-325-5052

1.4 Emergency telephone number

Emergency Phone #: (314) 776-6555

2. HAZARDS IDENTIFICATION

2.1 Classification of the substance or mixture

GHS Classification in accordance with 29 CFR 1910 (OSHA HCS)
Acute toxicity, Oral (Category 4), H302
Eye irritation (Category 2A), H319
Acute aquatic toxicity (Category 2), H401
Chronic aquatic toxicity (Category 2), H411

For the full text of the H-Statements mentioned in this Section, see Section 16.

2.2 GHS Label elements, including precautionary statements

Pictogram

Signal word: Warning

Hazard statement(s)
H302: Harmful if swallowed.
H319: Causes serious eye irritation.
H411: Toxic to aquatic life with long lasting effects.

Precautionary statement(s)
P264: Wash skin thoroughly after handling.
P270: Do not eat, drink or smoke when using this product.
P273: Avoid release to the environment.
P280: Wear protective gloves/ eye protection/ face protection.
IF SWALLOWED: Call a POISON CENTER or doctor/physician if you feel unwell.

IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing.

Rinse mouth.

If eye irritation persists: Get medical advice/attention.

If swallowed: Never give anything by mouth to an unconscious person. Rinse mouth.

Dispose of contents/container to an approved waste disposal plant.

2.3 Hazards not otherwise classified (HNOC) or not covered by GHS - none

3. COMPOSITION/INFORMATION ON INGREDIENTS

3.1 Substances

**Synonyms:**
- t-Octylphenoxy polyethoxyethanol
- 4-(1,1,3,3-Tetramethylbutyl)phenyl-polyethylene glycol
- Polyethylene glycol tert-octylphenyl ether

**Formula:** \((C_2H_4O)_nC_{14}H_{22}O\)

**CAS-No.:** 9002-93-1

**Hazardous components**

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<thead>
<tr>
<th>Component</th>
<th>Classification</th>
<th>Concentration</th>
</tr>
</thead>
<tbody>
<tr>
<td>p-tertiary-Octylphenoxy polyethyl alcohol</td>
<td>Included in the Candidate List of Substances of Very High Concern (SVHC) according to Regulation (EC) No. 1907/2006 (REACH)</td>
<td>90 - 100 %</td>
</tr>
<tr>
<td></td>
<td>Acute Tox. 4; Eye Irrit. 2A; Aquatic Acute 2; Aquatic Chronic 2; H302, H319, H411</td>
<td></td>
</tr>
</tbody>
</table>

For the full text of the H-Statements mentioned in this Section, see Section 16.

4. FIRST AID MEASURES

4.1 Description of first aid measures

**General advice**
Consult a physician. Show this safety data sheet to the doctor in attendance. Move out of dangerous area.

**If inhaled**
If breathed in, move person into fresh air. If not breathing, give artificial respiration. Consult a physician.

**In case of skin contact**
Wash off with soap and plenty of water. Consult a physician.

**In case of eye contact**
Rinse thoroughly with plenty of water for at least 15 minutes and consult a physician.

**If swallowed**
Never give anything by mouth to an unconscious person. Rinse mouth with water. Consult a physician.

4.2 Most important symptoms and effects, both acute and delayed
The most important known symptoms and effects are described in the labelling (see section 2.2) and/or in section 11

4.3 Indication of any immediate medical attention and special treatment needed
No data available

5. FIREFIGHTING MEASURES

5.1 Extinguishing media

**Suitable extinguishing media**
Use water spray, alcohol-resistant foam, dry chemical or carbon dioxide.
5.2 Special hazards arising from the substance or mixture
Carbon oxides

5.3 Advice for firefighters
Wear self contained breathing apparatus for fire fighting if necessary.

5.4 Further information
no data available

6. ACCIDENTAL RELEASE MEASURES

6.1 Personal precautions, protective equipment and emergency procedures
Use personal protective equipment. Avoid breathing vapours, mist or gas. Ensure adequate ventilation.
For personal protection see section 8.

6.2 Environmental precautions
Prevent further leakage or spillage if safe to do so. Do not let product enter drains. Discharge into the environment must be avoided.

6.3 Methods and materials for containment and cleaning up
Soak up with inert absorbent material and dispose of as hazardous waste. Keep in suitable, closed containers for disposal.

6.4 Reference to other sections
For disposal see section 13.

7. HANDLING AND STORAGE

7.1 Precautions for safe handling
Avoid contact with skin and eyes. Avoid inhalation of vapour or mist.
For precautions see section 2.2.

7.2 Conditions for safe storage, including any incompatibilities
Keep container tightly closed in a dry and well-ventilated place. Containers which are opened must be carefully resealed and kept upright to prevent leakage.
Packaged under inert gas.

7.3 Specific end use(s)
Apart from the uses mentioned in section 1.2 no other specific uses are stipulated

8. EXPOSURE CONTROLS/PERSONAL PROTECTION

8.1 Control parameters
Components with workplace control parameters
Contains no substances with occupational exposure limit values.

8.2 Exposure controls
Appropriate engineering controls
Handle in accordance with good industrial hygiene and safety practice. Wash hands before breaks and at the end of workday.

Personal protective equipment

Eye/face protection
Face shield and safety glasses Use equipment for eye protection tested and approved under appropriate government standards such as NIOSH (US) or EN 166(EU).

Skin protection
Handle with gloves. Gloves must be inspected prior to use. Use proper glove removal technique (without touching glove's outer surface) to avoid skin contact with this product. Dispose of contaminated gloves after use in accordance with applicable laws and good laboratory practices. Wash and dry hands.

Full contact
Material: Nitrile rubber
Minimum layer thickness: 0.11 mm
Break through time: 480 min
Material tested: Dermatril® (KCL 740 / Aldrich Z677272, Size M)
Splash contact
Material: Nitrile rubber
Minimum layer thickness: 0.11 mm
Break through time: 480 min
Material tested: Dermatril® (KCL 740 / Aldrich Z677272, Size M)

Data source: KCL GmbH, D-36124 Eichenzell, phone +49 (0)6659 87300, e-mail sales@kcl.de, test method: EN374
If used in solution, or mixed with other substances, and under conditions which differ from EN 374, contact the supplier of the CE approved gloves. This recommendation is advisory only and must be evaluated by an industrial hygienist and safety officer familiar with the specific situation of anticipated use by our customers. It should not be construed as offering an approval for any specific use scenario.

**Body Protection**

Complete suit protecting against chemicals. The type of protective equipment must be selected according to the concentration and amount of the dangerous substance at the specific workplace.

**Respiratory protection**

Where risk assessment shows air-purifying respirators are appropriate use a full-face respirator with multi-purpose combination (US) or type ABEK (EN 14387) respirator cartridges as a backup to engineering controls. If the respirator is the sole means of protection, use a full-face supplied air respirator. Use respirators and components tested and approved under appropriate government standards such as NIOSH (US) or CEN (EU).

**Control of environmental exposure**

Prevent further leakage or spillage if safe to do so. Do not let product enter drains. Discharge into the environment must be avoided.

### 9. PHYSICAL AND CHEMICAL PROPERTIES

#### 9.1 Information on basic physical and chemical properties

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>a) Appearance</td>
<td>Form: liquid, clear</td>
</tr>
<tr>
<td></td>
<td>Colour: light yellow</td>
</tr>
<tr>
<td>b) Odour</td>
<td>no data available</td>
</tr>
<tr>
<td>c) Odour Threshold</td>
<td>no data available</td>
</tr>
<tr>
<td>d) pH</td>
<td>9.7</td>
</tr>
<tr>
<td>e) Melting point/freezing point</td>
<td>6 °C (43 °F)</td>
</tr>
<tr>
<td>f) Initial boiling point and boiling range</td>
<td>&gt; 200 °C (&gt; 392 °F)</td>
</tr>
<tr>
<td>g) Flash point</td>
<td>251 °C (484 °F) - closed cup</td>
</tr>
<tr>
<td>h) Evaporation rate</td>
<td>no data available</td>
</tr>
<tr>
<td>i) Flammability (solid, gas)</td>
<td>no data available</td>
</tr>
<tr>
<td>j) Upper/lower flammability or explosive limits</td>
<td>no data available</td>
</tr>
<tr>
<td>k) Vapour pressure</td>
<td>&lt; 1.33 hPa (&lt; 1.00 mmHg) at 20 °C (68 °F)</td>
</tr>
<tr>
<td>l) Vapour density</td>
<td>no data available</td>
</tr>
<tr>
<td>m) Relative density</td>
<td>1.0700 g/cm³</td>
</tr>
<tr>
<td>n) Water solubility</td>
<td>soluble</td>
</tr>
<tr>
<td>o) Partition coefficient: n-octanol/water</td>
<td>no data available</td>
</tr>
<tr>
<td>p) Auto-ignition temperature</td>
<td>no data available</td>
</tr>
<tr>
<td>q) Decomposition</td>
<td>no data available</td>
</tr>
</tbody>
</table>
9.2 Other safety information
no data available

10. STABILITY AND REACTIVITY
10.1 Reactivity
no data available

10.2 Chemical stability
Stable under recommended storage conditions.

10.3 Possibility of hazardous reactions
no data available

10.4 Conditions to avoid
no data available

10.5 Incompatible materials
Strong acids, Strong bases, Strong oxidizing agents

10.6 Hazardous decomposition products
Other decomposition products - no data available
In the event of fire: see section 5

11. TOXICOLOGICAL INFORMATION
11.1 Information on toxicological effects

Acute toxicity
LD50 Oral - rat - 1,800 mg/kg
Inhalation: no data available
LD50 Dermal - rabbit - 8,000 mg/kg
no data available

Skin corrosion/irritation
no data available

Serious eye damage/eye irritation
Eyes - rabbit
Result: Moderate eye irritation - 24 h

Respiratory or skin sensitisation
no data available

Germ cell mutagenicity
no data available

Carcinogenicity
IARC: No component of this product present at levels greater than or equal to 0.1% is identified as probable, possible or confirmed human carcinogen by IARC.
ACGIH: No component of this product present at levels greater than or equal to 0.1% is identified as a carcinogen or potential carcinogen by ACGIH.
NTP: No component of this product present at levels greater than or equal to 0.1% is identified as a known or anticipated carcinogen by NTP.
OSHA: No component of this product present at levels greater than or equal to 0.1% is identified as a carcinogen or potential carcinogen by OSHA.
**Reproductive toxicity**
no data available

**Specific target organ toxicity - single exposure**
no data available

**Specific target organ toxicity - repeated exposure**
no data available

**Aspiration hazard**
no data available

**Additional Information**
RTECS: MD0907700
To the best of our knowledge, the chemical, physical, and toxicological properties have not been thoroughly investigated.

### 12. ECOLOGICAL INFORMATION

#### 12.1 Toxicity

**Toxicity to fish**
LC50 - *Pimephales promelas* (fathead minnow) - 8.9 mg/l - 96.0 h

**Toxicity to daphnia and other aquatic invertebrates**
EC50 - Daphnia - 26 mg/l - 48 h

#### 12.2 Persistence and degradability

**Biodegradability**
Biotic/Aerobic Biochemical oxygen demand - Exposure time 28 d
Result: 36 % - Not readily biodegradable.
(Closed Bottle test)

**Chemical Oxygen Demand (COD)**
2.19 mg/g

#### 12.3 Bioaccumulative potential
no data available

#### 12.4 Mobility in soil
no data available

#### 12.5 Results of PBT and vPvB assessment

PBT/vPvB assessment not available as chemical safety assessment not required/not conducted

#### 12.6 Other adverse effects

An environmental hazard cannot be excluded in the event of unprofessional handling or disposal.
Toxic to aquatic life with long lasting effects.

### 13. DISPOSAL CONSIDERATIONS

#### 13.1 Waste treatment methods

**Product**
Offer surplus and non-recyclable solutions to a licensed disposal company. Contact a licensed professional waste disposal service to dispose of this material.

**Contaminated packaging**
Dispose of as unused product.

### 14. TRANSPORT INFORMATION

**DOT (US)**
UN number: 3082  
Class: 9  
Packing group: III

Proper shipping name: Environmentally hazardous substance, liquid, n.o.s. (p-tertiary-Octylphenoxy polyethyl alcohol)
Reportable Quantity (RQ):
Marine pollutant: Marine pollutant
Poison Inhalation Hazard: No

IMDG
UN number: 3082  Class: 9  Packing group: III  EMS-No: F-A, S-F
Proper shipping name: ENVIRONMENTALLY HAZARDOUS SUBSTANCE, LIQUID, N.O.S. (p-tertiary-Octylphenoxy polyethyl alcohol)
Marine pollutant: No

IATA
UN number: 3082  Class: 9  Packing group: III
Proper shipping name: Environmentally hazardous substance, liquid, n.o.s. (p-tertiary-Octylphenoxy polyethyl alcohol)

15. REGULATORY INFORMATION

REACH No. : A registration number is not available for this substance as the substance or its uses are exempted from registration, the annual tonnage does not require a registration or the registration is envisaged for a later registration deadline.

SARA 302 Components
SARA 302: No chemicals in this material are subject to the reporting requirements of SARA Title III, Section 302.

SARA 313 Components
SARA 313: This material does not contain any chemical components with known CAS numbers that exceed the threshold (De Minimis) reporting levels established by SARA Title III, Section 313.

SARA 311/312 Hazards
Acute Health Hazard
Massachusetts Right To Know Components
No components are subject to the Massachusetts Right to Know Act.

Pennsylvania Right To Know Components
<table>
<thead>
<tr>
<th>Component</th>
<th>CAS-No.</th>
<th>Revision Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>p-tertiary-Octylphenoxy polyethyl alcohol</td>
<td>9002-93-1</td>
<td></td>
</tr>
</tbody>
</table>

New Jersey Right To Know Components
<table>
<thead>
<tr>
<th>Component</th>
<th>CAS-No.</th>
<th>Revision Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>p-tertiary-Octylphenoxy polyethyl alcohol</td>
<td>9002-93-1</td>
<td></td>
</tr>
</tbody>
</table>

California Prop. 65 Components
This product does not contain any chemicals known to State of California to cause cancer, birth defects, or any other reproductive harm.

16. OTHER INFORMATION

Full text of H-Statements referred to under sections 2 and 3.

Acute Tox. : Acute toxicity
Aquatic Acute : Acute aquatic toxicity
Aquatic Chronic : Chronic aquatic toxicity
Eye Irrit. : Eye irritation
H302 : Harmful if swallowed.
H319 : Causes serious eye irritation.
H401 : Toxic to aquatic life.

HMIS Rating
Health hazard: 2
Chronic Health Hazard: 1
Flammability: 1
Physical Hazard 0

NFPA Rating
Health hazard: 2
Fire Hazard: 1
Reactivity Hazard: 0
Further information
Copyright 2014 Sigma-Aldrich Co. LLC. License granted to make unlimited paper copies for internal use only. The above information is believed to be correct but does not purport to be all inclusive and shall be used only as a guide. The information in this document is based on the present state of our knowledge and is applicable to the product with regard to appropriate safety precautions. It does not represent any guarantee of the properties of the product. Sigma-Aldrich Corporation and its Affiliates shall not be held liable for any damage resulting from handling or from contact with the above product. See www.sigma-aldrich.com and/or the reverse side of invoice or packing slip for additional terms and conditions of sale.

Preparation Information
Sigma-Aldrich Corporation
Product Safety – Americas Region
1-800-521-8956

Version: 4.13  Revision Date: 02/21/2014  Print Date: 04/03/2014
Material Safety Data Sheet

Trypsin-EDTA  
Cat. No: 07901

1 Product and Company Identification

1.1 Product Name: Trypsin-EDTA
1.2 Catalogue Number: 07901
1.3 Synonyms: Not Available
1.4 Product Use: Cell Culture
1.5 Manufacturer/Supplier: STEMCELL Technologies Inc.  
Suite 400, 570 West 7th Avenue  
Vancouver, BC  V5Z 1B3  
Canada
1.6 In Case of Emergency Call: 604-877-0713
1.7 Date Prepared: December 14, 2011
1.8 Prepared By: Quality Control

2 Composition / Information on Ingredients

2.1 Component  
CAS No.  
%W/W
Trypsin  
9002-07-7  
0.25
EDTA Tetrasodium Salt Dihydrate  
10378-23-1  
.038

3 Hazards Identification

3.1 Emergency Overview: This product is a potential irritant to eyes, respiratory system, and skin. This product may also be harmful if ingested. Complete toxicological properties have yet to be determined.

3.2 Routes of Exposure: Absorbed through skin, eye contact, inhalation, and ingestion.

3.3 Potential Health Effects:

3.3.1 Eye: May cause eye irritation.
3.3.2 Skin: May cause skin irritation.
3.3.3 Inhalation: May be harmful if inhaled. Material may be irritating to mucous membranes and upper respiratory tract. Targets lungs.
3.3.4 Ingestion: May be harmful if swallowed.

3.4 Chronic Effects/Carcinogenicity: Not Available
3.5 OSHA Regulatory Status: Not Available

4 First Aid Measures

4.1 Eyes: In case of contact with eyes, flush thoroughly with water for at least 15 minutes. Assure adequate flushing by separating eyelids. Check for and remove contact lenses. Call a physician if symptoms develop (redness, itching, etc.).

4.2 Skin: In case of contact with skin, wash the affected area with soap and copious amounts of water. Remove contaminated clothing and wash before reuse. Should irritation occur, contact a physician.
4.3 Ingestion: If swallowed, wash out mouth with water provided person is conscious. Call a physician.
4.4 Inhalation: If inhaled, remove person to fresh air. If breathing becomes difficult, call a physician.
4.5 Puncture Wounds: Wash thoroughly with soap and water. Allow to bleed freely. Call a physician.
4.6 Note to Physician: Treat symptomatically.

5 Fire Fighting Measures
5.1 Flash Point/Method: Not Available
5.2 Explosive Limits:
   5.2.1 Upper: Not Available
   5.2.2 Lower: Not Available
5.3 Autoignition Temperature: Not Available
5.4 Hazardous Combustion Products: Not Available
5.5 Conditions of Flammability: Not Available
5.6 Extinguishing Media: Use extinguishing media appropriate to surrounding fire conditions.
5.7 Fire Fighting Procedures: Wear self-contained breathing apparatus and protective clothing to avoid contact with skin and eyes.
5.8 Explosion Data:
   5.8.1 Sensitivity to Mechanical Impact: Not Available
   5.8.2 Sensitivity to Static Discharge: Not Available

6 Accidental Release Measures
6.1 Leak and Spill Procedure: Wear self-contained breathing apparatus, chemical-resistant gloves and rubber boots. Absorb spill on sand or vermiculate and place in closed container for disposal. Ventilate and wash area thoroughly after clean-up is complete.

7 Handling and Storage
7.1 Handling: Should be handled by trained personnel observing good laboratory practices. Avoid breathing vapor. Avoid skin contact or swallowing. May cause allergic reaction in sensitized individuals.
7.2 Storage: Store at -20°C. Keep tightly closed.

8 Exposure Controls/Personal Protection
8.1 Engineering Controls: Use with adequate ventilation, safety shower, eye bath.
8.2 Personal Protective Equipment:
   8.2.1 Respiratory Protection: No respiratory protection needed under normal industrial operating conditions.
8.2.2 Eye Protection: Safety glasses.
8.2.3 Skin Protection: Lab coat, latex gloves.
8.3 General Hygiene Considerations: Wash hands after use.
8.4 Exposure Limits:
8.4.1 ACGIH TLV-TWA: Not Available
8.4.2 OSHA PEL-TWA: Not Available

9 Physical/Chemical Properties:
9.1 Appearance: Red liquid
9.2 Odor: None
9.3 Physical State: Liquid
9.4 pH: Approximately 7.2 – 7.4
9.5 Boiling Point: Not Available
9.6 Melting Point: Not Available
9.7 Freezing Point: Not Available
9.8 Vapor Pressure: Not Available
9.9 Vapor Density: Not Available
9.10 Specific Gravity: Not Available
9.11 Evaporation Rate: Not Available
9.12 Solubility in Water: Not Available
9.13 Odor Threshold: Not Applicable
9.14 Coefficient of Water/Oil Distribution: Not Available

10 Stability/Reactivity:
10.1 Chemical Stability: Stable
10.2 Conditions to Avoid: Not Available
10.3 Incompatibility (Material to Avoid): Strong oxidizing agents.
10.4 Hazardous Decomposition/By-Products: Not Available
10.5 Hazardous Polymerization: Not Available

11 Toxicological Information
11.1 Effects of Short-Term Exposure: EDTA RTECS #: AH4410000
Trypsin RTECS #: YN5075000
11.2 Effects of Long-Term Exposure: Not Available
11.3 Irritancy of Product: Not Available
11.4 Sensitization to Product: Not Available
Material Safety Data Sheet

Trypsin-EDTA
Cat. No: 07901

11.5 Carcinogenicity: Not Available
11.6 Reproductive Toxicity: Not Available
11.7 Teratogenicity and Embryotoxicity: Not Available
11.8 Mutagenicity: Not Available
11.9 Name of Toxicologically Synergistic Products: Not Available
11.10 LD50 (specify species and route):
   - Rat (Oral): >5 g/kg
   - Rat (IPR): >51 mg/kg
   - Rat (IVN): 36 mg/kg
   - Rat (IMS): 200 mg/kg
   - Mouse (Oral): 1450 mg/kg
   - Mouse (IPR): 100 mg/kg
   - Mouse (IVN): 11100 ug/kg
   - Mouse (IMS): 105 mg/kg
   - Rabbit (IVN): 2200 ug/kg
11.11 LC50 (specify species): Not Available

12 Ecological Information
12.1 Not Available. Bioconcentration not expected to occur.

13 Disposal Considerations
13.1 Waste Disposal Method: Dissolve or mix material with a combustible solvent and burn in a chemical incinerator with an afterburner and scrubber. Disposal should be in accordance with existing practices at your institution. Observe all Federal, Provincial/State and Local Laws.

14 Transport Information
14.1 Transport Canada
   14.1.1 PIN No.: Not Available
14.2 U.S. Department of Transportation:
   14.2.1 Proper Shipping Name: None
   14.2.2 Hazard Class: This substance not known to be hazardous for transport.
   14.2.3 ID. Number: Not Available
   14.2.4 Packing Group: Not Available
   14.2.5 Label Statement: Not Available

15 Regulatory Information
15.1 WHMIS Classification: Not Available
15.2 Note: This MSDS was prepared according to the Canadian Controlled Products Regulation and contains all the information required by those regulations.
16 Other Information

16.1 Preparation Information: Refer to PIS No. 07901.

16.2 This MSDS has been revised in the following section(s): 9.4

16.3 Original Issue Date: October 1, 2001.

16.4 Notice: The above information is believed to be correct but does not purport to be all inclusive and shall be used only as a guide. StemCell Technologies Inc., shall not be held liable for any damage resulting from handling or from contact with the product. The information contained in this Material Safety Data Sheet (MSDS) is current as of the Date Prepared shown in Section 1.7 of this document and may be subject to amendment by StemCell Technologies Inc.

16.5 Disclaimer: THIS PRODUCT IS FOR RESEARCH USE ONLY. NOT USED FOR DIAGNOSTIC OR THERAPEUTIC APPLICATIONS.
# 1. PRODUCT AND COMPANY IDENTIFICATION

<table>
<thead>
<tr>
<th>Product name</th>
<th>Lectin from <em>Ulex europaeus</em> (Gorse, Furze) UEA I + UEA II</th>
</tr>
</thead>
<tbody>
<tr>
<td>Product Number</td>
<td>L6762</td>
</tr>
<tr>
<td>Brand</td>
<td>Sigma</td>
</tr>
<tr>
<td>Supplier</td>
<td>Sigma-Aldrich</td>
</tr>
<tr>
<td>Telephone</td>
<td>+1 800-325-5832</td>
</tr>
<tr>
<td>Fax</td>
<td>+1 800-325-5052</td>
</tr>
<tr>
<td>Emergency Phone # (For both supplier and manufacturer)</td>
<td>(314) 776-6555</td>
</tr>
<tr>
<td>Preparation Information</td>
<td>Sigma-Aldrich Corporation</td>
</tr>
<tr>
<td>Telephone</td>
<td>1-800-521-8956</td>
</tr>
</tbody>
</table>

# 2. HAZARDS IDENTIFICATION

## Emergency Overview

**OSHA Hazards**
- Target Organ Effect

**Target Organs**
- Agglutinates human red blood cells.
- Not a dangerous substance according to GHS.

**HMIS Classification**
- Health hazard: 0
- Chronic Health Hazard: *
- Flammability: 0
- Physical hazards: 0

**NFPA Rating**
- Health hazard: 0
- Fire: 0
- Reactivity Hazard: 0

**Potential Health Effects**
- **Inhalation**
  May be harmful if inhaled. May cause respiratory tract irritation.
- **Skin**
  May be harmful if absorbed through skin. May cause skin irritation.
- **Eyes**
  May cause eye irritation.
- **Ingestion**
  May be harmful if swallowed.

# 3. COMPOSITION/INFORMATION ON INGREDIENTS

<table>
<thead>
<tr>
<th>Component</th>
<th>Concentration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lectin from <em>Ulex europaeus</em> (Gorse, Furze) UEA I + UEA II</td>
<td>-</td>
</tr>
</tbody>
</table>
4. FIRST AID MEASURES

General advice
Move out of dangerous area.

If inhaled
If breathed in, move person into fresh air. If not breathing, give artificial respiration.

In case of skin contact
Wash off with soap and plenty of water.

In case of eye contact
Flush eyes with water as a precaution.

If swallowed
Never give anything by mouth to an unconscious person. Rinse mouth with water.

5. FIREFIGHTING MEASURES

Conditions of flammability
Not flammable or combustible.

Suitable extinguishing media
Use water spray, alcohol-resistant foam, dry chemical or carbon dioxide.

Special protective equipment for firefighters
Wear self contained breathing apparatus for fire fighting if necessary.

Hazardous combustion products
Hazardous decomposition products formed under fire conditions. Nature of decomposition products not known.

6. ACCIDENTAL RELEASE MEASURES

Personal precautions
Avoid dust formation. Avoid breathing vapors, mist or gas.

Environmental precautions
Do not let product enter drains.

Methods and materials for containment and cleaning up
Sweep up and shovel. Keep in suitable, closed containers for disposal.

7. HANDLING AND STORAGE

Precautions for safe handling
Provide appropriate exhaust ventilation at places where dust is formed.

Conditions for safe storage
Keep container tightly closed in a dry and well-ventilated place.

Keep in a dry place. Keep in a dry place.

8. EXPOSURE CONTROLS/PERSONAL PROTECTION

Contains no substances with occupational exposure limit values.

Personal protective equipment

Respiratory protection
Respiratory protection is not required. Where protection from nuisance levels of dusts are desired, use type N95 (US) or type P1 (EN 143) dust masks. Use respirators and components tested and approved under appropriate government standards such as NIOSH (US) or CEN (EU).

Hand protection
Handle with gloves. Gloves must be inspected prior to use. Use proper glove removal technique (without touching glove’s outer surface) to avoid skin contact with this product. Dispose of contaminated gloves after use in accordance with applicable laws and good laboratory practices. Wash and dry hands.
Eye protection
Use equipment for eye protection tested and approved under appropriate government standards such as NIOSH (US) or EN 166(EU).

Skin and body protection
Choose body protection in relation to its type, to the concentration and amount of dangerous substances, and to the specific work-place. The type of protective equipment must be selected according to the concentration and amount of the dangerous substance at the specific workplace.

Hygiene measures
General industrial hygiene practice.

9. PHYSICAL AND CHEMICAL PROPERTIES

Appearance
Form powder, lyophilized
Colour no data available

Safety data
pH no data available
Melting point/freezing point no data available
Boiling point no data available
Flash point no data available
Ignition temperature no data available
Autoignition temperature no data available
Lower explosion limit no data available
Upper explosion limit no data available
Vapour pressure no data available
Density no data available
Water solubility no data available
Partition coefficient: n-octanol/water no data available
Relative vapour density no data available
Odour no data available
Odour Threshold no data available
Evaporation rate no data available

10. STABILITY AND REACTIVITY

Chemical stability
Stable under recommended storage conditions.

Possibility of hazardous reactions
no data available

Conditions to avoid
no data available

Materials to avoid
no data available
Hazardous decomposition products
Hazardous decomposition products formed under fire conditions. - Nature of decomposition products not known. Other decomposition products - no data available

11. TOXICOLOGICAL INFORMATION

Acute toxicity

Oral LD50
no data available

Inhalation LC50
no data available

Dermal LD50
no data available

Other information on acute toxicity
no data available

Skin corrosion/irritation
no data available

Serious eye damage/eye irritation
no data available

Respiratory or skin sensitization
no data available

Germ cell mutagenicity
no data available

Carcinogenicity

IARC: No component of this product present at levels greater than or equal to 0.1% is identified as probable, possible or confirmed human carcinogen by IARC.

ACGIH: No component of this product present at levels greater than or equal to 0.1% is identified as a carcinogen or potential carcinogen by ACGIH.

NTP: No component of this product present at levels greater than or equal to 0.1% is identified as a known or anticipated carcinogen by NTP.

OSHA: No component of this product present at levels greater than or equal to 0.1% is identified as a carcinogen or potential carcinogen by OSHA.

Reproductive toxicity

no data available

Teratogenicity

no data available

Specific target organ toxicity - single exposure (Globally Harmonized System)
no data available

Specific target organ toxicity - repeated exposure (Globally Harmonized System)
no data available

Aspiration hazard
no data available

Potential health effects

Inhalation May be harmful if inhaled. May cause respiratory tract irritation.

Ingestion May be harmful if swallowed.

Skin May be harmful if absorbed through skin. May cause skin irritation.
Eyes
May cause eye irritation.

Signs and Symptoms of Exposure
Agglutinates human red blood cells.

Synergistic effects
no data available

Additional Information
RTECS: Not available

12. ECOLOGICAL INFORMATION

Toxicity
no data available

Persistence and degradability
no data available

Bioaccumulative potential
no data available

Mobility in soil
no data available

PBT and vPvB assessment
no data available

Other adverse effects
no data available

13. DISPOSAL CONSIDERATIONS

Product
Offer surplus and non-recyclable solutions to a licensed disposal company.

Contaminated packaging
Dispose of as unused product.

14. TRANSPORT INFORMATION

DOT (US)
Not dangerous goods

IMDG
Not dangerous goods

IATA
Not dangerous goods

15. REGULATORY INFORMATION

OSHA Hazards
Target Organ Effect

SARA 302 Components
SARA 302: No chemicals in this material are subject to the reporting requirements of SARA Title III, Section 302.

SARA 313 Components
SARA 313: This material does not contain any chemical components with known CAS numbers that exceed the threshold (De Minimis) reporting levels established by SARA Title III, Section 313.

SARA 311/312 Hazards
Chronic Health Hazard

Massachusetts Right To Know Components
No components are subject to the Massachusetts Right to Know Act.
Pennsylvania Right To Know Components

Lectin from Ulex europaeus (Gorse, Furze) UEA I + UEA II

New Jersey Right To Know Components

Lectin from Ulex europaeus (Gorse, Furze) UEA I + UEA II

California Prop. 65 Components
This product does not contain any chemicals known to State of California to cause cancer, birth defects, or any other reproductive harm.

16. OTHER INFORMATION

Further information
Copyright 2012 Sigma-Aldrich Co. LLC. License granted to make unlimited paper copies for internal use only. The above information is believed to be correct but does not purport to be all inclusive and shall be used only as a guide. The information in this document is based on the present state of our knowledge and is applicable to the product with regard to appropriate safety precautions. It does not represent any guarantee of the properties of the product. Sigma-Aldrich Corporation and its Affiliates shall not be held liable for any damage resulting from handling or from contact with the above product. See www.sigma-aldrich.com and/or the reverse side of invoice or packing slip for additional terms and conditions of sale.
QUINCY QGS SERIES
ROTARY SCREW
AIR COMPRESSORS
5-100 HP
**QGS 5-30 HP BELT DRIVE**

**ROTARY SCREW TECHNOLOGY FOR EVERY APPLICATION**

Quincy understands the critical nature of your compressed air system to maintain production while simultaneously ensuring the profitability of your company. Quincy's QGS line of compressors help drive your profitability by lowering your total cost of ownership while providing you with the performance and reliability that people have come to know and expect from Quincy compressors. The QGS air compressor has many of the features, benefits, and advantages of larger compressed air systems in a package that fits your application and at a price you can afford.

The Quincy QGS rotary screw air compressor provides compressed air for a wide range of industrial applications. It is the result of over 100 years of compressed air knowledge combined with cutting edge technology and the voice of customers telling us what they want in an air compressor. Quincy QGS provides you with an industrial compressor that is designed around three innovative features that set it apart from other compressors in its class.

**STANDARD PREMIUM FEATURES (5-30)**

- 5-year warranty on airend, motor, separator tank, and cooler
- High efficiency air inlet filter
- TEFC motor
- WyeDelta Starting
- Proven, reliable V-belt drive
- Upward package air discharge
- Factory-filled 8,000 hour QuinSyn-Plus fluid
- Low sound enclosure (62-68 dBA)
- UL/cUL Control panel compliant
- Low oil carryover protects your tools and equipment
- Vibration isolation means a quieter machine
- Aircooled Aftercooler (Std. 20-30 hp)

**AVAILABLE OPTIONS (5-15)**

- High temperature refrigerated dryer (ship loose)
- Mounted 39°F dewpoint refrigerated air dryer with timer actuated drain
- Floor-mount units (high temperature dryer recommended)
- 100 & 150 psi conversion kits (available on 10 & 15 HP models only)
- Tank Mounted units on 60 gal. horizontal tank

**AVAILABLE OPTIONS (20-30)**

- 120 gallon receiver tank with manual drain
- Integrated 39°F dewpoint refrigerated air dryer with timer actuated drain
- 100 & 150 psi factory pressure conversion, or field conversion kit (shipped loose)
- 575/3/60 Hz & 380-415/3/50 Hz electrics
QGS 5-30 HP BELT DRIVE

FULL CONTROL

• Simple, efficient controls
• Start/stop (5 & 7.5 hp) and auto dual (10 & 15 hp) controls ensure that your QGS delivers efficient air only when you demand it
• Microprocessor controls (20-30 hp) add increased system flexibility and efficiency

INFOLOGIC CONTROL FUNCTIONS (20-30 HP)
The InfoLogic microprocessor controller is intuitive and easy to use, displaying key operational, safety and service information.

• Auto run, general alarm and power on LED’s
• Pressure display
• Temperature & dewpoint display
• Remote start/stop
• Programmable auto-restart
• Motor start limit
• Max and min temperature default settings

SERVICEABILITY

• All consumable components are located behind a single access panel
• Constant view fluid level display allows you to monitor fluid levels without removing any panels
• Quincy parts ensure efficient and reliable performance of your QGS air compressor
• Spin-on fluid filter and separator element allow for quick and easy maintenance

ARE YOU USING THE RIGHT TECHNOLOGY FOR YOUR APPLICATION?

With ease of service and reliability in mind, the Quincy QGS offers superior compressed air performance in a compact, modern design. With a continuous 100% duty cycle, this rotary screw compressor also operates without the elevated vibration and sound levels normally associated with typical piston compressors. A small footprint and lower noise levels mean increased installation flexibility, making the Quincy QGS ideal for most applications. And, with the optional receiver tank and integrated dryer, you will save valuable floor space and lower your cost of operation.
QGS 40-100 HP GEAR DRIVE

Quincy backs the QGS with a 5-year True Blue warranty on major components, including airend, motor, separator reservoir and cooler/heat-exchanger. Other compressor manufacturers charge extra for similar plans or an extended warranty. The 5-year True Blue warranty is standard on the QGS.

GEARBOX DRIVE-TRAIN
You work hard every day and it is important that your air compressor works as hard as you do. The gearbox drive-train maintains peak efficiencies and eliminates the chance of unplanned downtime due to broken or loose belts.

- Reliable gears eliminate the need of changing belts every 4,000 hours
- Energy efficient airend
- Minimal transmission losses
- No need to tension or replace troublesome belts
- Lower maintenance costs compared to belt driven units
- Energy consumption reduced over 3% compared to belt drive air compressors

AVAILABLE OPTIONS:
- 100 PSI Variant
- 125 PSI Variant
- Available in 230v and 460v
**STATE OF THE ART CONTROLLER**

Overseeing the operating parameters of your system is vital to maximizing the profitability of your air compressor. Quincy’s Airlogic² maximizes the operation of your compressor by maintaining the most efficient operation. The Airlogic² controller provides you with all of the information regarding your air compressor in a simple intuitive manner with full color screen and easy to navigate menus.

- Full color graphic display delivers all of the information you need in an easy to read display
- Intelligent unload cycle controls optimize your energy efficiency
- Integrates into any compressed air system with optional NetSYNC II System Controller

**QUINCY MODULAR COOLING (QMC)**

It is important to maintain the integrity of both your fluid cooling system as well as your air cooling system to maintain optimal efficiency of your air compressor. Quincy compressor provides you with the Quincy Modular Cooling system (QMC). The QMC isolates both of the cooling loops within your air compressor to improve longevity of your coolers for increased reliability. Also the QMC further reduces total cost of ownership by optimizing the serviceability of your air compressor!

- Modular cooling system provides increased cooler life by isolating thermal conductivity to the independent cooling loops
- Both coolers are easily accessible using the service slides. This reduces your service time and maximizes your operating time
QGS 40-100 HP GEAR DRIVE

PREMIUM COMPRESSORS DEMAND PREMIUM COMPONENTS

The Quincy QGS provides you with a premium gear drive air compressor not only through the optimal performance but also by its rugged construction with premium components. All Quincy QGS 40-100 units come standard with TEFC motors providing you with premium protection from dust and moisture. Combine the high efficiency intake filter, Quincy Modular Cooling system (QMC), and premium separation you help ensure that you are supplying the rest of your compressed air system with clean quality compressed air.

- High Quality, gear driven airend maximizes efficiency
- Premium TEFC motors provides premium reliable operation in harsh environment
- Radial Cooling fan provides quieter operation
- Premium filtration and separation provide high quality air
- Innovative canopy provides optimal serviceability with quiet operation
- Quincy Modular Cooling increases cooler lifetime
- Airlogic² Controller provides you with optimal control and energy efficiency

EXCEPTIONAL COMPRESSORS DESERVE EXCEPTIONAL SERVICE

All Quincy Compressors are designed for many long years of trouble-free service. Proper maintenance will help ensure that compressed air is one less thing to worry about. And Genuine Parts from Quincy Compressor will keep your compressor running like new, day in and day out. That’s exceptional.

The whole is equal to the sum of the parts. That’s why you bought a Quincy: to own the highest quality and most durable compressor available. Maintaining that high standard of quality can only be accomplished by using the same Genuine Parts that your compressor left our factory with. Quincy Engineers designed exceptional air compressors by selecting the latest technology and highest quality components. This same strict quality standard exists with only Genuine Parts. And of course, Genuine Parts ensure your extended warranty is properly maintained. Your new compressor is an important investment, and Genuine Parts are the only way to get maximum service life at the lowest cost. That’s exceptional.

Your local Authorized Quincy Compressor distributor is the best source to obtain Genuine Quincy Parts. Authorized Quincy Compressor distributors are the only centers who can supply Quincy-Certified Service Technicians, who can fix a problem right-the first time. Ask your distributor about money saving preventative maintenance and inspection programs. You will sleep better at night, and your bottom line will thank you. Truly exceptional.
THE QUINCY PROMISE

Quincy Compressor and its partnering distributors promise to provide you with uncompromising reliability in all Quincy equipment. This makes your compressed air system one less thing that you need to worry about, allowing you to focus on your company’s productivity and profitability.

THE QUINCY SOLUTION

Operating at peak efficiency and providing quality product is a priority for many of our customers. Quincy Compressor in partnership with our global network of authorized distributors strives to be your provider for all of your compressed air system needs. From the air compressor to filtration to dryers and storage solutions, Quincy Compressor is your single source provider for all of your compressed air system needs.

Air Compressors

Quincy Compressor is a premier manufacturer of many different types of air compressors designed for a variety of applications using different compression technologies.

The **Quincy QT** is a Reciprocating Splash Lubricated compressor for tough everyday use. The **Quincy QP** is a reciprocating fully pressure lubricated compressor for a competitive advantage. The **Quincy QR** is a reciprocating compressor designed for the most demanding conditions. The **Quincy QGS 5-30 HP** is a heavy-duty belt driven rotary compressor at a competitive price. The **Quincy QSI** provides an industrial grade premium fixed speed rotary screw air compressor. The **Quincy QGV** provides a premium variable speed rotary screw air compressor designed to optimize your energy efficiency.

Compressed Air Treatment

Quincy Compressor is your single-source provider of compressed air treatment products to complement your air compressor. Quincy provides refrigerated air dryers, desiccant air dryers, compressed air filtration from 5 to .01 micron, condensate drains, condensate management systems, storage solutions, and flow control valves. Quincy Compressor is truly a single-source provider for all of your compressed air needs.

Genuine Parts

Genuine Parts from Quincy Compressor keep your equipment running like new. When servicing your Quincy compressor, insist on Genuine Quincy parts. Not only will you save time and money, but you will gain the peace-of-mind from using only the highest quality parts worthy of the Quincy name.

System Controls

Whether you have one air compressor or many air compressors from different manufacturers, Quincy Compressor provides you with a way to control and monitor all of your system components in your compressed air system in a way that maximizes your energy efficiency. Whether you need to control your system on site or from half way around the world, Quincy Compressor is your source for reliable, efficient controls.
COMPRESSED AIR SYSTEMS BEST PRACTICE

QGS 5-15 TECHNICAL DATA

<table>
<thead>
<tr>
<th>Model</th>
<th>Capacity cfm</th>
<th>Air Receiver gallon</th>
<th>Pressure psig</th>
<th>Power hp</th>
<th>Sound dBA</th>
<th>Length inches</th>
<th>Width inches</th>
<th>Height inches</th>
<th>Weight lbs**</th>
</tr>
</thead>
<tbody>
<tr>
<td>QGS 5</td>
<td>16.6</td>
<td>60</td>
<td>150</td>
<td>5</td>
<td>62</td>
<td>56</td>
<td>22</td>
<td>50</td>
<td>465/543*</td>
</tr>
<tr>
<td>QGS 7.5</td>
<td>21.2</td>
<td>60</td>
<td>150</td>
<td>7.5</td>
<td>64</td>
<td>56</td>
<td>22</td>
<td>50</td>
<td>465/548**</td>
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<td>QGS 10</td>
<td>37.0</td>
<td>120</td>
<td>125</td>
<td>10</td>
<td>66</td>
<td>76</td>
<td>25</td>
<td>58</td>
<td>775/850*</td>
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<tr>
<td>QGS 15</td>
<td>52.0</td>
<td>120</td>
<td>125</td>
<td>15</td>
<td>68</td>
<td>76</td>
<td>25</td>
<td>58</td>
<td>815/890*</td>
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</table>

*Weight with optional integrated dryer  **Shipping weights can vary based on unit configuration and packaging.

QGS 20-30 TECHNICAL DATA

<table>
<thead>
<tr>
<th>Model</th>
<th>Capacity cfm</th>
<th>Air Receiver gallon</th>
<th>Pressure psig</th>
<th>Power hp</th>
<th>Sound dBA</th>
<th>Length inches</th>
<th>Width inches</th>
<th>Height inches</th>
<th>Weight lbs**</th>
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</thead>
<tbody>
<tr>
<td>QGS 20</td>
<td>84.0</td>
<td>120</td>
<td>125</td>
<td>20</td>
<td>63</td>
<td>53/73*</td>
<td>31</td>
<td>48</td>
<td>893/1021*</td>
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<tr>
<td>QGS 25</td>
<td>99.0</td>
<td>120</td>
<td>125</td>
<td>25</td>
<td>66</td>
<td>53/73*</td>
<td>31</td>
<td>48</td>
<td>913/1042**</td>
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<tr>
<td>QGS 30</td>
<td>122.0</td>
<td>120</td>
<td>125</td>
<td>30</td>
<td>68</td>
<td>53/73*</td>
<td>31</td>
<td>48</td>
<td>948/1076*</td>
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</tbody>
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*Length and weight with optional integrated dryer  **Shipping weights can vary based on unit configuration and packaging.

QGS 40-100 TECHNICAL DATA

<table>
<thead>
<tr>
<th>Model</th>
<th>Capacity cfm 100 PSI</th>
<th>Capacity cfm 125 PSI</th>
<th>Sound dBA</th>
<th>Length inches</th>
<th>Width inches</th>
<th>Height inches</th>
<th>Weight lbs**</th>
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<tbody>
<tr>
<td>QGS 40</td>
<td>189</td>
<td>177</td>
<td>70</td>
<td>55.9</td>
<td>41.7</td>
<td>64.17</td>
<td>1852</td>
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<td>QGS 50</td>
<td>226</td>
<td>208</td>
<td>70</td>
<td>55.9</td>
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<td>QGS 60</td>
<td>275</td>
<td>248</td>
<td>70</td>
<td>55.9</td>
<td>41.7</td>
<td>64.17</td>
<td>2039</td>
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<td>QGS 75</td>
<td>355</td>
<td>320</td>
<td>71</td>
<td>65.35</td>
<td>41.7</td>
<td>64.17</td>
<td>2645</td>
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<td>QGS 100</td>
<td>456</td>
<td>434</td>
<td>71</td>
<td>65.35</td>
<td>41.7</td>
<td>64.17</td>
<td>3058</td>
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</tbody>
</table>

**Shipping weights can vary based on unit configuration and packaging.

Air Quality Classification
ISO 8573.1

- DCN 5 Micron 0.01 PPM
- CSN 0.003 Micron 0.1 PPM
- CPN 0.01 Micron 0.01 PPM
- ACN Activated Carbon Absorber
- QSI-500i Quincy Rotary Screw Quincy Condensate Purifier
- QPHT-40 Quincy Condensate Purifier
- QPNC-500 Quincy Condensate Purifier
- QRHT—High Temp. Refrigerated Air Dryer
- QED Cycling Refrigerated Dryer
- QCS Condensate Purifier
- DP Drain Point
- OUD Over Under Duplex

Approximate Liquid Removal
100 CFM, 100 psi, 80˚F, 4000 hrs./yr., 2 PPM
MS Series Analytical and Precision Balances, METTLER TOLEDO®

Supplier: Mettler Toledo

- Features FACT® Fully Automated Calibration Technology
- Capacities from 120 g to 8200 g
- Readabilities from 0.1 mg to 0.1 g
- Built-in RS-232 Interface

The NewClassic MS line of balances ranges from high-resolution analytical to precision models. FACT® technology provides fully automatic, motorized calibration with an internal weight. In addition to basic operations such as weighing, taring, and calibration, the MS balances are also equipped with functions such as piece counting, percent weighing, and dynamic weighing. All models have programmable Smart Keys for shortcut access to preferred applications as well. DeltaRange® balances (97035-640 and 97035-644) feature a moveable fine range with ten times the readability anywhere in the weighing range, just by taring.

Balance housings are constructed of die-cast aluminum and supplied with transparent protective covers. Weighing pans are constructed from chromium-nickel steel. All models are protected against dust and water, and have an IP54 in-use rating. Built-in RS-232 and USB interfaces allow for easy communication exchange. The HCD (high contrast display) with large numbers, clear symbols, and an intuitive menu enables users to operate the balance quickly and easily. To allow for quick and easy cleaning, the QuickLock draft shield can be dismantled in a few simple steps, without moving the balance, and the separate glass panels can be cleaned in a dishwasher.

UL listed and CSA certified.

Ordering Information: The 2-place readability models do not include draft shields. QuickLock draft shields are only supplied with models featuring 3-place readability or better. Optional Gold and Silver calibration service packages are offered to assure continual reliability and maintain optimum balance performance. The Gold service package is suitable for many regulated balance uses requiring documentation to support installation, including a NIST traceable certificate. The Silver service package is suitable for many unregulated balance uses requiring no significant documentation to support installation. Contact your representative for package specifics.

### Analytical Balances

<table>
<thead>
<tr>
<th>Model</th>
<th>Capacity</th>
<th>Dimensions</th>
<th>Linearity</th>
<th>Pan Size</th>
<th>Readability</th>
<th>Repeatability (Std. Dev.)</th>
<th>Stabilization Time</th>
<th>Supplier No.</th>
<th>VWR Catalog Number</th>
<th>Unit</th>
<th>Price</th>
<th>Quantity</th>
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</thead>
<tbody>
<tr>
<td>MS204S</td>
<td>220 g</td>
<td>20.4W x 34.7L x 34.5H cm (8 x 131/16 x 131/32&quot;)</td>
<td>0.2 mg</td>
<td>9 cm (3 1/2&quot;) dia.</td>
<td>0.1 mg</td>
<td>0.1 mg</td>
<td>2 s</td>
<td>11144917</td>
<td>97035-622</td>
<td>Each</td>
<td>$4,797.01</td>
<td>0</td>
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<tr>
<td>MS304S</td>
<td>320 g</td>
<td>20.4W x 34.7L x 34.5H cm (8 x 131/16 x 131/32&quot;)</td>
<td>0.3 mg</td>
<td>9 cm (3 1/2&quot;) dia.</td>
<td>0.1 mg</td>
<td>0.1 mg</td>
<td>3 s</td>
<td>11144920</td>
<td>97035-624</td>
<td>Each</td>
<td>$5,432.35</td>
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<td>MS104S</td>
<td>120 g</td>
<td>20.4W x 34.7L x 34.5H cm (8 x 131/16 x 131/32&quot;)</td>
<td>0.2 mg</td>
<td>9 cm (3 1/2&quot;) dia.</td>
<td>0.1 mg</td>
<td>0.1 mg</td>
<td>2 s</td>
<td>11144914</td>
<td>97035-620</td>
<td>Each</td>
<td>$3,954.76</td>
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### Precision Balances

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<tr>
<th>Model</th>
<th>Capacity</th>
<th>Dimensions</th>
<th>Linearity</th>
<th>Pan Size</th>
<th>Readability</th>
<th>Repeatability (Std. Dev.)</th>
<th>Stabilization Time</th>
<th>Supplier No.</th>
<th>VWR Catalog Number</th>
<th>Unit</th>
<th>Price</th>
<th>Quantity</th>
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<tbody>
<tr>
<td>MS1602S</td>
<td>1620 g</td>
<td>19.4W x 34.7L x 9.6H cm (75/8 x 131/16 x 131/32&quot;)</td>
<td>0.02 g</td>
<td>17 x 20 cm (6 23/32 x 77/8&quot;)</td>
<td>0.01 g</td>
<td>0.01 g</td>
<td>1.5 s</td>
<td>11144956</td>
<td>97035-634</td>
<td>Each</td>
<td>$2,595.61</td>
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MS Series Analytical and Precision Balances, METTLER TOLEDO®

<table>
<thead>
<tr>
<th>Model</th>
<th>Capacity</th>
<th>Display</th>
<th>Resolution</th>
<th>Performance</th>
<th>Part Number</th>
<th>Price</th>
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<tr>
<td>MS1003S</td>
<td>1020 g</td>
<td>0.002 g</td>
<td>12.7 x 12.7 cm (5 x 5&quot;)</td>
<td>1 mg</td>
<td>2 s</td>
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<tr>
<td>MS603S</td>
<td>620 g</td>
<td>0.002 g</td>
<td>12.7 x 12.7 cm (5 x 5&quot;)</td>
<td>1 mg</td>
<td>2 s</td>
<td>11144938</td>
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<tr>
<td>MS4002SDR</td>
<td>820/4200 g</td>
<td>0.02/0.2 g</td>
<td>17 x 20 cm (6½ x 7½&quot;)</td>
<td>0.01/0.1 g</td>
<td>1.5 s</td>
<td>11144971</td>
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<td>MS3001S</td>
<td>3200 g</td>
<td>0.2 g</td>
<td>19 x 22.6 cm (7½ x 8&quot;)</td>
<td>0.1 g</td>
<td>1 s</td>
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<td>6200 g</td>
<td>0.02 g</td>
<td>17 x 20 cm (6½ x 7½&quot;)</td>
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<td>1.5 s</td>
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<td>1 s</td>
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<td>MS802S</td>
<td>820 g</td>
<td>0.02 g</td>
<td>17 x 20 cm (6½ x 7½&quot;)</td>
<td>0.01 g</td>
<td>1.5 s</td>
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<td>MS3002S</td>
<td>3200 g</td>
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<td>MS8001S</td>
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<td>1 s</td>
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<td>MS4002S</td>
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<td>0.002 g</td>
<td>12.7 x 12.7 cm (5 x 5&quot;)</td>
<td>1 mg</td>
<td>1.5 s</td>
<td>11144929</td>
</tr>
</tbody>
</table>

Add to Shopping List

Existing List  New List

Submit
GE STEAM STERILIZERS FOR PHARMACEUTICAL PRODUCTION
LIGTHS ON FOR THE NEW GENERATION STERILIZERS

The new Getinge GE Steam Sterilizers is a range of the new breed of state-of-the art sterilizers from the world’s leading brand in infection control. Sterilizers that further perfect the efficient performance and superior throughput you can always expect from Getinge. You recognize them by their clear, light and characteristic touch-screen panels, easily readable from a distance. As well as by their thought-through and user-friendly design, making them easier to operate than ever.

Ergonomic and user-friendly
The clear and intuitive interface of the new touch-screen panels is only one of many examples of how we ensure that Getinge sterilizers are easier to operate and more ergonomic. Read more about the new touch-screens on page 6.

The difference is in the details
Many steam sterilizers look alike from the outside - a grey stainless steel box. The difference is what is inside the box. Getinge has many years of experience of manufacturing steam sterilizers for GMP applications, and that practical experience, expertise and knowledge cannot be imitated.
FROM CONCEPT TO COMPLIANCE

When it comes to complete sterile systems, Getinge is with you all the way. The earlier we are involved in the planning process for your new or replacement system, the more we can offer you. Our knowledge and application expertise are drawn from over 100 years of dedication to washing and sterilization within healthcare and the life sciences.

We can support you with initial advice, system design, steam generation and water distillation equipment, extensive ranges of washer-disinfectors and sterilizers, closure processing systems, accessories, installation design, validation support and maintenance. Dealing with just one competent company will save you a lot of time, effort and costs. Getinge can satisfy virtually all your sterile processing needs from “concept to compliance”.

Optimal lifecycle economy
Our systems are based on compatible modular units that can be rapidly integrated and installed to form complete customized solutions based solely on your needs. The high quality and performance that have made Getinge a world leader in washing and sterilization ensure optimal lifecycle economy.

The Getinge GE Steam Sterilizers offers:
• Widest range of chamber sizes
• Leading-edge construction
• Strong on safety
• Outstanding flexibility and numerous design options
Getinge develops, manufactures and supplies completely integrated cleaning and sterilization systems for use within the pharmaceutical industry. Two typical installation examples for applications in bio-pharmaceutical production and quality assurance laboratories are shown below.
The versatility of GE Steam Sterilizers.

Getinge GE Steam Sterilizers kill the toughest microbes but are gentle enough to protect the integrity of the components, products and packaging.

The GE Series sterilizers are suitable for many common applications within bio-pharmaceutical production, and are equipped with appropriate features, options and processes for the demanding applications within production and the QA-QC Laboratory environments.

Smorgasbord or the chef’s special?

The complete GE Series of steam sterilizers is comprised of more than 280 models (24 chamber sizes and multiple program combinations) plus more than 80 standard options. For more simple selection, and using our experience and application knowledge, Getinge has pre-configured two variants, the “GE P” for production and the “GE Q” for the QA laboratory. Of course, additional options may be added according to application and customer needs.

A. Small GE Steam Sterilizers

600 Series. Fully automatic high-pressure steam sterilizers with a single vertical sliding door, or two vertical sliding doors for pass-through operation.

Standard chamber volume: 10 to 28 ft³ (0.3 to 0.8 m³)

B. Medium-size GE Steam Sterilizers

900 Series. Similar to the small sterilizers but with larger chamber sizes and automatic horizontal sliding door(s).

Standard chamber volume: 21 to 39 ft³ (0.6 to 1.1 m³)

C. Large GE Steam Sterilizers

1400 and 2200 Series. Sterilizers with automatic horizontal sliding door(s) for large-scale applications. They can be pit-mounted for convenient floor loading.

Standard chamber volume: 49 to 600 ft³ (1.4 to 17 m³)

1-8 Other products

1. Steam generators
2. Water pretreatment
3. CPS System-WSSD, MPV
4. CPS Discharge System
5. Component washers
6. WFI generation/storage
7. Glassware washers
8. Integral clean steam generator

Other equipment from Getinge includes terminal sterilization systems, isolators for formulation & filling, isolators for sterility testing

GE SERIES Options (sample) Production QA Lab

- Cross Contamination Seal
- cGMP Features
- Sanitary Process Piping
- Drain Line Scavenger System
- Self Cleaning Drain Strainer
- In-place Filter Sterilization
- In-place Filter Integrity Test
- Multiflow - Dual Control
- Laser Color Printer
- Pre-Qualification
- Functional Specification (FS)
- Software Design Specification
- Hardware Design Specification
- Vendor Data Sheet Package
- Sanitary Piping Documentation
- Videoboroscopy And Report
- P 3100 Program Combination
- P 3220 Program Combination
- L 3200 Program Combination

○ = Standard feature
• = Common Option
SAFEGUARDING YOUR INVESTMENT

A sterilization system represents a large capital investment. Therefore, Getinge takes measures to ensure that our GE Steam Sterilizers provide true value with regard to design, performance and lifecycle economy.

**Strong on safety**
Getinge steam sterilizers are designed and built to meet the world’s highest standards of quality and safety. Production facilities are ISO 9001-certified and all appropriate international regulations for safety, pressure vessels and the environment are rigorously followed. A risk assessment is performed on all products, focusing on personnel safety.

**Leading-edge construction**
The production of Getinge sterilizers involves leading-edge construction techniques and use of the highest-grade materials. Accurate laser cutting minimizes the number of construction welds. Robotic welding provides a level of weld consistency superior to manual techniques and virtually eliminates defects in welded seams. Robotic grinding systems reduce sites of potential corrosion and allow easy cleaning. And the unique sectional jacket design provides rigidity, allows visual inspection of all welds and reduces weight.

**Advantages of sliding doors**
The sliding doors of GE Steam Sterilizers offer a number of advantages over traditional hinged doors. They are cleaner, safer and simpler. Hinges require grease which can collect dirt. Sliding doors are safe since the hot inner surface is not exposed when the door is open. Space is optimized as the door does not swing outward, and there is free access to the chamber for loading/unloading.
FEATURES THAT SATISFY YOUR PROCESSING NEEDS

The features built into Getinge GE Steam Sterilizers involve two prime considerations – sterilizer customization and high performance in everyday use. The extensive range of features offered ensures a high degree of customization, and the most appropriate program combination and goods handling accessories facilitate smooth everyday operation.

Getinge’s modular approach assures the most cost-effective solution for your processing needs.

Numerous design options
Design options that reflect Getinge's reputation as a flexible and innovative supplier include:

- Chamber capacities ranging from 10 to 600 ft³ (0.3 to 17 m³)
- Single-door or double-door, pass-through models
- Dual sequencing controls at both ends of a pass-through model with master control panels if required
- Service area on either side of the chamber
- Integral clean steam generators
- Sterilizer mounted in either a cabinet, recessed between two walls, or recessed in a cabinet within one wall
- Cross-contamination wall seals to prevent airflow between areas served
- Models that can be installed directly on a floor for loading with carts or transfer trolleys, or pit-mounted models for convenient roll-in, roll-out load handling

You can select the program combination best suited to your particular applications.
THE DIFFERENCE IS IN THE DETAILS

Many steam sterilizers look alike from the outside - a grey stainless steel box. The difference is what is inside the box. Getinge has many years of experience of manufacturing steam sterilizers for GMP applications, and that practical experience, expertise and knowledge cannot be imitated.

1. Easy accessibility for maintenance is a key consideration in the design and assembly of Getinge sterilizers.
2. The unique sectional jacket adds strength and rigidity to the chamber, and robotic welding virtually eliminates defects. The resulting construction ensures a long lifetime with even the most rigorous use to safeguard your capital investment.
3. A wide range of loading accessories is available for diverse applications.
4. The doors of Getinge sterilizers are the cleanest, safest and simplest on the market.
5. Getinge has the widest range of sterilizer capacities available from a single supplier.
6. Top-quality piping and components are assembled to the highest standards. A variety of piping and documentation options are available.
7. State-of-the-art control systems.

8. CFC-free insulation enclosed in corrosion-proof aluminium.

9. Robust stainless steel jacket and frame on the outside, cleanable polished surfaces for cleanliness on the inside.

10. In-process inspection and testing is performed throughout the manufacturing process. Comprehensive documentation is delivered with every sterilizer.
Getinge GE Steam Sterilizers
GE STEAM STERILIZER SELECTION GUIDE
P & Q CONFIGURATIONS

Getinge GE Steam Sterilizers in P and Q configuration incorporate all the features needed for bio-pharmaceutical production and the related Quality Assurance laboratory. The table below lists the core features found in the two ranges of GE Steam Sterilizers, as well as those of particular interest to each specific application.

Double-door sterilizers may be equipped for ‘Multiflow’ operation to optimize operational efficiency while protecting the areas served.

<table>
<thead>
<tr>
<th>CORE FEATURES, GE Steam Sterilizers for Pharmaceutical Production &amp; QA/QC</th>
<th>COMMON OPTIONS, PRODUCTION</th>
<th>Common Options, QA / QC Laboratory</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Solid stainless steel chamber, jacket &amp; frame</td>
<td>• Integral pharmaceutical grade steam generator</td>
<td>• Integral clean steam generator</td>
</tr>
<tr>
<td>• Unique sectional jacket design with efficient insulation encased in Aluminum.</td>
<td>• In Situ Filter Integrity Test (WIT)</td>
<td>• In Situ Filter Integrity Test (WIT)</td>
</tr>
<tr>
<td>• Roboticallly welded &amp; polished chamber (Ra &lt; 0.63µm / 25µinch)</td>
<td>• “Multiflow” door sequencing</td>
<td>• Jacket cooling</td>
</tr>
<tr>
<td>• Clean, safe and simple automatic sliding door(s)</td>
<td>• Cross contamination seal</td>
<td>• Fan-assisted jacket cooling (L3300 program combination)</td>
</tr>
<tr>
<td>• Pneumatically operated process valves</td>
<td>• Jacket cooling</td>
<td>• PLC Control System (Allen Bradley Compact Logix with PanelView Plus HMI)</td>
</tr>
<tr>
<td>• Fully automatic leak rate test</td>
<td>• Fan-assisted jacket cooling (L3300 program combination)</td>
<td>• Choice of printers or recorder for process documentation</td>
</tr>
<tr>
<td>• 0.2µm membrane type sterilizing grade air admission filter in stainless steel housing</td>
<td>• Biohazard process (decontamination - vaccines production)</td>
<td>• PACS Supervisor for independent process monitoring</td>
</tr>
<tr>
<td>• In-situ steam sterilization of air filter (maintenance programme)</td>
<td>• PLC Control System (Allen Bradley Compact Logix with PanelView Plus HMI)</td>
<td>• Pre-Qualification during FAT (saves time and expense during site validation)</td>
</tr>
<tr>
<td>• cGMP features including:</td>
<td>• Choice of printers or recorder for process documentation</td>
<td></td>
</tr>
<tr>
<td>- Secondary (independent) temperature sensor in chamber drain</td>
<td>• PACS Supervisor for independent process monitoring</td>
<td></td>
</tr>
<tr>
<td>- Level sensor (and alarm) in chamber drain</td>
<td>• Pre-Qualification during FAT (saves time and expense during site validation)</td>
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<tr>
<td>- Membrane isolated pressure gauges</td>
<td></td>
<td></td>
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<tr>
<td>• Sanitary stainless steel chamber piping (media to chamber / product contact media)</td>
<td></td>
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</tr>
<tr>
<td>• Stainless steel media-to-jacket piping</td>
<td></td>
<td></td>
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<tr>
<td>• Getinge PACS 3500 Purpose designed control system with Avanti HMI</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Choice of convenient loading systems. Removable rails for easy cleaning</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Hinged front fascia for easy service access</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Validation Support Documentation incl. Functional, Hardware and Software Design Specifications, Vendor Data Sheets and Extended Sanitary Piping Documentation.</td>
<td></td>
<td></td>
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<tr>
<td>• Optional controls above door or beside door (Small GE Steam sterilizers)</td>
<td></td>
<td></td>
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<tr>
<td>• Ergonomic loading height</td>
<td></td>
<td></td>
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<tr>
<td>- Small GE Steam Sterilizers - 32” (800 mm) loading height</td>
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<tr>
<td>- Medium-size GE Steam Sterilizers - 24” (600 mm) loading height</td>
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<tr>
<td>- Large GE Steam Sterilizers - 12” (300 mm) loading height, or pit-mounted for direct floor loading</td>
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</tbody>
</table>
SMALL GE STEAM STERILIZERS

The modular design of Getinge small GE Steam Sterilizers allows them to be used for a broad range of applications – from QA laboratory use to small scale pharmaceutical production. The base specification includes a comprehensive variety of core features designed to provide intrinsic safety, functionality, reliability and longevity. A range of optional features facilitates customization according to the customer’s application.

Vertical sliding doors
These fully automatic high-pressure steam sterilizers are available with a single vertical sliding door, or two sliding doors for pass-through operation. The loading height is 32” (800 mm). Control panels may be on one or both sides (see also Multiflow operation). The small GE Steam Sterilizers can be connected to a central steam supply or equipped with an integral electrical or steam-heated steam generator.

Typical loading equipment consists of a shelf rack, trolley, or extendable / sliding shelves.

MEDIUM-SIZE GE STEAM STERILIZERS

Getinge medium-size GE Steam Sterilizers are similar to the small sterilizers with the exception of larger chamber sizes and automatic horizontal sliding door(s). The loading height is 24” (600mm).

As with our small GE Steam Sterilizers L3300 program combination further enhances the cooling rate of GE Steam Sterilizers by accelerating the airflow with a centrifugal fan, bringing more air into contact with the chamber wall (externally cooled by water in the jacket).

For high-capacity production, the Getinge GEV model with mechanically driven fan and internal heat exchangers for rapid cooling and drying is recommended.

Typical loading equipment consists of a shelf, rack and trolley.
LARGE GE STEAM STERILIZERS

This range of sterilizers covers large-scale production applications in the pharmaceutical industry.

Program combinations are available for sterilization of items such as vessels, textiles, rubber stoppers and filters as well as machine parts, tanks, carboys, etc. And there are cycles for cooling vented liquids and effluent sterilization (which may be used for decontamination of materials in vaccines production).

Large GE Steam Sterilizers incorporate a program for the slow cooling of liquids in vented rigid containers. To prevent liquid boiling or loss, or the rupture of containers, an option is available which incorporates assisted cooling with air overpressure. For higher capacity liquid production, Getinge recommends the GEV process.

Typical loading equipment consists of a loading trolley and a shelf rack. On pit mounted units, a shelf trolley may be used for direct floor loading.

Four main functions
Getinge large GE Steam Sterilizers, with automatic horizontal sliding door(s) provide four main functions:

- Sterilization of material entering a sterile zone
- Sterilization of product or used items and waste from a sterile/containment zone
- A pass-through barrier between a sterile/containment zone and the outside world
- Stand-alone sterilization capacity

Installation alternatives
Large GE Steam Sterilizers are either floor-mounted or pit-mounted. When pit mounted, the sterilizer floor is flush with the facility floor allowing trolleys/racks to roll easily in and out of the chamber. A pit depth of only 10 to 12” (250 to 300 mm) facilitates building work and sterilizer installation.

<table>
<thead>
<tr>
<th>1400 and 2200 series</th>
<th>71413</th>
<th>91413</th>
<th>91425</th>
<th>121422</th>
<th>92222</th>
<th>122222</th>
<th>152222</th>
<th>182222</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chamber volume ft³ / m³</td>
<td>19 / 1.4</td>
<td>60 / 1.7</td>
<td>116 / 3.3</td>
<td>140 / 4.0</td>
<td>160 / 4.5</td>
<td>212 / 6.0</td>
<td>265 / 7.5</td>
<td>318 / 9.0</td>
</tr>
<tr>
<td>Chamber depth, in/mm</td>
<td>53 / 1350</td>
<td>98 / 2500</td>
<td>86 / 2200</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chamber height, in/mm</td>
<td>57 / 1450</td>
<td>86 / 2200</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chamber width, in/mm</td>
<td>27 / 700</td>
<td>35 / 900</td>
<td>49 / 1250</td>
<td>35 / 900</td>
<td>49 / 1250</td>
<td>61 / 1550</td>
<td>72 / 1830</td>
<td></td>
</tr>
</tbody>
</table>

The above dimensions are for models selected from a much wider range of standard chambers. Non standard chambers are available on request.
At Getinge, we are committed to contribute to a sustainable society. We work purposefully to optimize our use of energy and natural resources, minimize our emissions to air and reduce the environmental impact of our waste management.

The environmental engagement of Getinge does not cease with product delivery but include the complete product life cycle. To gain maximum eco-effectiveness, we consider the environmental aspects of the entire life cycle including stages as product development, operational factory administration, production processes, distribution, intended use of the product and, finally, scrapping of the product.

Main focus: energy efficiency
Our overriding environmental objective is optimizing energy consumption and thus reducing the impact on the climate.

Thanks to Getinge’s design concept, the process times are among the shortest on the market. This means that sterilization of the goods will require less energy consumption.

A loading system for every need
A new sterilizer represents a large capital investment. Therefore Getinge ensures that our sterilizers provide true value with regard to design, performance and life cycle economy. This includes the loading system and accessories which are an integral part of the complete system, and the part that the operator comes into contact mostly during the routine operation of the equipment.

For each application, Getinge offers a variety of loading alternatives, from simple sliding shelves to completely automated systems.
INSPECTION, TESTING AND DOCUMENTATION

As a general principle, Getinge follows ISPE GAMP guidelines in respect of project execution and provision of documentation to support our clients’ qualification of sterile process equipment.

Quality is an intrinsic feature of every Getinge product. From the design specification, through component selection, fabrication, assembly and factory testing, every aspect of the manufacturing process is examined and documented to ensure and prove that the product is designed, built and tested according to the customer specifications and performance requirements.

Our objective is to demonstrate and document that we adhere to a cohesive quality control program in accordance with Good Engineering Practice.

Comprehensive validation support documentation
During the manufacturing process, in-process checking is performed to ensure compliance with specifications, and documentation is maintained as confirmation.

After manufacture, every unit undergoes comprehensive and rigorous Factory Acceptance Testing (FAT), again accompanied by detailed documentation. A complete package comprising these, together with installation, user and technical manuals, is provided with the equipment. These documents are intended to support your subsequent qualification procedures, thus saving considerable time, effort and expense on site.

Optionally, we can also provide a “Pre-Qualification” of the system, carrying out the same test procedures as defined in the IQ-OQ protocols, which will later be performed on site as part of the validation exercise. This exhaustive procedure identifies the inevitable minor issues with equipment and documentation and ensures a trouble free start-up and site acceptance testing later on.

Deliverable documentation packages include:
- Submittals (design documentation)
- Construction
- Automation
- Testing & Qualification
- Installation Manual
- User Manual
- Technical Manual

Every GE Steam Sterilizer undergoes rigorous factory acceptance testing in a dedicated test bay with facilities to support our clients during the inspection and test of their equipment.
Reproducibility and reliability of process control is crucial in life science applications.

To achieve this and minimize human error, Getinge supplies PLC based automation systems designed for the challenging environments typically found in life science applications, and programmed using a wealth of experience gained since Getinge introduced the first PACS computer controlled sterilizers in the mid 1980s.

Getinge offers a choice of hardware platforms, each with the same fundamental equipment functionality and programming methodology.

- Rockwell – Allen Bradley (Logix Platform)
- Siemens – Simatic (S7 Based platform)
- Getinge – PACS 3500

All systems accurately handle tasks such as parameter setting, recipe handling, sequence control, and data processing, presentation and storage.

**Versatile features**
The features included in our automation systems are:
- User friendly interface
- Extensive documentation
- Remaining cycle-time indicator
- Automatic sensor calibration
- Comprehensive alarms/alerts
- Process and alarm logging
- Multi-level password protection

**Regulatory compliance**
Getinge’s automation systems are developed according to stringent GAMP (Good Automated Manufacturing Practice) guidelines of the pharmaceutical industry, and are FDA 21 CFR part 11 capable. Every system is supported with comprehensive documentation.

Ask your representative for more detailed information concerning the range of automation systems available from Getinge.
FROM INSPIRATION TO INSTALLATION
Getinge specializes in early planning consultation and smart contamination prevention solutions for bio-pharmaceutical production, biomedical research, medical device manufacturing, laboratories and highly contaminated environments. Backed by more than 100 years of experience, global reach and the largest installed base for many equipment areas, we help our customers plan for maximum productivity in the most cost-efficient way. From logistics planning and premium equipment, to unmatched service and training, count on Getinge – Right from the start.
Features of Suncombe Range of BioWaste Effluent Treatment Systems

**Suncombe and BioWaste**

We offer Continuous Flow BioWaste decontamination systems and Batch BioWaste decontamination systems. Our systems are available for both thermal and thermochemical inactivation. Thermal inactivation can be performed using steam, super heated water or an established licensed electrical heating technique which minimises time and space.

- First System installed in 1990s
- 50+ years of design experience.
- Suitable for full validation.

**BioWaste Levels**

Bio-waste can be classified by the relative danger to the surrounding environment as biological safety levels (BSL). There are four safety levels. These are level 1 through level 4. Higher numbers indicate a greater risk to the external environment.

**Risk Assessments**

Suncombe Bio-Waste Inactivation Systems are individually subject to risk assessments throughout the design, development and build process.

**Safety Integrity Level**

The Critical processes within BioWaste systems should be designed to Safety Integrity Level as defined within IEC 61508. In cooperation with site personnel, a SIL assessment, calculation and report would be carried out on the critical processes.

**Automation System**

The Integrated Biosuite™ automation packages are designed to be operator friendly and simple to use whilst providing flexibility and optimisation. Reliable and robust, they have been developed over the last 10 years in co-ordination with clients operations staff, engineers and validation staff. They encompass all elements required to provide a controllable, repeatable automatic system.

A range of automation levels are available, starting from low level semi-automated systems, through low and mid level PLC and HMI versions, to advanced SCADA based systems. All levels are designed with the facilities required to provide a repeatable automated cycle.

**Manufacturing Standards**

- 316 stainless steel product contact parts, 304 non-contact parts, Hastelloy and Duplex Stainless
- ASME BPE, 3A, cGMP standards, fully drainable, crevice free.
- ASME BPE standard Pipework, fully annealed, chemistry to ASTM A-269, manufactured to ASTM A-270, and 3A Standard.

**Totaly Integrated Automation**

**Pressure Relief**

Complying with worldwide regulations, the pressure relief requirements are considered for each project individually. Detailed design activities provide the relieving requirements ranging from the removal of relief to double redundant bursting disc and pressure safety valves. Pressure relieving is also fitted to incoming services to ensure a positive pressure is always applied to the containment envelope.

**Suncombe Process Development**

Suncombe process engineers are qualified, experienced designers who are dedicated to serving the critical process sectors. With vast experience in BioWaste processing, we will apply leverage to all design methodologies, to ensure a smooth, reliable, robust BioWaste Treatment project is completed.

**Dual Redundancy**

Each section of the plant can be Cleaned (CIP) and sterilized (SIP) with a double valve arrangement in place thereby ensuring operator safety and maintenance of containment. This facility provides secondary containment with the inter-valve space decontaminated on every cycle.

**Instrumentation**

High quality analytical and process instrumentation.

**Process Valves**

Sanitary and sterile process routing valves providing reliable, robust routing.

**Maintainability**

The schemes are designed to ensure 100% safe and straightforward maintenance and service operations.

**Validation/ Documentation**

The lifecycle approach is adopted (DQ, FDS, HDS, SDS, FAT, SAT, IQ & OQ) with validation being key to every stage of the development process, including Factory Acceptance Testing (FAT), SAT and Qualification.

**Batch Records**

Electronically recorded Batch records.

**System Equipment**

Best quality sterile suitable equipment.
Introduction To Suncombe Bio-Waste Operation

Suncombe Bio-Waste Inactivation Systems decontaminate liquid hazardous infectious waste streams for research, production, laboratory and bio-containment environments. The systems are engineered to be robust and reliable and are available in a number of different configurations with capacities to suit the waste volume. The Systems are based on standard modules with individual units custom designed for your specific requirement and cGMP applications.

Design

Using robust, proven design principles, the systems deal with BioSafety level 2 to 4 waste and take into account two main areas of concern. Firstly, the systems effectively sterilise or inactivate any harmful pathogens in the waste stream and secondly, total containment must be assured at all times. The systems are supplied with controls and interlocking functionality to ensure containment is always maintained and there is always a positive release prior to discharge of treated waste.

BioWasteSink™

The BioWasteSink™ effluent treatment system is units of laboratory furniture and placed against the service spine or a wall. They are pre-designed systems for use in biocontainment labs, to treat low volumes of effluent using an innovative batch process allowing positive release of all of your waste. The system is designed to fit into new or retrofit into existing laboratories.

Designed to operate from a single 13 amp 230 Vac plug (European versions), the BioWasteSink™ uses SteriHeat™ established licensed electrical heating technology to treat the effluent in batches at variable f0 lethality settings.

BioWasteMicro™

The BioWasteMicro™ effluent treatment system is a pre-designed system which treats low volumes of effluent using an innovative batch process allowing positive release of all of your waste. A buffer vessel is used to provide a continuous collection facility and a set volume batch treatment facility is used.

Using SteriHeat™ our trademarked established licensed electrical heating technology, steam or super heated water, the effluent is inactivated in batch at variable f0 lethality settings.

BioWasteFlow™

The BioWasteFlow™ effluent treatment system is a pre-designed system which treats effluent continuously. It consists of a buffer tank which buffers the effluent, ensuring that there is a controlled supply to the continuous system regardless of flow peaks and troughs.

Using SteriHeat™ our trademarked established licensed electrical heating technology, steam or super heated water, the effluent is inactivated in batch at variable f0 lethality settings.

ETP+Plus™

The ETP+Plus system is a pre-designed system consisting of 2 vessels, which are used for both collection and treatment. With capacities to suit the waste volume, the systems are supplied with controls and interlocking functionality to ensure containment is always maintained and there is always a positive release prior to discharge of treated waste.

Our Bio-Waste Effluent Treatment Systems are available for both thermal and thermochemical inactivation. Thermal inactivation can be performed using steam, super heated water or an established licensed electrical heating technique which minimises time and space.

BioWasteBatch™

The BioWasteBatch™ effluent treatment systems are custom designed systems which provide any number of collection and treatment vessels. They are available in the traditional, heat and cool in the treatment vessels or our new hybrid technology that heats them in vessel and cools them on discharge. On higher level systems, Safety Integrity Assessments and facilities are carried out to ensure that there is no possibility of untreated waste being inadvertently discharged.

Address
Suncombe Ltd
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United Kingdom

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+44(0) 208 443 3454

Fax
+44(0) 208 443 3969

Email
mail@suncombe.com
**PRODUCT AVAILABILITY:** Did you know you can view a product’s availability right on the product page? Simply enter the quantity you want to purchase and the current availability will appear below the item.

**Corning**

**Cell Strainers**

**Description**

Corning Cell Strainers are an easy and ready-to-use solution for obtaining a more uniform single cell suspension

- Nylon mesh provides a strong, uniform filtration device
- Strainers reduce chance of contamination

Cell strainers fit inside a Falcon®™ 50 mL centrifuge tube. Each strainer is pre-sterilized, individually wrapped in medical grade packaging and gamma-irradiated. Available in 40 (blue frame), 70 (clear frame) or 100 (yellow frame) micron sizes.

Cell strainer tubes have same convenient features as cell strainers with a strainer incorporated into a 6 mL tube (12 x 75 mm). Saves time by filtering directly into a working tube. Blue frame, 35 micron.

**NOTE:** for 50 mL conical tube receptacles for cell strainers, see Thomas numbers 2610L52 and L54.

**Please Enter Your Order Info**

Filter by: Frame Color Material Pore Size Type Clear Filters

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<tr>
<td>4620E99</td>
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<td>Falcon® 40µm Cell Strainer, Blue, Sterile, Individually Packaged</td>
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<td>$0.00</td>
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<td></td>
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<td>500/CS</td>
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</table>
In today’s pharmaceutical and biologic manufacturing, cleaning the process equipment and systems is crucial to the overall success of the enterprise. For larger production and bulk facilities, cleaning is accomplished by a centralized CIP system and is considered a critical utility.

Elements of a CIP System:

- **CIP SKID**
  - "T.A.C.T.
  - Controllable Parameters

- **PROCESS EQUIPMENT AND SYSTEMS**
  - Equipment geometry
  - Hygienic design of system
  - Tactical selection of CIP devices

Non-controllable elements, as they are set in the design and construction phase

There are three important elements to consider in the design and implementation of any CIP System; the CIP Skid, the equipment & systems to be cleaned and the CIP supply & return lines.

The CIP Skid controls the cleaning (“T.A.C.T.”) parameters of Temperature, Action (velocity/pressure), Chemical concentration and Time of exposure. It can be configured with many different options as required by the owner to achieve the desired cleaning results.

### Knowledge and Experience Required

More of a challenge is the design considerations of the equipment & systems to be cleaned. In recent years the industry has given more attention to this and important guidelines have been published by ASME-BPE, ISPE, etc. And while these guideline have made large strides addressing the mechanical aspects, it is not mandatory (or sometimes possible!) for equipment suppliers to follow them. Thus it requires knowledge and experience in identifying potential CIP issues relating to equipment geometry and developing a tactical CIP approach to the process system.

There are several integration techniques for connecting the CIP skid with the targeted processes to be cleaned with the CIP supply & return circuits. Perhaps the most known is the use of flow-plates so that “make-break” circuits can be established, thus giving the owner a safe operation with a degree of flexibility albeit a manual operation. In more advanced operations, the use of matrix piping technology is used which employs mix-proof valves that allow the CIP supply & return to be totally “hardpiped” and automated, thus maximize the efficiency of the CIP operation.

GEA Liquid Processing takes complete responsibility for all aspects of the CIP System.

Our Process Engineers will audit your process for cleanability. Our CIP System skids are completely designed, engineered, fabricated, automated and tested in our workshop. We can further integrate the CIP System Skid into your operating plant utilizing the latest integration techniques.

We assign a qualified Process Engineer to your project to facilitate discussions regarding site-specific requirements, integration concerns and final FAT/SAT protocols. This vertically integrated project approach has the benefit of:

- Seamless communications between disciplines
- Eliminates budget variances that would result from having multiple contracts
- Enhances the “speed to market” of the overall project
Control System Integration

One of the keys to success is the correct integration of the control system to the process design and the CIP elements. In many cases, the CIP flow path will share process devices such as valves, pumps, agitators etc. which will need to be energized in sequential fashion to ensure that cleaning will take place.

Furthermore, CIP programs are set-up to allow configuration of the controllable parameters by authorized operators, thus allowing the system to be easily optimized during commissioning or during the life cycle of the process. The result is a secure CIP system that will be repeatable and reliable in operation!

GEA Liquid Processing is staffed with knowledgeable Control Engineers that are experienced with GAMP guidelines and can deliver complete, seamless control systems or provide the required interface with existing control systems.
Options

GEA’s single use CIP System Skid can be configured with the following options to meet your specific needs.

1. CIP tank
2. Secondary dedicated water tank
3. CIP return pump with low point drain valve
4. Chemical addition system(s)
5. Tank insulation
6. Air blow
7. CIP supply pressure transmitter
8. CIP supply temperature transmitter
9. CIP supply flow transmitter
10. Steam supply condensate drip leg
11. Heat exchanger drain
12. CIP return temperature transmitter
13. CIP return flow switch
14. CIP return conductivity transmitter
15. Portable
16. Explosion Proof (Class I / Div 1,2)

For detailed technical support, call us at 410-997-8700. Our engineers will assist you with the final CIP system skid configuration required to deliver specified CIP solutions and discuss plant integration options.
**Technical Data**

**Typical Utility Requirements**

Steam . . . . . . . . . . . . .1000 lb/hr at 35 psi.
Process water . . . . . .30-60 gpm
Electrical . . . . . . .120 VAC, 20 Amp for control cabinet.
460V, 3 phase 60 Hz for the MCC
Air . . . . . . . . . . . . . .90 psi (30CFH for airblow)

*Specific flow data and utility requirements will be altered to suit individual process requirements.*

**Dimensional Information**

**One-tank system**
A = Height: 8’
B = Width: 6’
C = Length: 9’
Dry weight: 4200 lbs

**Two-tank system**
A = Height: 8’
B = Width: 6’
C = Length: 13’
Dry weight: 6800 lbs

**Standard Documentation Package**

- Pipe and Instrument Diagram (P&ID)
- Dimensional drawings
- Complete set of electrical drawings
- Functional Design Specification (FDS)
- Software Design Specification (SDS)
- I/O list
- Set of software applications
- Maintenance manuals and spare parts list for all components
- Welding & inspection documentation
- Material certificates and surface finish reports for all process components
cGMP Process Solutions
for the Pharmaceutical and Biotech Industries

GEA Liquid Processing is a world leader in providing technically advanced cGMP process solutions for liquid processes. Utilizing good engineering practices and GAMP compliant automation, our knowledgeable staff delivers completely integrated and reliable hygienic liquid process systems that meet the most stringent regulations.
Description
The CSM-K range of high capacity clean steam generators has been designed to provide sterilizer grade clean steam from suitably treated feedwater using plant steam as the heating medium. Units using other fluids on the heating media can be provided to special order.

The range covers outputs up to 3,800 kg/h.

The pressure vessel is manufactured in accordance with PED 97/23/EC and is supplied with a standard package of documentation. The primary medium passes through a tube bundle which can be extracted for cleaning and maintenance. All secondary wetted parts are manufactured from 316 stainless steel.

Applications
Suitable for process applications, laundries, food and beverage applications, hospital sterilizers, laboratories and humidification. The CSM-K can also be used in a number of electronic production processes, pharmaceutical and general biotechnological applications. Please refer to our general sales brochure on clean steam for information on other products that can be used in association with the clean steam generator.

Principle features:
- Produces clean steam for sterilization, humidification, and culinary or clean processes, from standard plant steam.
- Fully assembled skid-mounted with all essential safety systems.
- PLC for accurate steam and feedwater pressure control.
- All clean steam wetted parts in 316 stainless steel to avoid contamination.
- Produces steam to HTM 2031 standards.
- Automatic blowdown controls - TDS and bottom blowdown.

Materials
| Primary steam header          | Carbon steel          |
| Primary side pipework and fittings | SG iron and carbon steel |
| Tube sheet                    | Stainless steel AISI 316L |
| Gaskets                       | Reinforced graphite   |
| Tube bundle                   | Stainless steel AISI 316L |
| Shell                         | Stainless steel AISI 316L |
| Shell side flanges            | Stainless steel AISI 316L |
| Support frame                 | Carbon steel          |
| Insulation (optional extra)   | Rock wool + Cover in Aluminium (standard) or stainless steel 304 |

Maximum steam pressures
- Maximum primary steam pressure: 12 bar g
- Maximum clean steam pressure: 7 bar g

The typical package shown below is for illustration purposes only.
Technical data

**Pneumatics**

Compressed air: A 6 bar g compressed air supply is required; where this is unavailable an optional compressor can be supplied with the unit (at extra cost).

**Electrical**

Electrical requirements: 400 V 3-phase 50Hz. A fused isolator of the correct rating must be incorporated in the supply line as near as possible to the unit. Information on the installed load for each individual unit will be supplied by Spirax Sarco.

**Feedwater quality**

To meet the requirements of HTM 2031 we would recommend the use of de-mineralised or reverse osmosis feedwater. It is advised that analysis of the feedwater is undertaken prior to installation and commissioning. Whilst not mandatory the table opposite gives a guide to recommended typical values.

<table>
<thead>
<tr>
<th>Property</th>
<th>Maximum value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ammonium</td>
<td>0.2 mg/l</td>
</tr>
<tr>
<td>Heavy metals substitute</td>
<td>0.1 mg/l</td>
</tr>
<tr>
<td>Chloride</td>
<td>0.5 mg/l</td>
</tr>
<tr>
<td>Nitrate</td>
<td>0.2 mg/l</td>
</tr>
<tr>
<td>Residue on evaporation</td>
<td>30.0 mg/l</td>
</tr>
<tr>
<td>Phosphate</td>
<td>0.1 mg/l</td>
</tr>
<tr>
<td>Silicate</td>
<td>0.1 mg/l</td>
</tr>
<tr>
<td>Electrical conducivity at 25°C</td>
<td>35.0 µS/cm</td>
</tr>
</tbody>
</table>

**Dimensions (approximate in mm) and standard output production (approximate in kg/h)**

Standard output production is based on the following conditions:
- Primary steam pressure 10 bar g;
- Clean steam pressure 3.5 bar g;
- Feedwater inlet temperature 20°C

**Dimensions**

<table>
<thead>
<tr>
<th>Model CSM-K</th>
<th>401</th>
<th>402</th>
<th>403</th>
<th>501</th>
<th>502</th>
<th>503</th>
<th>601</th>
<th>602</th>
<th>603</th>
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<th>702</th>
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<tbody>
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<td>3400</td>
<td>3700</td>
<td>3000</td>
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<td>3800</td>
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<td>3800</td>
<td>4000</td>
<td>4750</td>
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<td>4150</td>
<td>4900</td>
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<td><strong>Width W</strong></td>
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<tr>
<td><strong>Height H</strong></td>
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<td>2050</td>
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<td>2050</td>
<td>2050</td>
<td>2250</td>
<td>2250</td>
</tr>
<tr>
<td><strong>Clean steam output (kg/h)</strong></td>
<td>260</td>
<td>320</td>
<td>370</td>
<td>500</td>
<td>620</td>
<td>700</td>
<td>930</td>
<td>1150</td>
<td>1300</td>
<td>1700</td>
<td>1730</td>
<td>2000</td>
<td>2630</td>
<td>2600</td>
<td>2900</td>
<td>3800</td>
</tr>
</tbody>
</table>

**Control**

The unit is PLC controlled with the generator having pressure and level control.

**Sizing and selection**

For further information, please refer to TI-P486-13.

**Typical specification**

The clean steam provider shall be a Spirax Sarco clean steam generator CSM-K704 designed and built to produce steam to the HTM 2031 standard, dependant upon feedwater.

To raise 2000 kg/h of clean steam at 3 bar g when supplied with plant steam at 8 bar g.

All items are to be pre-assembled and mounted on to a compact frame.

**How to order**

Example: 1 off Spirax Sarco CSM-K704 clean steam generator.

Please provide details of primary steam pressure, clean steam pressure, clean steam flowrate and feedwater system.

**Ancillary items to be used depending on installation:**
- Blowdown vessel and system.
- Clean steam check valves.
- Clean steam isolation valves.
- Primary steam isolation valves.
- Clean steam and primary steam trapsets.
- CSM-PD preheater and degasser unit.

Other items may be required, please contact Spirax Sarco to discuss the full installation.
Thermo Scientific™ CryoMed™ Controlled-Rate Freezers

Precise freezing from -180° to +50°C for maximum accuracy of cell freezing

With six standard preset and 10 user-defined (20 steps each) freezing profiles that can be modified for custom protocols.

- Includes: 6 ft. (1.8m) flexible stainless-steel transfer hose, 0.5 in. 35° flare, thermal paper, 25- to 9-pin serial interface cable/adapter, and 10 ft. (3m) RS-232 cable
- Easy Programming and Monitoring
  - Chamber and sample temperatures and operation status simultaneously display on backlit LCD
  - Chamber temperature monitored by fixed-mount Type T thermocouple
  - Sample temperature monitored by Type T thermocouple with flexible cable (included)
  - Pre-Cool step automatically begins temperature ramp when chamber and sample temperatures are equilibrated within 1°C
  - Audible indicators alert operator when hold time has elapsed
  - Continual operation if power outage lasts less than 10 seconds; audible/visual alarm for outages lasting longer than 10 seconds
  - Modifiable access code for added security
- LN₂ Freezing System Components

<table>
<thead>
<tr>
<th>Catalog No.</th>
<th>Description</th>
<th>Price per Unit</th>
<th>Quantity &amp; Availability</th>
<th>Add Item(s)</th>
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<tbody>
<tr>
<td>TF7450</td>
<td>0.6 cu. ft.; Front access; 120V 60Hz</td>
<td>Each for $20,074.27</td>
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<tr>
<td>TF7456</td>
<td>0.6 cu. ft.; Front and top access IVF Unit; 120V 60Hz</td>
<td>N/A</td>
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<tr>
<td>TF7452</td>
<td>1.2 cu. ft.; Front access; 120V 60Hz</td>
<td>Each for $21,154.35</td>
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<td>Add to Cart</td>
</tr>
<tr>
<td>TF7458</td>
<td>1.2 cu. ft.; Front and top access IVF Unit; 120V 60Hz</td>
<td>Each for $23,370.75</td>
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<tr>
<td>TF7454</td>
<td>1.7 cu. ft.; Front access; 120V 60Hz</td>
<td>Each for $22,234.31</td>
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<td>11-679-078</td>
<td>0.6 cu. ft.; Front access; 100V 50/60Hz</td>
<td>Each for $20,074.37</td>
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<tr>
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<td>Each for $21,154.35</td>
<td></td>
<td>Add to Cart</td>
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<tr>
<td>No.</td>
<td>Description</td>
<td>Price</td>
<td>Quantity</td>
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</tr>
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<td>-------------</td>
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<tr>
<td>11-679-080</td>
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<td></td>
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<tr>
<td>11-679-081</td>
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<tr>
<td>11-679-082</td>
<td>1.2 cu ft; Front and top access IVF unit; 100V 50/60 Hz</td>
<td>$23,118.79</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Corning is helping to make your research possibilities real with new and innovative products.

Introduction

Corning is pleased to present our Life Sciences Selection Guide. In this guide, you will find a selection of our newest, most innovative and most requested products.

For more than 150 years, Corning Incorporated has leveraged its materials science and process engineering expertise to collaborate closely with customers worldwide — turning what were once only possibilities into breakthrough realities.

One such reality is the Corning® Epic® System, a high-throughput label-free screening platform based on optical biosensor technology. The system performs both biochemical and cell-based drug discovery applications and offers drug developers the ability to evaluate promising new drug targets. It also allows for the observation of direct biological interactions not previously detectable in high-throughput applications.

For hard-to-attach cell lines, Corning offers a number of modified or synthetic surfaces including Corning CellBIND® Surface, Ultra-Low Attachment, and Ultra-Web™ Surfaces. If you are trying to prevent or reduce attachment, we offer plates, dishes, flasks and the CellSTACK® Culture Chambers with our Ultra-Low Attachment surface. We also offer two new vessel formats, the HYPERFlask™ Cell Culture Vessel and Low Profile flask, for conserving incubator space.

We have recently advanced our microplate line to include many enhancements and new products. Check out the new 384 well solid, low-volume and Poly-D-Lysine microplates, as well as 384 and 1536 well microplates with generic bar codes in the Microplates Section.

For up-to-date information on Corning Life Sciences’ comprehensive range of products and services, go to [www.corning.com/lifesciences](http://www.corning.com/lifesciences) where you can access:

- New Products Information
- Technical Information including:
  - Application Notes
  - Instruction Manuals
  - Product Bulletins
- Educational Opportunities
- Product Catalog Information
- Product Literature
- Complete Distributor Information

For additional product information, please visit [www.corning.com/lifesciences](http://www.corning.com/lifesciences), or call 1.800.492.1110. Customers outside the United States, please call 1.978.442.2200 or contact your local support office (see back cover).

Try one of our newest innovations and see if it can help to make your research possibilities real.
Cell Culture

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Online Cell Culture and Assay Training

The Corning Scientific Seminar Series is a series of free online technical presentations that provide novel tips, best practices and proven techniques to help advance your research. Delivered by scientists, these one hour sessions have proven useful for technicians as well as for researchers who have been doing cell culture and assays for years.

Join us online for an upcoming session or download any of our previously recorded sessions. New topics are added monthly. Former topics include:

- Cell Culture Contamination – Every Researcher’s Nightmare!
- Effects of Cell Culture Surfaces on Cellular Behavior
- Detecting, Removing and Managing Mycoplasma Contamination
- Grow More Cells! Scaling Up Cell Production
- Growing Happier Cells
- Growing Cells on Transwell Inserts – Tips and Techniques
- Life and Death In Vitro - Growth and Toxicity
- HeLa Cells - A Blessing or a Curse?
- More In Vivo-like Cell Cultures and Better Assays with Permeable Supports
- Optimizing Assay Performance through Microplate Attributes and Equipment Setting
- Primary Cell Culture – Tips and Techniques for Getting Started
- Solving Cell Culture Problems
- Using Frozen vs. Continuously Cultured Cells for HTS

Register at www.corning.com/lifesciences

What attendees had to say about past seminars:

“"We are not getting information like this from anywhere. The seminar was amazing, very useful to my work. Thanks for organizing these sessions.”

“Great tips! I'll pass along information I learned here to my colleagues to let them know how we should conduct cell culture properly. Many thanks again indeed.”

“I use your seminars as training for new employees and estimate they save my company more than $24,000 a year in training costs.”

All attendees receive a certificate of completion.

Training is co-sponsored by:
Product Ordering Information

Ordering Products Direct from Corning
For our U.S. customers who currently have Corning accounts, you can order direct through our Customer Service group or online:
Tel.: 800.492.1110, 978.442.2200
Fax: 978.442.2476
Email: CLSCustServ@corning.com
Web: www.corning.com/lifesciences
Hours of Operation: Monday to Friday, 8 a.m. to 8 p.m. (Eastern Standard Time)
Customers outside of the U.S., please contact your local Corning distributor. Visit www.corning.com/lifesciences and click on “Contact Us.”

Phone/Fax Orders
For each order, customers should provide the Corning product number, product description, and desired quantity. You should also include your billing and shipping address and your Corning account number.

Online Orders
In order to purchase Corning products online, please visit the Corning Life Sciences website at www.corning.com/lifesciences. Click on register/login and complete the online registration form. Customers using credit cards may immediately place orders. Full Service Direct accounts with account specific contract pricing will need to establish a direct account with Corning Customer Service before online transactions can be made. You can complete the online registration form or contact Corning Customer Service directly at 1.800.492.1110 in order to establish a direct account with Corning.

Ordering Products through our Distribution Partners
Customers can purchase Corning products from any one of our more than 50 authorized distributors. See our complete listing of Corning distributors Online at www.corning.com/lifesciences. Our distribution partners can offer our customers a variety of value added services from local inventory and service, to managed services, and preferred programs. Please contact your distributor of choice for more details.

Pricing
Prices shown on the Corning Life Sciences website (in our online www.corning.com/lifesciences catalog) reflect our current suggested U.S. list price. For customer specific pricing information, please contact Corning Customer Service or your authorized Corning Distributor.

Product Return Policy
To return product, contact your local customer service representative. In some countries, the order and lot number details are required. Please have this information available to obtain a Return Authorization Number. This Return Authorization Number must be referenced on the outside of the shipping carton. Returns without an appropriate Return Authorization Number will be refused and returned at customer expense.
Overview

DEIGNED FOR PERFORMANCE

Corning Life Sciences offers a full line of cell culture products that are manufactured under strict process controls guaranteeing consistent product performance. All Corning Life Sciences plastics manufacturing facilities are ISO 9001:9002 registered. ISO registration is recognized worldwide as a standard of excellence for quality systems.

In addition, customers can now obtain a Certificate of Compliance or product description for any Corning® or Costar® cell culture product from our website. This certificate details lot-specific information on component materials, sterility testing, pyrogen testing, cell attachment, and growth characteristics.

Also available are detailed drawings that highlight product dimensions. Drawings are available simply by calling your local Corning Life Sciences office.

ADDITIONAL QUALITY ASSURANCES

Nonpyrogenic Certification

Most Corning and Costar cell culture products are certified nonpyrogenic with a documented endotoxin level of equal to or less than 0.1 EU/mL. Endotoxins have been shown to cause variability in cell culture. Nonpyrogenic certification is just another way Corning helps ensure consistent cell culture results. Corning also offers a detailed technical bulletin on the effects of endotoxins in cell culture. This may be obtained by calling your local Corning Life Sciences office or by downloading the bulletin from the Corning web site www.corning.com/lifesciences.

Lot Number Traceability

To ensure accurate lot number traceability in biotechnology research and production facilities, most Corning and Costar cell culture flasks and most roller bottles feature a lot number individually printed on each product. Lot number traceability helps simplify quality assurance procedures for tracking and monitoring production and research processes.

Consistent Surface Chemistry

All Corning and Costar cell culture products are produced in ISO-certified facilities. Cell culture products are made from USP Class VI materials in accordance with documented manufacturing procedures. By carefully controlling both the materials we use and our manufacturing process, Corning is able to provide consistent surface chemistries across our entire line of cell culture products. This consistency increases the researcher’s ability to produce reliable results.

Visit www.corning.com/lifesciences for additional product and technical information.
Innovative Cell Culture Surfaces for the 21st Century

**Corning® Surfaces**

For over 30 years, Corning culture vessels have been modified using corona discharge and vacuum plasma to generate better surfaces for growing attached cells.

Today’s new culture technologies, such as stem cells and tissue engineering, require new surfaces with new capabilities. Corning’s investments in developing surface technologies are paving the way for these new cell culture applications. See for yourself why Corning is the first and only name to trust for surfaces that are backed with a performance guarantee.

**Surfaces for Enhancing Cell Attachment**

**Corning CellBIND® Surface**

The unique Corning CellBIND surface uses a patented microwave process for incorporating significantly more oxygen into the cell culture surface, rendering it better for cell attachment especially under difficult conditions.

- Quickly adapts cells to reduced serum or serum-free conditions
- Improves attachment and yield
- No special handling or storage required

**Corning Labware with Ultra-Web™ Synthetic Surfaces**

Innovative Ultra-Web synthetic nanofiber surfaces offer cells a more in vivo-like 3-D fibrillar topography for cells where current surfaces do not allow the desired cell culture performance or function.

- Growing cells, such as stem cells, liver, neuronal and primary cultures
- Helps promote a more in vivo-like cell morphology not obtainable with plastic 2-D surface
- Easy to view and harvest cells using standards methods

- Compatible with cell-based luminescence-reporter gene and FLIPR calcium flux assays

**Corning Microplates with Poly-D-Lysine Coated Surface**

Corning Poly-D-Lysine (PDL) microplates are coated with PDL (molecular weight range of 70 to 150 kDa) giving the surface a net positive charge for better cell attachment.

- Improves differentiation of primary neurons, glial cells, neuroblastomas
- Enhances attachment of transfected cell lines, including HEK-293
- Helps cells stay attached during assay processing

**Surfaces for Reducing or Preventing Cell Attachment**

**Corning Ultra-Low Attachment Coated Polystyrene Surface**

The Corning Ultra-Low Attachment surface uses a covalently bound hydrogel layer to inhibit cell attachment.

- Growing primary cultures of tumor or adult stem cells as unattached spheroids
- Preventing anchorage-dependent cells, such as fibroblasts, from attaching and dividing
- Promoting embryoid body formation from ES cells

<table>
<thead>
<tr>
<th>Cell Culture Formats</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
<tr>
<td>Corning Cell Culture Surfaces</td>
</tr>
<tr>
<td>For enhancing cell attachment:</td>
</tr>
<tr>
<td>Original Tissue Culture Surface</td>
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<tr>
<td>Corning CellBIND Surface</td>
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<tr>
<td>Ultra-Web Surfaces</td>
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<tr>
<td>Poly-D-Lysine Coated Surface</td>
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<tr>
<td>For reducing or preventing cell attachment:</td>
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<tr>
<td>Ultra-Low Attachment Surface</td>
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<tr>
<td>Untreated Surface</td>
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For more information or product numbers, reference the format categories within the Cell Culture section of this catalog.
Corning® CellBIND® Surface
A Novel Surface for Improved Cell Attachment, Serum Reduction, or the Elimination of Coatings

Increase Cell Growth and Yields with Corning CellBIND Surface
The Corning CellBIND surface enhances cell attachment under difficult conditions, such as reduced-serum or serum-free medium, resulting in higher cell yields. The first novel cell culture surface treatment in over 20 years.

Developed by Corning scientists, this patented technology (U.S. Patent No. 6,617,152) uses a microwave plasma process for treating the culture surface. This process improves cell attachment by incorporating significantly more oxygen into the cell culture surface, rendering it more hydrophilic (wettable) and increasing surface stability.

Benefits
- May eliminate the need for tedious, time-consuming, expensive and low stability biological coatings
- More quickly adapts cells to reduced-serum or serum-free conditions
- Increase cell survival following cryopreservation
- Reduces premature cell detachment from confluent cultures especially in roller bottles
- Better cell attachment leads to increased cell growth and yields

- More consistent and even cell attachment
- Requires no refrigeration or special handling and is stable at room temperature

Same High Quality Standards as Other Corning Vessels
- Manufactured from optically clear polystyrene
- Rigorous QC testing for consistency and reproducibility
- Certified nonpyrogenic and sterile
- Lot numbers for quality assurance and tracking
- Corning CellBIND surface logo differentiates from standard treatment cell culture products and avoids mix-ups

Cell Dissociation Recommendations
Culture inoculating and harvesting should be performed in the same manner as methods currently being employed. Both enzymatic and nonenzymatic dissociating solutions have been successfully used to remove cells from Corning CellBIND surfaces. These include: Trypsin-EDTA, Accutase®, Versene®, Disperse®, and Citric Saline. Some dissociating agents, such as Disperse or Versene, should be removed by centrifugation prior to plating the cells.

Corning CellBIND Surface is now available on flasks, CellSTACK® Culture Chambers, multiple well plates, 96 and 384 well plates, dishes, and roller bottles.

HYPERFlask® Cell Culture Vessel
CellSTACK Culture Chambers

Visit www.corning.com/lifesciences for additional product and technical information.
Enhanced Attachment of LNCaP Cells to the Corning® CellBIND® Surface*

Figure 1. Left: Adherent cell recovery and growth of LNCaP cells 24 hours post-seeding. Data is average ± standard error from 3 independent experiments. Right: Average ± standard error from 3 independent experiments for 7 day growth after initial attachment.

Figure 2. Attachment of LNCaP cells. Cells were thawed and plated onto the Corning CellBIND Surface (right) or tissue culture treated (left) T25 flasks. 24 hours post seeding a random field was viewed by light microscopy (100× magnification).

*From Enhanced Attachment of LNCaP Cells to the Corning CellBIND Surface, Corning SnAPPSht publication CLS-AN-048.

Corning CellBIND Surface Product Ordering Information

<table>
<thead>
<tr>
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<th>Description</th>
<th>Qty/ Pk</th>
<th>Qty/ Cs</th>
</tr>
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<tbody>
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<td><strong>Roller Bottles</strong></td>
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<td></td>
<td></td>
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<tr>
<td>3907</td>
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<td>431134</td>
<td>Expanded Surface Roller Bottle, 1700 cm², Corning CellBIND Surface, PS, Easy Grip Cap, Sterile</td>
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<td><strong>Flasks</strong></td>
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<tr>
<td>3289</td>
<td>Flask, 25 cm², Corning CellBIND Surface with Vent Cap, Sterile</td>
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<td>Flask, 225 cm², Corning CellBIND Surface with Vent Cap, Sterile</td>
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<td>3298</td>
<td>Flask, 175 cm², Corning CellBIND Surface with Phenolic Cap, Sterile</td>
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<td>431328</td>
<td>Flask, 175 cm², Corning CellBIND Surface, Bar coded with Vent Cap, Sterile</td>
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**Corning® CellBIND® Surface Product Ordering Information (Continued)**

<table>
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<th>Qty/Pk</th>
<th>Qty/Cs</th>
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<tbody>
<tr>
<td>10010</td>
<td>HYPER Flask® Vessel, 1720 cm², Corning CellBIND Surface, Bar Code, Sterile</td>
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<td>3068</td>
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**CellSTACK® Culture Chambers**

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<th>Description</th>
<th>Qty/Pk</th>
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<td>CellSTACK-1 Chamber, 636 cm² growth area, Corning CellBIND Surface, Sterile</td>
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<tr>
<td>3310</td>
<td>CellSTACK-2 Chamber, 1,272 cm² growth area, Corning CellBIND Surface, Sterile</td>
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<tr>
<td>3311</td>
<td>CellSTACK-5 Chamber, 3,180 cm² growth area, Corning CellBIND Surface, Sterile</td>
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<tr>
<td>3312</td>
<td>CellSTACK-10 Chamber, 6,360 cm² growth area, Corning CellBIND Surface, Sterile</td>
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<td>3321</td>
<td>CellSTACK-40 Chamber, 25,440 cm² growth area, Corning CellBIND Surface, Sterile</td>
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**Dishes**

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<tr>
<td>3294</td>
<td>Dish, 35 x 10 mm style, Corning CellBIND Surface, Sterile</td>
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<td>3295</td>
<td>Dish, 60 x 15 mm style, Corning CellBIND Surface, Sterile</td>
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<td>Dish, 100 x 20 mm style, Corning CellBIND Surface, Sterile</td>
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**Multiple Well Plates**

<table>
<thead>
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<th>Qty/Cs</th>
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<tbody>
<tr>
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<tr>
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<td>48 Well Plate, Corning CellBIND Surface, Clear, Sterile, with Lid</td>
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**Microplates**

<table>
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<th>Qty/Cs</th>
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<tr>
<td>3300</td>
<td>96 Well Plate, Corning CellBIND Surface, Clear Bottom, Sterile, with Lid</td>
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<tr>
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<td>96 Well Plate, Corning CellBIND Surface, Black/Clear Bottom, Sterile, with Lid</td>
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<td>384 Well Plate, Corning CellBIND Surface, Black/Clear Bottom, Sterile, with Lid</td>
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</table>
Ultra-Low Attachment Dishes, Plates, Flasks, and CellSTACK® Culture Chambers

The Ultra-Low Attachment surface is a unique covalently bonded hydrogel surface that is hydrophilic and neutrally charged. It minimizes cell attachment, protein absorption and enzyme activation. The surface is noncytotoxic, biologically inert and nondegradable.

### Ultra-Low Attachment Dishes Ordering Information

<table>
<thead>
<tr>
<th>Cat. No.</th>
<th>Dish Style (mm)*</th>
<th>Height (mm)</th>
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<th>Qty/Pk</th>
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<td>3262</td>
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<td>55</td>
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*60 mm dish = 52.1 mm; 100 mm dish = 83.8 mm

### Ultra-Low Attachment Plates Ordering Information

<table>
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<th>Cat. No.</th>
<th>Plate Type</th>
<th>Bottom Type</th>
<th>Diameter (mm)</th>
<th>Growth Area (cm²)</th>
<th>Qty/Pk</th>
<th>Qty/Cs</th>
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<td>3471</td>
<td>6 well plate</td>
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<td>34.8</td>
<td>9.5</td>
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<td>3473</td>
<td>24 well plate</td>
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<tr>
<td>3474</td>
<td>96 well plate</td>
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<td>Round</td>
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<td>0.32</td>
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### Ultra-Low Attachment Flasks Ordering Information

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<thead>
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<th>Cat. No.</th>
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<th>Cap Style</th>
<th>Growth Area (cm²)</th>
<th>Qty/Pk</th>
<th>Qty/Cs</th>
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<tr>
<td>3815</td>
<td>Rectangular</td>
<td>Vent</td>
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<td>6</td>
<td>24</td>
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<tr>
<td>3814</td>
<td>Rectangular</td>
<td>Vent</td>
<td>75</td>
<td>4</td>
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### Ultra-Low Attachment CellSTACK Ordering Information

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<th>Cat. No.</th>
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<th>Growth Area (cm²)</th>
<th>Qty/Pk</th>
<th>Qty/Cs</th>
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</thead>
<tbody>
<tr>
<td>3303</td>
<td>CellSTACK Chamber, 1-Stack</td>
<td>Vent</td>
<td>636</td>
<td>1</td>
<td>8</td>
</tr>
</tbody>
</table>

### Comparison of Cell Attachment in Ultra-Low vs. Standard Tissue Culture Treated Plates

Vero cells plated at 2.6 x 10⁶ cells per well grown for 4 days at 37°C in a 5% CO₂ environment show a 99% reduction in cellular attachment vs. standard culture treated product.

Suggested working volumes for Ultra-Low Attachment products:

- 96 well plate: 0.1 to 0.2 mL/well
- 24 well plate: 0.4 to 0.8 mL/well
- 6 well plate: 1.9 to 3.8 mL/well
- 60 mm dish: 4.2 to 6.3 mL/dish
- 100 mm dish: 11.0 to 16.5 mL/dish
- 25 cm² flask: 5 to 7.5 mL/flask
- 75 cm² flask: 15 to 22.5 mL/flask
- CellSTACK Chamber, 1-STACK: 127 to 190 mL/stack

There are no special procedures that need to be followed in order to use this surface.
Corning® Labware with Ultra-Web™ Surfaces

Innovative synthetic surfaces which provide cells with 3-D in vivo-like nanofibrillar substrates for better performance and functionality

SEM cross sectional (top left) and top down (top right) images (10,000X) of the Ultra-Web Synthetic Surface. Pores between the nanofibers are so small that the cells grow on the surface rather than in it. Primary Rat Cortex Neurons Ultra-Web (bottom left): surfaces support neuronal attachment, neurite outgrowth, and promote earlier neuronal aggregation, and are compatible with fluorescent staining and visualization or photography of cells. Primary rat cortex neurons (20X) were stained with anti-Tuj-1 (Class III beta tubulin), Hoechst (nuclei) and anti-Synapsin I. Synapsin I binds synaptic vesicles containing neurotransmitters to components of the cytoskeleton and facilitate their release, and thus indicate preserved neuronal function. Synapsin staining is greatest in areas between bundle formation on Ultra-Web surface (red stain, indicated by arrows). Corning Labware with Ultra-Web synthetic surface (bottom right).

Visit www.corning.com/lifesciences for additional product and technical information.
Corning® Labware with Ultra-Web™ Surfaces

Technical Information
Ultra-Web Synthetic Surfaces are composed of randomly orientated electrospun polyamide nanofibers with an average fiber diameter of ~180 nm. This creates a culturing substrate that mimics structural components within the basement membrane or extracellular matrix.

Ultra-Web synthetic surface is available with two surface chemistries:
- Untreated electrospun polyamide nanofibers with an uncharged slightly hydrophilic surface
- Polyamine treated electrospun polyamide nanofibers with a positively charged surface for enhanced cell attachment or binding and covalently linking biomolecules

Ultra-Web Synthetic Surface Applications
- Ideal for culturing liver, neuronal, kidney and stem cell lines or primary cultures where current surfaces do not provide the necessary culture performance or function
- Replacement for poly-lysine or animal-derived biological coatings
- Ideal substrate for binding cell attachment and growth factors to create more in vivo-like culture environments
- Compatible with cell-based luminescence-reporter gene and FLIPR calcium flux assays
- Promotes more in vivo-like morphology (spheroid and dome formation)

Ultra-Web Synthetic Surface Features
- Synthetic surfaces are more stable and consistent lot to lot than biological coatings
- Cells grow on the nanofiber surface, not in it, for easy harvesting
- Easy to view cells using phase contrast microscopy
- Ready to use and room temperature stable
- Animal component-free and irradiation sterilized (SAL 10⁻⁶) for extra security
- Compatible with most existing cell culture protocols and methods
- Easily coated with ECM molecules and growth factors

Imaging
Ultra-Web nanofibers provide a very thin three-dimensional surface on which the cells grow; consequently, focusing on and recognizing cells can be a little more difficult than traditional flat surfaces. Light microscopy, including phase contrast and differential interference contrast (DIC) can be used to view cells seeded on Ultra-Web surfaces.

Ultra-Web nanofibers should not interfere with imaging cells via fluorescence microscopy and has been tested successfully with Texas Red, Cy3, Cy5, FITC, and GFP filters. DAPI and Hoechst dyes demonstrate limited nonspecific binding to the Ultra-Web surface resulting in a slight increase in background staining dependent upon intensity of cell staining. Diluting DAPI or Hoechst staining solutions between 1:10 and 1:20 the recommended dose is suggested for routine staining to reduce this background staining. Testing with a cell-free control is advised.

Harvesting
Cells grown on Ultra-Web or Ultra-Web polyamine surfaces may be subcultured using standard cell dissociation techniques with trypsin, collagenase, or other enzymatic and nonenzymatic dissociation solutions or cell scraping (for recommended scrapers see Corning Cat. No. 3008 or 3010). Note: To aid cell detachment gentle pipetting or mechanical agitation by tapping the culture vessel may be used. Scraping can be used to detach any remaining cells. Gentle cell scraping results in minimal damage to the Ultra-Web surface. However, robust scraping will remove the Ultra-Web surface.

Corning Labware with Ultra-Web Surfaces Product Ordering Information

<table>
<thead>
<tr>
<th>Cat. No.</th>
<th>Description</th>
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<td>3871XX1</td>
<td>Corning 100 mm Dish with Ultra-Web Synthetic Polyamine Surface,</td>
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<td></td>
<td>Bottom, Sterile with Lid</td>
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<td>3873XX1</td>
<td>Corning 96 Well Plate with Ultra-Web Synthetic Polyamine Surface,</td>
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<tr>
<td></td>
<td>Black/Clear Bottom, Sterile with Lid</td>
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</table>

These products are covered by one or more of the following patents: U.S. Patent numbers 5002582, 5512329, 6121027, 6514734, 6924028, and 6955775. Additional U.S. and international patents pending.
Cell Culture Flasks

Corning® and Costar® flasks are available in a variety of sizes, designs and cap styles to meet your needs.

- **Corning CellBIND® Surface** is a novel cell culture treatment that increases surface wettability for more even and consistent cell attachment
- Ultra-Low Attachment flasks feature a covalently bound hydrogel layer that minimizes cell attachment, protein absorption and cellular activation
- Manufactured from optically clear virgin polystyrene
- Treated for optimal cell attachment
- Printed with lot numbers for ease in traceability
- 100% integrity tested
- Sterilized by gamma irradiation
- Certified nonpyrogenic

**Flask Cap Styles**

**Plug seal caps** feature one-piece linerless construction and are designed for use in closed systems, providing a liquid- and gas-tight seal. When loosened, this cap can also be used in open systems. This cap design was a Corning innovation that first appeared in 1974.

**Phenolic style caps** are designed (when loosened) for use in open systems requiring gas exchange. With the caps slightly loosened, gas is exchanged between the environments inside and outside of the flask.

**Vent caps** contain a 0.2 μm pore nonwettable membrane sealed to the cap, providing consistent, sterile gas exchange while minimizing the risk of contamination. These caps are highly recommended for use in all CO₂ incubators, especially for long-term use. The vent cap was a Corning innovation that first appeared in 1988.

**Septum caps** maintain a closed sterile environment within the RoboFlask™ vessel. The septum allows for adding or removing cells and solutions with a blunt tip cannula while reducing the opportunity for contamination. The septum is pre-split to prevent coring of the septum by the cannula. The cap may also be removed to allow pipet access (up to 5 mL) or assist in harvesting of cells. This cap septum is validated for multiple entries.

**Flask Neck Styles**

Straight neck flasks are ideal for larger medium volumes since this design reduces medium sloshing into the cap.

Canted neck flasks allow easier pouring and improved access to the flask for pipetting or scraping. The canted neck design was a Corning innovation that first appeared in 1974.

Angled neck improves pipet access and reduces medium sloshing into the neck. This patented design was a Corning innovation that first appeared in 1988.

Visit [www.corning.com/lifesciences](http://www.corning.com/lifesciences) for additional product and technical information.
Flask Shapes
Choosing a flask shape is usually a matter of personal preference:

Low Profile flasks have reduced height for incubator space savings. The corner neck gives direct access to the flask corner.

Triangular and modified triangular flasks offer good pipet and cell scraper access to the corners. The wider base provides added stability.

Rectangular flasks have a ramp from the bottom to the canted neck for easier pouring and pipet access. Most canted neck flasks also have an antitip skirt to enhance stability.

Angled neck and traditional straight neck flasks utilize the entire bottom area for cell growth. Their design saves on space and reduces medium sloshing into the neck.

RoboFlask™ vessels are robotics compatible cell culture flasks offering 92.6 cm² cell growth surface area. The flasks are designed for use in automated cell culture systems utilizing a microplate-size format.

Corning® Cell Culture Flask Ordering Information

25 cm² Growth Area Flasks

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<th>Cap Style</th>
<th>Qty/Pk</th>
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<td>Angled</td>
<td>Vent Cap</td>
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75 cm² Growth Area Flasks

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<th>Cat. No.</th>
<th>Surface</th>
<th>Flask Style</th>
<th>Neck Style</th>
<th>Cap Style</th>
<th>Qty/Pk</th>
<th>Qty/Cs</th>
</tr>
</thead>
<tbody>
<tr>
<td>430641</td>
<td>TC</td>
<td>Rectangular</td>
<td>Canted</td>
<td>Vent Cap</td>
<td>5</td>
<td>100</td>
</tr>
<tr>
<td>430720</td>
<td>TC</td>
<td>Rectangular</td>
<td>Canted</td>
<td>Plug Seal</td>
<td>5</td>
<td>100</td>
</tr>
<tr>
<td>430725</td>
<td>TC</td>
<td>Rectangular</td>
<td>Canted</td>
<td>Phenolic-Style</td>
<td>5</td>
<td>100</td>
</tr>
<tr>
<td>3275</td>
<td>TC</td>
<td>Modified triangular</td>
<td>Straight</td>
<td>Phenolic-Style</td>
<td>5</td>
<td>100</td>
</tr>
<tr>
<td>3276</td>
<td>TC</td>
<td>Modified triangular</td>
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<td>Vent Cap</td>
<td>5</td>
<td>100</td>
</tr>
<tr>
<td>3290</td>
<td>Corning CellBIND Surface</td>
<td>Rectangular</td>
<td>Canted</td>
<td>Vent Cap</td>
<td>5</td>
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</tr>
<tr>
<td>3814</td>
<td>Ultra-Low Attachment</td>
<td>Rectangular</td>
<td>Canted</td>
<td>Vent Cap</td>
<td>4</td>
<td>24</td>
</tr>
</tbody>
</table>

Cell Culture Tip
Check the Corning web site (www.corning.com/lifesciences) for technical cell culture application bulletins.

3056 25 cm² Triangular Flask with Vent Cap

430639 25 cm² Canted Neck Flask with Vent Cap

430641 75 cm² Canted Neck Flask with Vent Cap

430725 75 cm² Canted Neck Flask with Phenolic Style Cap

3275 75 cm² Triangular Flask with Phenolic Style Cap
Cell Culture Flask Selection Tip

Corning’s unique RoboFlask™ (U.S. Patent 7,078,228) Cell Culture Vessels are designed to an SBS standard microplate footprint for use in automated cell maintenance and assay systems.

92.6 cm² Growth Area RoboFlask™ Vessels

<table>
<thead>
<tr>
<th>Cat. No.</th>
<th>Description</th>
<th>Qty/Pk</th>
<th>Qty/Cs</th>
</tr>
</thead>
<tbody>
<tr>
<td>3070</td>
<td>RoboFlask Cell Culture Vessel for automation, tissue culture treated, with bar code, septum cap, sterile</td>
<td>20</td>
<td>100</td>
</tr>
<tr>
<td>3071</td>
<td>RoboFlask Cell Culture Vessel for manual use, tissue culture treated, with bar code, flat cap (without septum), sterile</td>
<td>20</td>
<td>100</td>
</tr>
<tr>
<td>3069</td>
<td>RoboFlask Cell Culture Vessel for automation, tissue culture treated, with bar code, septum cap, sterile</td>
<td>10</td>
<td>50</td>
</tr>
<tr>
<td>3059</td>
<td>RoboFlask Cell Culture Vessel for manual use, tissue culture treated, with bar code, flat cap (without septum), sterile</td>
<td>10</td>
<td>50</td>
</tr>
<tr>
<td>3067</td>
<td>RoboFlask Cell Culture Vessel for automation, Corning® CellBIND® surface treatment with bar code, septum cap, sterile</td>
<td>20</td>
<td>100</td>
</tr>
<tr>
<td>3068</td>
<td>RoboFlask Cell Culture Vessel for automation, Corning CellBIND surface treatment with bar code, septum cap, sterile</td>
<td>10</td>
<td>50</td>
</tr>
</tbody>
</table>

100 cm² Growth Area Low Profile Flask

<table>
<thead>
<tr>
<th>Cat. No.</th>
<th>Description</th>
<th>Qty/Pk</th>
<th>Qty/Cs</th>
</tr>
</thead>
<tbody>
<tr>
<td>3073</td>
<td>Low Profile Flask, 100 cm², Corning CellBIND Surface with Vent Cap, Sterile</td>
<td>6</td>
<td>60</td>
</tr>
<tr>
<td>3816</td>
<td>Low Profile Flask, 100 cm², tissue culture surface with Vent Cap, Sterile</td>
<td>6</td>
<td>60</td>
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</tbody>
</table>

150 cm² Growth Area Flasks

<table>
<thead>
<tr>
<th>Cat. No.</th>
<th>Surface</th>
<th>Flask Style</th>
<th>Neck Style</th>
<th>Cap Style</th>
<th>Qty/Pk</th>
<th>Qty/Cs</th>
</tr>
</thead>
<tbody>
<tr>
<td>430823</td>
<td>TC</td>
<td>Rectangular</td>
<td>Canted</td>
<td>Plug Seal</td>
<td>5</td>
<td>50</td>
</tr>
<tr>
<td>430824</td>
<td>TC</td>
<td>Rectangular</td>
<td>Canted</td>
<td>Phenolic Style</td>
<td>5</td>
<td>50</td>
</tr>
<tr>
<td>430825</td>
<td>TC</td>
<td>Rectangular</td>
<td>Canted</td>
<td>Vent Cap</td>
<td>5</td>
<td>50</td>
</tr>
<tr>
<td>3291</td>
<td>Corning CellBIND Surface</td>
<td>Rectangular</td>
<td>Canted</td>
<td>Vent Cap</td>
<td>5</td>
<td>50</td>
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</tbody>
</table>

162 cm² Growth Area Flasks

<table>
<thead>
<tr>
<th>Cat. No.</th>
<th>Surface</th>
<th>Flask Style</th>
<th>Neck Style</th>
<th>Cap Style</th>
<th>Qty/Pk</th>
<th>Qty/Cs</th>
</tr>
</thead>
<tbody>
<tr>
<td>3150</td>
<td>TC</td>
<td>Traditional</td>
<td>Straight</td>
<td>Phenolic Style</td>
<td>5</td>
<td>25</td>
</tr>
<tr>
<td>3151</td>
<td>TC</td>
<td>Traditional</td>
<td>Straight</td>
<td>Vent Cap</td>
<td>5</td>
<td>25</td>
</tr>
</tbody>
</table>

Visit www.corning.com/lifesciences for additional product and technical information.
175 cm² Growth Area Flasks

<table>
<thead>
<tr>
<th>Cat. No.</th>
<th>Surface</th>
<th>Flask Style</th>
<th>Neck Style</th>
<th>Cap Style</th>
<th>Qty/Pk</th>
<th>Qty/Cs</th>
</tr>
</thead>
<tbody>
<tr>
<td>431079</td>
<td>TC</td>
<td>Rectangular</td>
<td>Angled</td>
<td>Plug Seal</td>
<td>5</td>
<td>50</td>
</tr>
<tr>
<td>431080</td>
<td>TC</td>
<td>Rectangular</td>
<td>Angled</td>
<td>Vent Cap</td>
<td>5</td>
<td>50</td>
</tr>
<tr>
<td>431085</td>
<td>TC</td>
<td>Rectangular</td>
<td>Angled</td>
<td>Phenolic Style</td>
<td>5</td>
<td>50</td>
</tr>
<tr>
<td>431306*</td>
<td>TC</td>
<td>Rectangular</td>
<td>Angled</td>
<td>Vent Cap</td>
<td>7</td>
<td>84</td>
</tr>
<tr>
<td>431328*</td>
<td>Corning® CellBIND® Surface</td>
<td>Rectangular</td>
<td>Angled</td>
<td>Vent Cap</td>
<td>7</td>
<td>84</td>
</tr>
<tr>
<td>3292</td>
<td>Corning CellBIND Surface</td>
<td>Rectangular</td>
<td>Angled</td>
<td>Vent Cap</td>
<td>5</td>
<td>50</td>
</tr>
<tr>
<td>3298</td>
<td>Corning CellBIND Surface</td>
<td>Rectangular</td>
<td>Angled</td>
<td>Phenolic Style</td>
<td>5</td>
<td>50</td>
</tr>
</tbody>
</table>

*Flask prelabeled with bar code, validated for use with Select™ Robotic System.

225 cm² Growth Area Flasks

<table>
<thead>
<tr>
<th>Cat. No.</th>
<th>Surface</th>
<th>Flask Style</th>
<th>Neck Style</th>
<th>Cap Style</th>
<th>Qty/Pk</th>
<th>Qty/Cs</th>
</tr>
</thead>
<tbody>
<tr>
<td>431081</td>
<td>TC</td>
<td>Traditional</td>
<td>Angled</td>
<td>Plug Seal</td>
<td>5</td>
<td>25</td>
</tr>
<tr>
<td>431082</td>
<td>TC</td>
<td>Traditional</td>
<td>Angled</td>
<td>Vent Cap</td>
<td>5</td>
<td>25</td>
</tr>
<tr>
<td>3000</td>
<td>TC</td>
<td>Rectangular</td>
<td>Canted</td>
<td>Phenolic Style</td>
<td>4</td>
<td>24</td>
</tr>
<tr>
<td>3001</td>
<td>TC</td>
<td>Rectangular</td>
<td>Canted</td>
<td>Vent Cap</td>
<td>4</td>
<td>24</td>
</tr>
<tr>
<td>3293</td>
<td>Corning CellBIND Surface</td>
<td>Traditional</td>
<td>Angled</td>
<td>Vent Cap</td>
<td>5</td>
<td>25</td>
</tr>
</tbody>
</table>

235 cm² Expanded Growth Area Flask

<table>
<thead>
<tr>
<th>Cat. No.</th>
<th>Surface</th>
<th>Flask Style</th>
<th>Neck Style</th>
<th>Cap Style</th>
<th>Qty/Pk</th>
<th>Qty/Cs</th>
</tr>
</thead>
<tbody>
<tr>
<td>431346*</td>
<td>Corning CellBIND Surface</td>
<td>Rectangular</td>
<td>Angled</td>
<td>Vent Cap</td>
<td>7</td>
<td>42</td>
</tr>
</tbody>
</table>

*Flask prelabeled with bar code for use with Select Automation System with same footprint as the 175 cm² flask.

1720 cm² Growth Area HYPERFlask™ Vessel

<table>
<thead>
<tr>
<th>Cat. No.</th>
<th>Description</th>
<th>Qty/Pk</th>
<th>Qty/Cs</th>
</tr>
</thead>
<tbody>
<tr>
<td>10010*</td>
<td>HYPERFlask Vessel, 1720 cm², Corning CellBIND Surface, Bar Code, Sterile</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>10024*</td>
<td>HYPERFlask Vessel, 1720 cm², Corning CellBIND Surface, Bar Code, Sterile</td>
<td>4</td>
<td>24</td>
</tr>
</tbody>
</table>

*Flask prelabeled with bar code for use with Select™ Robotic System.

Cell Yields and Recommended Medium Volume

<table>
<thead>
<tr>
<th>Corning and Costar® Flasks</th>
<th>Approximate Growth Area (cm²)</th>
<th>Average Cell Yield*</th>
<th>Recommended Medium Volume (mL)</th>
<th>Maximum Working Volume (mL)†</th>
</tr>
</thead>
<tbody>
<tr>
<td>25 cm²</td>
<td>25</td>
<td>2.5 x 10⁶</td>
<td>5 - 7.5</td>
<td>10</td>
</tr>
<tr>
<td>75 cm² Canted neck</td>
<td>75</td>
<td>7.5 x 10⁶</td>
<td>15 - 22.5</td>
<td>60</td>
</tr>
<tr>
<td>75 cm² Straight neck</td>
<td>75</td>
<td>7.5 x 10⁶</td>
<td>15 - 22.5</td>
<td>90</td>
</tr>
<tr>
<td>RoboFlask™ Vessel</td>
<td>93</td>
<td>9.4 x 10⁶</td>
<td>20 - 30</td>
<td>70</td>
</tr>
<tr>
<td>100 cm²</td>
<td>100</td>
<td>1.0 x 10⁷</td>
<td>20 - 30</td>
<td>40</td>
</tr>
<tr>
<td>150 cm²</td>
<td>150</td>
<td>1.5 x 10⁷</td>
<td>30 - 45</td>
<td>210</td>
</tr>
<tr>
<td>162 cm²</td>
<td>162</td>
<td>1.6 x 10⁷</td>
<td>32 - 48</td>
<td>175</td>
</tr>
<tr>
<td>175 cm²</td>
<td>175</td>
<td>1.75 x 10⁷</td>
<td>35 - 52.5</td>
<td>250</td>
</tr>
<tr>
<td>225 cm²</td>
<td>225</td>
<td>2.25 x 10⁷</td>
<td>45 - 67.5</td>
<td>370</td>
</tr>
<tr>
<td>235 cm²</td>
<td>235</td>
<td>2.35 x 10⁷</td>
<td>47 - 70.5</td>
<td>250</td>
</tr>
<tr>
<td>1720 cm²</td>
<td>1720</td>
<td>2.5 x 10⁸</td>
<td>565</td>
<td>565</td>
</tr>
</tbody>
</table>

*Assumes an average yield of 1 x 10⁶ cells/cm² from a 100% confluent culture. Yields from many cell types can be lower than this.
†Maximum working volume is the amount a flask can hold in the horizontal position when filled to the neck.
Cell Culture Dishes

**Corning Cell Culture Treated Dishes**

- **Corning® CellBIND® Surface** is a novel cell culture treatment that increases surface wettability for more even and consistent cell attachment.
- **Ultra-Low Attachment** dishes feature a covalently bound hydrogel layer that minimizes cell attachment, protein absorption and cellular activation.
- **Ultra-Web™ Synthetic Surface** is composed of electrospun polyamide nanofibers, creating a culturing substrate that mimics structural components within the basement membrane or extracellular matrix.
- 6-pack carriers with only 10 dishes/bag are available for 100 mm dishes (Cat No. 430293)
- 245 mm square dishes offer 500cm² growth surface
- Manufactured from optically clear virgin polystyrene
- Sterilized by gamma radiation
- Certified nonpyrogenic
- Have stacking beads to aid in handling
- Supplied with vents to provide consistent gas exchange

**Corning® Cell Culture Dish Ordering Information**

<table>
<thead>
<tr>
<th>Cat. No.</th>
<th>Surface</th>
<th>Dish Style (mm)</th>
<th>Approx. Height (mm)</th>
<th>Growth Area (cm²)</th>
<th>Qty/Pk</th>
<th>Qty/Cs</th>
</tr>
</thead>
<tbody>
<tr>
<td>3294</td>
<td>Corning CellBIND Surface</td>
<td>35</td>
<td>10</td>
<td>8</td>
<td>10</td>
<td>210</td>
</tr>
<tr>
<td>430165</td>
<td>TC</td>
<td>35</td>
<td>10</td>
<td>8</td>
<td>20</td>
<td>500</td>
</tr>
<tr>
<td>430166</td>
<td>TC</td>
<td>60</td>
<td>15</td>
<td>21</td>
<td>20</td>
<td>500</td>
</tr>
<tr>
<td>3295</td>
<td>Corning CellBIND Surface</td>
<td>60</td>
<td>15</td>
<td>21</td>
<td>7</td>
<td>126</td>
</tr>
<tr>
<td>3261</td>
<td>Ultra-Low Attachment</td>
<td>60</td>
<td>15</td>
<td>21</td>
<td>5</td>
<td>20</td>
</tr>
<tr>
<td>3262</td>
<td>Ultra-Low Attachment</td>
<td>100</td>
<td>20</td>
<td>55</td>
<td>5</td>
<td>20</td>
</tr>
<tr>
<td>430196</td>
<td>TC</td>
<td>60 with 2 mm grid</td>
<td>15</td>
<td>21</td>
<td>20</td>
<td>500</td>
</tr>
<tr>
<td>3296</td>
<td>Corning CellBIND Surface</td>
<td>100</td>
<td>20</td>
<td>55</td>
<td>5</td>
<td>40</td>
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<tr>
<td>3870XX1</td>
<td>Ultra-Web Synthetic Surface</td>
<td>100</td>
<td>20</td>
<td>55</td>
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<td>20</td>
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<tr>
<td>3871XX1</td>
<td>Ultra-Web Synthetic Polymine Surface</td>
<td>100</td>
<td>20</td>
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<td>20</td>
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<td>100</td>
<td>20</td>
<td>55</td>
<td>20</td>
<td>500</td>
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<td>430293</td>
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<td>100</td>
<td>20</td>
<td>55</td>
<td>10</td>
<td>480</td>
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<td>430599</td>
<td>TC</td>
<td>150</td>
<td>25</td>
<td>148</td>
<td>5</td>
<td>60</td>
</tr>
<tr>
<td>431110</td>
<td>TC</td>
<td>245</td>
<td>25</td>
<td>500</td>
<td>4</td>
<td>16</td>
</tr>
</tbody>
</table>

*Disp style (mm) = actual growth surface diameters: 35 mm dish = 34.4 mm; 60 mm dish = 52.1 mm; 100 mm dish = 81.8 mm; 150 mm dish = 139.1 mm. The square dishes have interior bottom dimensions of 224 mm x 224 mm.*

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**Cell Culture Tip**

Check the Corning web site ([www.corning.com/lifesciences](http://www.corning.com/lifesciences)) for technical cell culture application bulletins.

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Visit [www.corning.com/lifesciences](http://www.corning.com/lifesciences) for additional product and technical information.
**Corning Nontreated Cell Culture Dishes**

- Manufactured from optically clear virgin polystyrene
- Not cell culture treated for applications where cell attachment is not desired
- Have stacking beads to aid in handling
- Supplied with vents to provide consistent gas exchange
- Sterilized by gamma radiation
- Certified nonpyrogenic

**Corning Nontreated Cell Culture Dish Ordering Information**

<table>
<thead>
<tr>
<th>Cat. No.</th>
<th>Dish Style* (mm)</th>
<th>Height (mm)</th>
<th>Approx. Growth Area (cm²)</th>
<th>Qty/Pk</th>
<th>Qty/Cs</th>
</tr>
</thead>
<tbody>
<tr>
<td>430588</td>
<td>35</td>
<td>10</td>
<td>9</td>
<td>20</td>
<td>500</td>
</tr>
<tr>
<td>430589</td>
<td>60</td>
<td>15</td>
<td>21</td>
<td>20</td>
<td>500</td>
</tr>
<tr>
<td>430591</td>
<td>100</td>
<td>20</td>
<td>55</td>
<td>20</td>
<td>500</td>
</tr>
<tr>
<td>430597</td>
<td>150</td>
<td>25</td>
<td>152</td>
<td>5</td>
<td>60</td>
</tr>
<tr>
<td>431111†</td>
<td>245</td>
<td>25</td>
<td>500</td>
<td>4</td>
<td>16</td>
</tr>
</tbody>
</table>

*Note: Dish style (mm) = actual growth surface diameters: 35 mm dish = 34.4 mm; 60 mm dish = 52.1 mm; 100 mm dish = 83.8 mm; 150 mm dish = 139.1 mm.

†Cat. No. 431111 is a square dish with interior bottom plate dimensions of 224 mm x 224 mm.

**Expected Cell Yields and Recommended Medium Volumes**

<table>
<thead>
<tr>
<th>Corning Dishes</th>
<th>Approximate Growth Area (cm²)</th>
<th>Average Cell Yield*</th>
<th>Recommended Medium Volume (mL)†</th>
</tr>
</thead>
<tbody>
<tr>
<td>35 mm</td>
<td>9</td>
<td>9.0 x 10⁵</td>
<td>1.8 - 2.7</td>
</tr>
<tr>
<td>60 mm</td>
<td>21</td>
<td>2.1 x 10⁶</td>
<td>4.2 - 6.3</td>
</tr>
<tr>
<td>100 mm</td>
<td>55</td>
<td>5.5 x 10⁶</td>
<td>11 - 16.5</td>
</tr>
<tr>
<td>150 mm</td>
<td>152</td>
<td>1.52 x 10⁷</td>
<td>30.4 - 45.6</td>
</tr>
<tr>
<td>245 mm (square)</td>
<td>500</td>
<td>5.0 x 10⁷</td>
<td>100 - 150</td>
</tr>
</tbody>
</table>

*Assumes an average yield of 1 x 10⁵ cells/cm² from a 100% confluent culture.
†Yields from many cell types can be lower than this.

**Costar® IVF Culture Dish**

- 20 mm center well
- Inner well holds 3 mL of medium while the outer well holds 10 mL
- Treated for optimal cell attachment
- Sterilized by gamma radiation
- Certified nonpyrogenic
- For research use only

**Costar IVF Culture Dish Ordering Information**

<table>
<thead>
<tr>
<th>Cat. No.</th>
<th>Size (mm)</th>
<th>Description (mm)</th>
<th>Center Well (mm)</th>
<th>Qty/Pk</th>
<th>Qty/Cs</th>
</tr>
</thead>
<tbody>
<tr>
<td>3260</td>
<td>60</td>
<td>60 x 15</td>
<td>20</td>
<td>20</td>
<td>500</td>
</tr>
</tbody>
</table>
Multiple Well Plates

Costar® 6, 12, 24, and 48 Well Cell Culture Plates

- Corning® CellBIND® Surface is a novel cell culture treatment that increases surface wettability for more even and consistent cell attachment
- Ultra-Low Attachment plates feature a covalently bound hydrogel layer that minimizes cell attachment, protein absorption and cellular activation
- Nonreversible lids with condensation rings to reduce contamination, uniform footprint for ease in stacking
- Individual alphanumerical codes for well identification, flat bottoms
- Treated for optimal cell attachment (except where noted)
- Sterilized by gamma irradiation, certified nonpyrogenic

6, 12, 24, and 48 Well Plates Ordering Information

<table>
<thead>
<tr>
<th>Cat. No.</th>
<th>Surface</th>
<th>Plate Type</th>
<th>Qty/Pk</th>
<th>Qty/Cs</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>6 Well Plates</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3335</td>
<td>Corning CellBIND Surface</td>
<td>Standard clear plate</td>
<td>5</td>
<td>50</td>
</tr>
<tr>
<td>3506</td>
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<td>5</td>
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<tr>
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<td>Standard clear plate</td>
<td>1</td>
<td>50</td>
</tr>
<tr>
<td>3471</td>
<td>Ultra-Low Attachment</td>
<td>Standard clear plate with hydrogel*</td>
<td>1</td>
<td>24</td>
</tr>
<tr>
<td><strong>12 Well Plates</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3336</td>
<td>Corning CellBIND Surface</td>
<td>Standard clear plate</td>
<td>5</td>
<td>50</td>
</tr>
<tr>
<td>3512</td>
<td>TC</td>
<td>Standard clear plate</td>
<td>5</td>
<td>100</td>
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<tr>
<td>3513</td>
<td>TC</td>
<td>Standard clear plate</td>
<td>1</td>
<td>50</td>
</tr>
<tr>
<td><strong>24 Well Plates</strong></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>3337</td>
<td>Corning CellBIND Surface</td>
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</tr>
<tr>
<td>3524</td>
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<td>3526</td>
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<td>50</td>
</tr>
<tr>
<td>3527</td>
<td>TC</td>
<td>Standard clear plate</td>
<td>5</td>
<td>100</td>
</tr>
<tr>
<td>3473</td>
<td>Ultra-Low Attachment</td>
<td>Standard plate with hydrogel*</td>
<td>1</td>
<td>24</td>
</tr>
<tr>
<td><strong>48 Well Plates</strong></td>
<td></td>
<td></td>
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</tr>
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<td>Corning CellBIND Surface</td>
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<tr>
<td>3548</td>
<td>TC</td>
<td>Standard clear plate</td>
<td>1</td>
<td>100</td>
</tr>
</tbody>
</table>

*This covalently bonded hydrogel surface minimizes cell attachment, protein absorption, enzyme activation and cellular activation. The surface is nontoxic, biologically inert and nondegradable.

Well Dimensions, Expected Cell Yields, and Recommended Medium Volumes

<table>
<thead>
<tr>
<th>Cell Culture Plates</th>
<th>Well Diameter (Bottom, mm)</th>
<th>Approx. Growth Area (cm²)</th>
<th>Average Cell Yield*</th>
<th>Total Well Volume (mL)</th>
<th>Working Volume (mL)</th>
<th>Approx. Growth Area (cm²)</th>
<th>Average Cell Yield*</th>
<th>Working Volume (mL)</th>
</tr>
</thead>
<tbody>
<tr>
<td>6 well</td>
<td>34.8</td>
<td>9.5</td>
<td>9.5 x 10⁵</td>
<td>16.8</td>
<td>1.9 - 2.9</td>
<td>57</td>
<td>5.7 x 10⁶</td>
<td>11.4 - 17.1</td>
</tr>
<tr>
<td>12 well</td>
<td>22.1</td>
<td>3.8</td>
<td>3.8 x 10⁵</td>
<td>6.9</td>
<td>0.760 - 1.14</td>
<td>45.6</td>
<td>4.56 x 10⁶</td>
<td>9.1 - 13.7</td>
</tr>
<tr>
<td>24 well</td>
<td>15.6</td>
<td>1.9</td>
<td>1.9 x 10⁵</td>
<td>3.4</td>
<td>0.380 - 0.570</td>
<td>45.6</td>
<td>4.56 x 10⁶</td>
<td>9.1 - 13.7</td>
</tr>
<tr>
<td>48 well</td>
<td>11</td>
<td>0.95</td>
<td>9.5 x 10⁴</td>
<td>1.6</td>
<td>0.19 - 0.285</td>
<td>45.6</td>
<td>38.4 x 10⁶</td>
<td>9.1 - 13.7</td>
</tr>
</tbody>
</table>

*Assumes an average yield of 1 x 10⁵ cells/cm² from a 100% confluent culture. Yields from many cell types can be lower than this.

Visit www.corning.com/lifesciences for additional product and technical information.
Corning® and Costar® 96 Well Cell Culture Plates

- **Corning CellBIND® Surface** is a novel cell culture treatment that increases surface wettability for more even and consistent cell attachment.
- **Ultra-Low Attachment** plates feature a covalently bound hydrogel layer that minimizes cell attachment, protein absorption and cellular activation.
- **Ultra-Web™ Synthetic Surface** is composed of electrospun polyamide nanofibers, creating a culturing substrate that mimics structural components within the basement membrane or extracellular matrix.
- **Corning Poly-D-Lysine (PDL)** microplates are coated with PDL (molecular weight range of 70 to 150 kDa) giving the surface a net positive charge for better cell attachment.
- Nonreversible lids with condensation rings to reduce contamination (except where noted).
- Treated for optimal cell attachment (except where noted).
- Sterilized by gamma radiation, certified nonpyrogenic.
- Individual alphanumeric codes for well identification, flat bottoms (except where noted).

Black plates are designed to lower background in fluorescent assays and reduce crosstalk. White plates are designed for luminescent assays. Some plates have the Corning CellBIND surface or a poly-D-lysine coating to enhance cell attachment. Corning offers many other 96 well plate types for applications other than cell culture; for a complete listing, check the catalog at [www.corning.com/lifesciences](http://www.corning.com/lifesciences).

### Corning® Assay Surface Properties and Applications

<table>
<thead>
<tr>
<th>Corning Surface</th>
<th>Applications</th>
<th>Binding Interaction</th>
<th>Sample Properties</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard Tissue Culture Surface</td>
<td>Assays using standard attachment dependent cell lines</td>
<td>Hydrophilic and ionic interactions (negatively charged)</td>
<td>Allows cell attachment and binding</td>
</tr>
<tr>
<td>Corning CellBIND Surface</td>
<td>Assays for difficult to attach cells</td>
<td>Hydrophilic and ionic interactions (negatively charged)</td>
<td>Enhances cell attachment uniformity and binding to polystyrene</td>
</tr>
<tr>
<td></td>
<td>Help cells stay attached during washing steps</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Poly-D-Lysine-Coated Surface</td>
<td>Assays for difficult to attach cells</td>
<td>Hydrophilic and ionic interactions (positively charged)</td>
<td>Enhances cell attachment and binding</td>
</tr>
<tr>
<td></td>
<td>Help cells stay attached during washing steps</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ultra-Low Attachment Surface</td>
<td>Assays where preventing cell attachment is required</td>
<td>Nonionic hydrogel layer reduces or eliminates ionic and hydrophobic binding</td>
<td>Prevents or reduces cell attachment and binding</td>
</tr>
<tr>
<td></td>
<td>Hybridoma production and clonal isolation by limiting dilution</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ultra-Web Surface</td>
<td>Assays where cell attachment or performance is enhanced by using a 3D surface</td>
<td>Hydrophilic interactions on a 3D surface</td>
<td>Enhances cell attachment and performance</td>
</tr>
<tr>
<td>Ultra-Web Polyamine Surface</td>
<td>Assays where cell attachment or performance is enhanced by using a 3D surface</td>
<td>Hydrophilic and ionic interactions (positively charged) on a 3D surface</td>
<td>Enhances cell attachment and performance</td>
</tr>
</tbody>
</table>
### Well Geometry

<table>
<thead>
<tr>
<th>Volume</th>
<th>360 µL</th>
<th>330 µL</th>
<th>320 µL</th>
<th>190 µL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Height</td>
<td>6.9 mm</td>
<td>6.9 mm</td>
<td>6.9 mm</td>
<td>5.0 mm</td>
</tr>
<tr>
<td>Width</td>
<td>10.7 mm</td>
<td>10.7 mm</td>
<td>10.5 mm</td>
<td>4.3 mm</td>
</tr>
</tbody>
</table>

### 96 Well Plate Ordering Information

<table>
<thead>
<tr>
<th>Cat. No.</th>
<th>Surface</th>
<th>Description</th>
<th>Qty/ Pk</th>
<th>Qty/ Cs</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Clear Plates</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3300</td>
<td>Corning® CellBIND® Surface</td>
<td>Standard clear plate</td>
<td>5</td>
<td>50</td>
</tr>
<tr>
<td>3596</td>
<td>TC</td>
<td>Standard clear plate</td>
<td>1</td>
<td>50</td>
</tr>
<tr>
<td>3997</td>
<td>TC</td>
<td>Standard clear plate</td>
<td>10</td>
<td>50</td>
</tr>
<tr>
<td>3598</td>
<td>TC</td>
<td>Standard clear plate</td>
<td>5</td>
<td>100</td>
</tr>
<tr>
<td>3599</td>
<td>TC</td>
<td>Standard clear plate</td>
<td>1</td>
<td>100</td>
</tr>
<tr>
<td>3585</td>
<td>TC</td>
<td>Standard clear plate with special low evaporation lid</td>
<td>5</td>
<td>50</td>
</tr>
<tr>
<td>3595</td>
<td>TC</td>
<td>Standard clear plate with special low evaporation lid</td>
<td>1</td>
<td>50</td>
</tr>
<tr>
<td>3696</td>
<td>TC</td>
<td>96 well half area, flat bottom clear plate</td>
<td>1</td>
<td>50</td>
</tr>
<tr>
<td>3697</td>
<td>TC</td>
<td>96 well half area clear plate</td>
<td>20</td>
<td>100</td>
</tr>
<tr>
<td>3790</td>
<td>Not Treated</td>
<td>96 well round bottom, polypropylene plate with polystyrene lid</td>
<td>1</td>
<td>50</td>
</tr>
<tr>
<td>3799</td>
<td>TC</td>
<td>96 well round bottom clear plate</td>
<td>1</td>
<td>50</td>
</tr>
<tr>
<td>3894</td>
<td>TC</td>
<td>96 well V-bottom clear plate</td>
<td>1</td>
<td>50</td>
</tr>
<tr>
<td>3665</td>
<td>Poly-D-lysine</td>
<td>Standard clear plate, coated</td>
<td>20</td>
<td>100</td>
</tr>
<tr>
<td>9102</td>
<td>TC</td>
<td>8-well strip plate, assembled 12 strips per plate</td>
<td>1</td>
<td>50</td>
</tr>
<tr>
<td>3474</td>
<td>Ultra-Low Attachment</td>
<td>Standard clear plate with hydrogel*</td>
<td>1</td>
<td>24</td>
</tr>
<tr>
<td>7007</td>
<td>Ultra-Low Attachment</td>
<td>96 well round bottom plate with hydrogel*</td>
<td>1</td>
<td>24</td>
</tr>
<tr>
<td><strong>White Plates</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3917</td>
<td>TC</td>
<td>Solid white plate</td>
<td>20</td>
<td>100</td>
</tr>
<tr>
<td>3362</td>
<td>TC</td>
<td>Solid white plate without lid</td>
<td>25</td>
<td>100</td>
</tr>
<tr>
<td>3688</td>
<td>TC</td>
<td>96 well half area solid white plate</td>
<td>20</td>
<td>100</td>
</tr>
<tr>
<td>3885</td>
<td>TC</td>
<td>96 well half area white plate with clear bottom</td>
<td>20</td>
<td>100</td>
</tr>
<tr>
<td>3610</td>
<td>TC</td>
<td>White plate with clear bottom</td>
<td>1</td>
<td>48</td>
</tr>
<tr>
<td>3903</td>
<td>TC</td>
<td>White plate with clear bottom</td>
<td>20</td>
<td>100</td>
</tr>
<tr>
<td>3666</td>
<td>Poly-D-lysine</td>
<td>White plate with clear bottom</td>
<td>20</td>
<td>100</td>
</tr>
<tr>
<td><strong>Black Plates</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3340</td>
<td>Corning CellBIND Surface</td>
<td>Black plate with clear bottom</td>
<td>5</td>
<td>50</td>
</tr>
<tr>
<td>3872XX1</td>
<td>Ultra-Web™ Synthetic Surface</td>
<td>Black plate with clear bottom, with lid</td>
<td>5</td>
<td>10</td>
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<tr>
<td>3873XX1</td>
<td>Ultra-Web Synthetic Polyamine Surface</td>
<td>Black plate with clear bottom, with lid</td>
<td>5</td>
<td>10</td>
</tr>
<tr>
<td>3916</td>
<td>TC</td>
<td>Solid black plate</td>
<td>20</td>
<td>100</td>
</tr>
<tr>
<td>3875</td>
<td>TC</td>
<td>96 well half area solid black plate</td>
<td>20</td>
<td>100</td>
</tr>
<tr>
<td>3882</td>
<td>TC</td>
<td>96 well half area black plate with clear bottom</td>
<td>20</td>
<td>100</td>
</tr>
<tr>
<td>3603</td>
<td>TC</td>
<td>Black plate with clear bottom</td>
<td>1</td>
<td>48</td>
</tr>
<tr>
<td>3904</td>
<td>TC</td>
<td>Black plate with clear bottom</td>
<td>20</td>
<td>100</td>
</tr>
<tr>
<td>3667</td>
<td>Poly-D-lysine</td>
<td>Black plate with clear bottom</td>
<td>25</td>
<td>100</td>
</tr>
<tr>
<td>3614</td>
<td>TC</td>
<td>Black plate with special optics, ultrathin, clear bottom, without lid</td>
<td>20</td>
<td>100</td>
</tr>
<tr>
<td><strong>Lids and Tape</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3099</td>
<td>–</td>
<td>Universal lid, sterile</td>
<td>25</td>
<td>50</td>
</tr>
<tr>
<td>3345</td>
<td>–</td>
<td>Breathable Sealing tape, sterile</td>
<td>50</td>
<td>500</td>
</tr>
<tr>
<td>3930</td>
<td>–</td>
<td>Rigid styrene lid with condensation rings, sterile</td>
<td>1</td>
<td>100</td>
</tr>
<tr>
<td>3931</td>
<td>–</td>
<td>Rigid styrene lid with condensation rings, sterile</td>
<td>25</td>
<td>50</td>
</tr>
</tbody>
</table>

*This covalently bonded hydrogel surface minimizes cell attachment, protein absorption, enzyme activation and cellular activation. The surface is nontoxic, biologically inert and nondegradable.

---

**Cell Culture Tip**

Check the Corning web site ([www.corning.com/lifesciences](http://www.corning.com/lifesciences)) for technical cell culture application bulletins.

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Visit [www.corning.com/lifesciences](http://www.corning.com/lifesciences) for additional product and technical information.
96 Well Cell Culture Plates

Well Dimensions, Expected Cell Yields, and Recommended Medium Volume

<table>
<thead>
<tr>
<th>Cell Culture Plates</th>
<th>Well Diameter (Bottom, mm)</th>
<th>Single Well Only</th>
<th>Entire Plate</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Approx. Growth Area (cm²)</td>
<td>Average Cell Yield *</td>
<td>Total Well Volume (mL)</td>
</tr>
<tr>
<td>96 well flat bottom</td>
<td>6.4</td>
<td>0.32</td>
<td>3.2 x 10⁶</td>
</tr>
<tr>
<td>96 well round bottom</td>
<td>6.4</td>
<td>NA†</td>
<td>NA†</td>
</tr>
<tr>
<td>96 well V' bottom</td>
<td>6.4</td>
<td>0.38</td>
<td>3.8 x 10⁶</td>
</tr>
<tr>
<td>96 half area</td>
<td>4.5</td>
<td>0.16</td>
<td>1.6 x 10⁶</td>
</tr>
</tbody>
</table>

*Assumes an average yield of 1 x 10⁶ cells/cm² from a 100% confluent culture. Yields from many cell types can be lower than this.
† Because these wells are round, the surface area available for cell attachment is dependent on the medium volume used.

384 Well Cell Culture Plates

- Flat bottoms and lids
- New low volume plates have only a 50 µL total well volume, with recommended working volume of 5 to 40 µL
- Treated for optimal cell attachment
- Sterilized by gamma radiation
- Certified nonpyrogenic

Black plates are designed to lower background in fluorescent assays and reduce crosstalk. White plates are designed for luminescent assays. Some plates have the Corning® CellBIND® Surface or a poly-D-lysine coating to enhance cell attachment. Corning offers many other 384 well plate types for applications other than cell culture; for a complete listing, check the catalog at www.corning.com/lifesiences.

384 Well Cell Culture Plate Ordering Information

<table>
<thead>
<tr>
<th>Cat. No.</th>
<th>Description</th>
<th>Surface</th>
<th>Qty/Pk</th>
<th>Qty/Cs</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>Clear Plates</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3701</td>
<td>Standard clear plate, low flange</td>
<td>TC</td>
<td>20</td>
<td>100</td>
</tr>
<tr>
<td>3662</td>
<td>Standard clear plate</td>
<td>Poly-D-lysine</td>
<td>25</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td><strong>White Plates</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3570</td>
<td>Solid white plate</td>
<td>TC</td>
<td>10</td>
<td>50</td>
</tr>
<tr>
<td>3707</td>
<td>White plate with clear bottom</td>
<td>TC</td>
<td>20</td>
<td>100</td>
</tr>
<tr>
<td>3663</td>
<td>White plate with clear bottom</td>
<td>Poly-D-lysine</td>
<td>25</td>
<td>100</td>
</tr>
<tr>
<td>3826</td>
<td>Solid white plate, low volume</td>
<td>TC</td>
<td>10</td>
<td>50</td>
</tr>
<tr>
<td></td>
<td><strong>Black Plates</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3571</td>
<td>Solid black plate, low flange</td>
<td>TC</td>
<td>10</td>
<td>50</td>
</tr>
<tr>
<td>3712</td>
<td>Black plate with clear bottom</td>
<td>TC</td>
<td>20</td>
<td>100</td>
</tr>
<tr>
<td>3664</td>
<td>Black plate with clear bottom</td>
<td>Poly-D-lysine</td>
<td>25</td>
<td>100</td>
</tr>
<tr>
<td>3683</td>
<td>Black plate with clear bottom</td>
<td>Corning CellBIND Surface</td>
<td>10</td>
<td>50</td>
</tr>
<tr>
<td>3542</td>
<td>Low volume, black plate with clear bottom</td>
<td>TC</td>
<td>10</td>
<td>50</td>
</tr>
<tr>
<td>3822</td>
<td>Low volume, solid black plate</td>
<td>TC</td>
<td>10</td>
<td>50</td>
</tr>
<tr>
<td>3985</td>
<td>Black optical imaging plate with clear bottom</td>
<td>TC</td>
<td>20</td>
<td>100</td>
</tr>
</tbody>
</table>

3707 and 3712 384 Well Clear Bottom Plates
Well Dimensions, Expected Cell Yields, and Recommended Medium Volumes

<table>
<thead>
<tr>
<th>Well Culture Plates</th>
<th>Well Diameter (Bottom, mm)</th>
<th>Approx. Growth Area (cm²)</th>
<th>Average Cell Yield¹</th>
<th>Total Well Volume (mL)</th>
<th>Working Volume (mL)</th>
<th>Approx. Growth Area (cm²)</th>
<th>Average Cell Yield¹</th>
<th>Working Volume (mL)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard 384 Well</td>
<td>2.7 x 2.7†</td>
<td>0.056</td>
<td>5.6 x 10¹</td>
<td>0.125</td>
<td>0.025 - 0.050</td>
<td>21.5</td>
<td>2.15 x 10⁶</td>
<td>9.6 - 19.2</td>
</tr>
<tr>
<td>Low Volume 384 Well</td>
<td>2.0</td>
<td>0.031</td>
<td>3.1 x 10¹</td>
<td>0.050</td>
<td>0.005 - 0.040</td>
<td>12.0</td>
<td>1.2 x 10⁶</td>
<td>1.9 - 15.3</td>
</tr>
</tbody>
</table>

¹Assumes an average yield of 1 x 10⁵ cells/cm² from a 100% confluent culture. Yields from many cell types can be lower than this.
†These wells are square.

1536 Well Cell Culture Plates

- Superior performance compared to competitor plates: lower CVs, higher signal-to-noise ratios, and lower background fluorescence
- Compatible with bar coding, standard readers and automation
- Recommended working volume of up to 8 µL
- Treated for optimal cell attachment
- Flat bottoms and lids
- Sterilized by gamma radiation
- Certified nonpyrogenic

Black plates are designed to lower background in fluorescent assays and reduce crosstalk. White plates are designed for luminescent assays. Corning offers other 1536 well plate types for applications other than cell culture; for a complete listing, check the catalog at www.corning.com/lifesciences.

1536 Well Cell Culture Plate Ordering Information

<table>
<thead>
<tr>
<th>Cat. No.</th>
<th>Description</th>
<th>Surface</th>
<th>Qty/Pk</th>
<th>Qty/Cs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clear Plates</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3853</td>
<td>Standard clear plate</td>
<td>TC</td>
<td>20</td>
<td>100</td>
</tr>
<tr>
<td>White Plates</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3727</td>
<td>Solid white plate</td>
<td>TC</td>
<td>10</td>
<td>50</td>
</tr>
<tr>
<td>3855</td>
<td>Solid white plate, low volume</td>
<td>TC</td>
<td>20</td>
<td>100</td>
</tr>
<tr>
<td>Black Plates</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3726</td>
<td>Solid black plate</td>
<td>TC</td>
<td>10</td>
<td>50</td>
</tr>
<tr>
<td>3893</td>
<td>Black clear bottom plate</td>
<td>TC</td>
<td>10</td>
<td>50</td>
</tr>
<tr>
<td>3854</td>
<td>Solid black plate, low volume</td>
<td>TC</td>
<td>20</td>
<td>100</td>
</tr>
</tbody>
</table>

Well Dimensions, Expected Cell Yields, and Recommended Medium Volumes

<table>
<thead>
<tr>
<th>Cell Culture Plates</th>
<th>Well Diameter (Bottom, mm)</th>
<th>Approx. Growth Area (cm²)</th>
<th>Average Cell Yield¹</th>
<th>Total Well Volume (µL)</th>
<th>Working Volume (µL)</th>
<th>Approx. Growth Area (cm²)</th>
<th>Average Cell Yield¹</th>
<th>Working Volume (µL)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1536 Well Clear Flat Bottom</td>
<td>1.63 x 1.63</td>
<td>0.025</td>
<td>2.5 x 10¹</td>
<td>12.5</td>
<td>5 - 8</td>
<td>38.3</td>
<td>3.8 x 10⁶</td>
<td>7.7 - 15.4</td>
</tr>
<tr>
<td>1536 Well Solid Flat Bottom</td>
<td>1.53 x 1.53</td>
<td>0.023</td>
<td>2.3 x 10¹</td>
<td>12.5</td>
<td>5 - 8</td>
<td>35.3</td>
<td>3.5 x 10⁶</td>
<td>7.7 - 15.4</td>
</tr>
</tbody>
</table>

¹Assumes an average yield of 1 x 10⁵ cells/cm² from a 100% confluent culture. Yields from many cell types can be lower than this.
Transwell® Permeable Supports

Transwell cell culture inserts are convenient, easy-to-use permeable support devices for the study of both anchorage-dependent and anchorage-independent cell lines
- Designed to produce a cell culture environment that closely resembles the in vivo state
- Allows polarized cells to feed basolaterally and thereby carry out metabolic activities in a more natural fashion
- Unique patented self-centered hanging design prevents medium wicking between the insert and outer well
- Permits access to the lower compartment through windows in the insert wall
- Suspended design allows for undamaged co-culturing of cells in the lower compartment
- Available in a range of pore sizes and different membranes to satisfy diverse experimental requirements

### Characteristics of Transwell Membranes

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Polyester (PET)</th>
<th>Polycarbonate</th>
<th>PTFE/Collagen</th>
</tr>
</thead>
<tbody>
<tr>
<td>Optical properties</td>
<td>Clear</td>
<td>Translucent</td>
<td>Clear when wet</td>
</tr>
<tr>
<td>Cell visibility</td>
<td>Good</td>
<td>Poor</td>
<td>Cell outlines</td>
</tr>
<tr>
<td>Tissue culture treated</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Membrane thickness</td>
<td>10 µm</td>
<td>10 µm</td>
<td>50 µm</td>
</tr>
<tr>
<td>Matrix/ECM coatable</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Collagen treated</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Available Pore Sizes (µm)</td>
<td>0.4, 1.0, 3.0, 8.0</td>
<td>0.4, 3.0, 5.0, 8.0</td>
<td>0.4, 3.0</td>
</tr>
</tbody>
</table>

### Chemical Compatibility

All of the Transwell membranes are compatible with histological fixatives including methanol and formaldehyde. The polyester Transwell membranes have the best overall chemical resistance. These membranes (but not the polystyrene housings) are compatible with many alcohols, amines, esters, ethers, ketones, oils and some solvents, including many halogenated hydrocarbons and DMSO but are not recommended for use with strong acids and bases.

### Pore Density

Of the three types of Transwell membranes, only the PTFE does not have a defined pore density because it is a tortuous path membrane. The two membranes with a nominally defined pore density are polycarbonate and polyester. The polyester Transwell membranes do not have as high a pore density as the polycarbonate Transwell but have better optical clarity as a result. The nominal pore densities for Corning® Polycarbonate and Polyester (PET) membranes are given in the following table.

---

**Transwell Permeable Supports Tip**

Check the Corning web site ([www.corning.com/lifesciences](http://www.corning.com/lifesciences)) for an extensive list of references, listed by application, citing the use of Transwell permeable supports in cell culture research.
Nominal Pore Densities for Transwell Polyester and Polycarbonate Membranes

<table>
<thead>
<tr>
<th>Pore Size</th>
<th>Polycarbonate Membrane Transwell (pores/cm²)</th>
<th>Transwell-Clear Polyester Membrane (pores/cm²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.4 µm</td>
<td>1 x 10^8</td>
<td>4 x 10^6</td>
</tr>
<tr>
<td>1.0 µm</td>
<td>n/a</td>
<td>1.6 x 10^6</td>
</tr>
<tr>
<td>3.0 µm</td>
<td>2 x 10^6</td>
<td>2 x 10^6</td>
</tr>
<tr>
<td>5.0 µm</td>
<td>4 x 10^5</td>
<td>n/a</td>
</tr>
<tr>
<td>8.0 µm</td>
<td>1 x 10^5</td>
<td>1 x 10^5</td>
</tr>
</tbody>
</table>

Growth Areas and Recommended Medium Volumes for Transwell Permeable Supports

<table>
<thead>
<tr>
<th>Multiple Well Plate or Dish Type</th>
<th>Transwell Insert Diameter (mm)</th>
<th>Insert Membrane Growth Area (cm²)</th>
<th>Volume Added per Plate Well</th>
<th>Volume Added to Inside of Transwell Insert (mL)</th>
</tr>
</thead>
<tbody>
<tr>
<td>HTS 96</td>
<td>4.26</td>
<td>0.143</td>
<td>0.235</td>
<td>0.075</td>
</tr>
<tr>
<td>HTS 24</td>
<td>6.5</td>
<td>0.33</td>
<td>0.6</td>
<td>0.1</td>
</tr>
<tr>
<td>24 well</td>
<td>6.5</td>
<td>0.33</td>
<td>0.6</td>
<td>0.1</td>
</tr>
<tr>
<td>12 well</td>
<td>12</td>
<td>1.12</td>
<td>1.5</td>
<td>0.5</td>
</tr>
<tr>
<td>6 well</td>
<td>24</td>
<td>4.67</td>
<td>2.6</td>
<td>1.5</td>
</tr>
<tr>
<td>100 mm dish</td>
<td>75</td>
<td>44</td>
<td>13</td>
<td>9</td>
</tr>
</tbody>
</table>

Transwell® Polycarbonate Membrane Insert

- 10 µm thick translucent membrane
- Pore sizes ranging from 0.4 µm to 8 µm diameters
- Treated for optimal cell attachment
- Supplied in multiple well plates
- Membrane must be stained for cell visibility
- Sterilized by gamma radiation

Transwell Polycarbonate Membrane Permeable Support Ordering Information

<table>
<thead>
<tr>
<th>Cat. No.</th>
<th>Membrane Diameter (mm)</th>
<th>Growth Surface Area (cm²)</th>
<th>Membrane Pore Size (µm)</th>
<th>Tissue Culture Treated</th>
<th>Inner Packaging*</th>
<th>Inserts/ Cs</th>
</tr>
</thead>
<tbody>
<tr>
<td>3413</td>
<td>6.5</td>
<td>0.33</td>
<td>0.4</td>
<td>Yes</td>
<td>12/plate*</td>
<td>48</td>
</tr>
<tr>
<td>3415</td>
<td>6.5</td>
<td>0.33</td>
<td>3.0</td>
<td>Yes</td>
<td>12/plate*</td>
<td>48</td>
</tr>
<tr>
<td>3421</td>
<td>6.5</td>
<td>0.33</td>
<td>5.0</td>
<td>Yes</td>
<td>12/plate*</td>
<td>48</td>
</tr>
<tr>
<td>3422</td>
<td>6.5</td>
<td>0.33</td>
<td>8.0</td>
<td>Yes</td>
<td>12/plate*</td>
<td>48</td>
</tr>
<tr>
<td>3401</td>
<td>12</td>
<td>1.12</td>
<td>0.4</td>
<td>Yes</td>
<td>12/plate</td>
<td>48</td>
</tr>
<tr>
<td>3402</td>
<td>12</td>
<td>1.12</td>
<td>3.0</td>
<td>Yes</td>
<td>12/plate</td>
<td>48</td>
</tr>
<tr>
<td>3412</td>
<td>24</td>
<td>4.67</td>
<td>0.4</td>
<td>Yes</td>
<td>6/plate</td>
<td>24</td>
</tr>
<tr>
<td>3414</td>
<td>24</td>
<td>4.67</td>
<td>3.0</td>
<td>Yes</td>
<td>6/plate</td>
<td>24</td>
</tr>
<tr>
<td>3428</td>
<td>24</td>
<td>4.67</td>
<td>8.0</td>
<td>Yes</td>
<td>6/plate</td>
<td>24</td>
</tr>
<tr>
<td>3419</td>
<td>75</td>
<td>44</td>
<td>0.4</td>
<td>Yes</td>
<td>1/dish</td>
<td>12</td>
</tr>
<tr>
<td>3420</td>
<td>75</td>
<td>44</td>
<td>3.0</td>
<td>Yes</td>
<td>1/dish</td>
<td>12</td>
</tr>
</tbody>
</table>

*6.5 mm membrane diameter are packaged 12 inserts in a 24 well plate, 4 plates per case.
**Corning® Transwell® Invasion Inserts**

Transwell Polycarbonate Membrane Insert Coated with Cultiex® Basement Membrane Extract

- 8 μm pore size membrane, 10 μm thick
- Coated with Cultiex basement membrane extract
- For cell invasion assays
- Supplied in 2-24 well plates, 12 inserts per plate

**Transwell Cultiex Polycarbonate Membrane Permeable Support Ordering Information**

<table>
<thead>
<tr>
<th>Cat. No.</th>
<th>Membrane Diameter (mm)</th>
<th>Growth Surface Area (cm²)</th>
<th>Membrane Pore Size (μm)</th>
<th>Tissue Culture Treated</th>
<th>Inner Packaging</th>
<th>Inserts/Cs</th>
</tr>
</thead>
<tbody>
<tr>
<td>3458</td>
<td>6.5</td>
<td>0.33</td>
<td>0.8</td>
<td>Yes</td>
<td>12/plate</td>
<td>24</td>
</tr>
</tbody>
</table>

**Transwell-Clear Polyester Membrane Insert**

- 10 μm transparent membrane
- Treated for optimal cell attachment
- Excellent visibility under phase contrast microscopy
- Supplied in multiple well plates
- Sterilized by gamma radiation

**Transwell-Clear Insert Ordering Information**

<table>
<thead>
<tr>
<th>Cat. No.</th>
<th>Membrane Diameter (mm)</th>
<th>Growth Surface Area (cm²)</th>
<th>Membrane Pore Size (μm)</th>
<th>Inner Packaging</th>
</tr>
</thead>
<tbody>
<tr>
<td>3450</td>
<td>24</td>
<td>4.67</td>
<td>0.4</td>
<td>6/plate</td>
</tr>
<tr>
<td>3452</td>
<td>24</td>
<td>4.67</td>
<td>3.0</td>
<td>6/plate</td>
</tr>
<tr>
<td>3460</td>
<td>12</td>
<td>1.12</td>
<td>0.4</td>
<td>12/plate</td>
</tr>
<tr>
<td>3462</td>
<td>12</td>
<td>1.12</td>
<td>3.0</td>
<td>12/plate</td>
</tr>
<tr>
<td>3470</td>
<td>6.5</td>
<td>0.33</td>
<td>0.4</td>
<td>12/plate*</td>
</tr>
<tr>
<td>3472</td>
<td>6.5</td>
<td>0.33</td>
<td>3.0</td>
<td>12/plate*</td>
</tr>
</tbody>
</table>

*6.5 mm membrane diameter are packaged 12 inserts in a 24 well plate, 4 plates per case.

**Transwell-COL Collagen-Coated Membrane Insert**

- Transparent collagen treated PTFE membrane
- Promotes cell attachment and spreading
- Equimolar mixture of types I and III collagen
- Individually packaged
- Multiple well plates included in each case
- Supplied sterile

**Transwell-COL Insert Ordering Information**

<table>
<thead>
<tr>
<th>Cat. No.</th>
<th>Membrane Diameter (mm)</th>
<th>Growth Surface Area (cm²)</th>
<th>Membrane Pore Size (μm)</th>
<th>Inner Packaging</th>
<th>Multiple Well Plate</th>
<th>Inserts/Cs</th>
</tr>
</thead>
<tbody>
<tr>
<td>3491</td>
<td>24</td>
<td>4.67</td>
<td>0.4</td>
<td>Individual</td>
<td>6 well</td>
<td>24</td>
</tr>
<tr>
<td>3492</td>
<td>24</td>
<td>4.67</td>
<td>3.0</td>
<td>Individual</td>
<td>6 well</td>
<td>24</td>
</tr>
<tr>
<td>3493</td>
<td>12</td>
<td>1.12</td>
<td>0.4</td>
<td>Individual</td>
<td>12 well</td>
<td>24</td>
</tr>
<tr>
<td>3494</td>
<td>12</td>
<td>1.12</td>
<td>3.0</td>
<td>Individual</td>
<td>12 well</td>
<td>24</td>
</tr>
<tr>
<td>3495*</td>
<td>6.5</td>
<td>0.33</td>
<td>0.4</td>
<td>Individual</td>
<td>24 well</td>
<td>24</td>
</tr>
<tr>
<td>3496*</td>
<td>6.5</td>
<td>0.33</td>
<td>3.0</td>
<td>Individual</td>
<td>24 well</td>
<td>24</td>
</tr>
</tbody>
</table>

*Includes twenty-four 6.5 mm inserts packaged separately with two 24 well plates.
**Snapwell™ Inserts**

- A modified Transwell permeable support containing a 12 mm diameter membrane supported by a detachable ring
- Once cells are grown to confluence on the Snapwell insert, the ring can be placed in a vertical or horizontal diffusion chamber
- Sterilized by gamma radiation
- Packaged in 6 well plates

**Snapwell Insert Ordering Information**

<table>
<thead>
<tr>
<th>Cat. No.</th>
<th>Membrane Pore Size (µm)</th>
<th>Membrane</th>
<th>Inner Packaging</th>
<th>Inserts/Cs</th>
</tr>
</thead>
<tbody>
<tr>
<td>3407</td>
<td>0.4</td>
<td>Polycarbonate</td>
<td>6/plate</td>
<td>24</td>
</tr>
<tr>
<td>3802</td>
<td>3.0</td>
<td>Polycarbonate</td>
<td>6/plate</td>
<td>24</td>
</tr>
<tr>
<td>3801</td>
<td>0.4</td>
<td>Clear Polyester</td>
<td>6/plate</td>
<td>24</td>
</tr>
</tbody>
</table>

*Diffusion Chambers are available through Harvard Apparatus (www.harvardapparatus.com)*

**Corning® HTS Transwell®-24 Well Permeable Supports**

- The HTS Transwell-24 Well Permeable Support has an array of 24 wells with membrane inserts connected by a rigid, robotics-friendly tray that enables all 24 Transwell supports to be handled as a single unit
- Cell growth area is 0.33 cm²/well
- Choice of either polyester (PET) membrane (0.4 µm pore size) or polycarbonate (PC) membrane (0.4 µm, 3.0 µm pore sizes)
- Treated for optimal cell attachment
- Individual pack has 2 HTS Transwell-24 units loaded into two open reservoir trays and two individually wrapped 24 well plates
- Bulk pack has 12 HTS Transwell-24 units loaded into 24 well plates only. Reservoirs may be purchased separately
- Sterilized by gamma radiation

**HTS Transwell-24 Well Permeable Supports Ordering Information**

<table>
<thead>
<tr>
<th>Cat. No.</th>
<th>Description</th>
<th>Membrane Pore Size (µm)</th>
<th>Membrane</th>
<th>Qty/Pk</th>
<th>Plates/Cs</th>
</tr>
</thead>
<tbody>
<tr>
<td>3396</td>
<td>HTS Transwell-24, individual</td>
<td>0.4</td>
<td>PC</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>3397</td>
<td>HTS Transwell-24, bulk</td>
<td>0.4</td>
<td>PC</td>
<td>12</td>
<td>12</td>
</tr>
<tr>
<td>3398</td>
<td>HTS Transwell-24, individual</td>
<td>3.0</td>
<td>PC</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>3399</td>
<td>HTS Transwell-24, bulk</td>
<td>3.0</td>
<td>PC</td>
<td>12</td>
<td>12</td>
</tr>
<tr>
<td>3395</td>
<td>HTS Transwell nontreated reservoir</td>
<td>–</td>
<td>–</td>
<td>12</td>
<td>48</td>
</tr>
<tr>
<td>3378</td>
<td>HTS Transwell-24, bulk</td>
<td>0.4</td>
<td>PET</td>
<td>12</td>
<td>12</td>
</tr>
<tr>
<td>3379</td>
<td>HTS Transwell-24, individual</td>
<td>0.4</td>
<td>PET</td>
<td>1</td>
<td>2</td>
</tr>
</tbody>
</table>

Visit [www.corning.com/lifesciences](http://www.corning.com/lifesciences) for additional product and technical information.
Corning® HTS Transwell®-96 Well Permeable Support Systems and Plates

- The HTS Transwell-96 Well Permeable Support has an array of 96 wells with membrane inserts connected by a rigid, robotics-friendly tray that enables all 96 inserts to be handled as a single unit
- Choice of either polyester (PET) membrane (1.0 µm, 8.0 µm pore sizes) or polycarbonate (PC) membrane (0.4 µm, 3.0 µm, 5.0 µm pore sizes)
- 0.143 cm² membrane area per well, providing 20 to 50% more surface area for cell growth than other commercially available systems
- Large apical and basolateral access ports allow efficient media sampling and facilitate automated or manual access
- Optimized for automation, with multichannel feeder ports, improved gripping surface, and standard bar codes
- The reservoir plate allows for simultaneous feeding of 96 wells and comes with a removable media stabilizer to reduce the risk of spills during handling
- The receiver plate isolates each well to enable 96 individual assays
- Sterilized by gamma radiation
- The HTS Transwell-96 Systems (0.4 µm PC and 1.0 µm PET) are packaged with the 96 well insert plate in a reservoir plate and includes the 96 well receiver plate with lid.
- The HTS Transwell-96 Well Plates (3.0 and 5.0 µm PC, 8.0 µm PET) are packaged with the 96 well insert plate in the 96 well receiver plate with lid. Reservoir plates may be purchased separately.

HTS Transwell®-96 Well Permeable Supports Ordering Information

<table>
<thead>
<tr>
<th>Cat. No.</th>
<th>Description</th>
<th>Membrane Pore Size (µm)</th>
<th>Membrane</th>
<th>Qty/ Pk</th>
<th>Qty/ Cs</th>
</tr>
</thead>
<tbody>
<tr>
<td>3381</td>
<td>HTS Transwell-96 System, reservoir and receiver plates with 2 lids</td>
<td>0.4</td>
<td>PC</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>3391</td>
<td>HTS Transwell-96 System, reservoir and receiver plates with 2 lids</td>
<td>0.4</td>
<td>PC</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>3380</td>
<td>HTS Transwell-96 System, reservoir and receiver plates with 2 lids</td>
<td>1.0</td>
<td>PET</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>3392</td>
<td>HTS Transwell-96 System, reservoir and receiver plates with 2 lids</td>
<td>1.0</td>
<td>PET</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>3385</td>
<td>HTS Transwell-96 Well Plate, receiver plate and lid, individual</td>
<td>3.0</td>
<td>PC</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>3386</td>
<td>HTS Transwell-96 Well Plate, receiver plate and lid, bulk</td>
<td>3.0</td>
<td>PC</td>
<td>4</td>
<td>8</td>
</tr>
<tr>
<td>3387</td>
<td>HTS Transwell-96 Well Plate, receiver plate and lid, bulk</td>
<td>5.0</td>
<td>PC</td>
<td>4</td>
<td>8</td>
</tr>
<tr>
<td>3388</td>
<td>HTS Transwell-96 Well Plate, receiver plate and lid, individual</td>
<td>5.0</td>
<td>PC</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>3374</td>
<td>HTS Transwell-96 Well Plate, receiver plate and lid, individual</td>
<td>8.0</td>
<td>PET</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>3384</td>
<td>HTS Transwell-96 Well Plate, receiver plate and lid, bulk</td>
<td>8.0</td>
<td>PET</td>
<td>4</td>
<td>8</td>
</tr>
<tr>
<td>3382</td>
<td>HTS Transwell-96 receiver plate with lid, tissue culture treated</td>
<td>n/a</td>
<td>n/a</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>3383</td>
<td>HTS Transwell-96 reservoir plate with removable media stabilizer and lid, not treated</td>
<td>n/a</td>
<td>n/a</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>3583</td>
<td>HTS Transwell-96 black receiver plate with lid, tissue culture treated</td>
<td>n/a</td>
<td>n/a</td>
<td>10</td>
<td>10</td>
</tr>
</tbody>
</table>
**Netwell™ Inserts**

- Costar® Netwell inserts have polyester mesh bottoms attached to polystyrene rings or housing
- They are used as tissue carriers, supports and strainers for culture of small organs, tissue slices or explants at the air-media interface
- Handy carrier for immunocytochemical staining of tissue slices (see accessories below)
- Provides coarse filtration of tissue homogenates, cell suspensions and microcarriers
- Available in two mesh sizes and diameters
- Supplied sterile and preloaded in 6- or 12-well plates
- 24 mm Netwell inserts fit in Corning® 50 mL plastic centrifuge tubes

<table>
<thead>
<tr>
<th>Cat. No.</th>
<th>Membrane Dia. (mm)</th>
<th>Polyester Membrane Mesh Size (µm)</th>
<th>Sterile</th>
<th>Inner Packaging</th>
<th>Inserts/Cs</th>
</tr>
</thead>
<tbody>
<tr>
<td>3477</td>
<td>15</td>
<td>74</td>
<td>Yes</td>
<td>12/plate</td>
<td>48</td>
</tr>
<tr>
<td>3478</td>
<td>15</td>
<td>500</td>
<td>Yes</td>
<td>12/plate</td>
<td>48</td>
</tr>
<tr>
<td>3479</td>
<td>24</td>
<td>74</td>
<td>Yes</td>
<td>6/plate</td>
<td>48</td>
</tr>
<tr>
<td>3480</td>
<td>24</td>
<td>500</td>
<td>Yes</td>
<td>6/plate</td>
<td>48</td>
</tr>
</tbody>
</table>

**Netwell Accessories**

- Specially designed Netwell carriers and handles allow simultaneous processing of up to 12 samples per carrier
- Polystyrene reagent trays are available in white for colorimetric reaction contrast, or black for better visibility of tissue sections
- Each carrier kit contains eight carriers and eight handles

<table>
<thead>
<tr>
<th>Cat. No.</th>
<th>Description</th>
<th>Qty/Cs</th>
</tr>
</thead>
<tbody>
<tr>
<td>3517</td>
<td>Netwell Reagent Tray, black</td>
<td>200</td>
</tr>
<tr>
<td>3519</td>
<td>Netwell Reagent Tray, white</td>
<td>200</td>
</tr>
<tr>
<td>3520</td>
<td>Netwell Carrier Kit, 15 mm</td>
<td>8</td>
</tr>
<tr>
<td>3521</td>
<td>Netwell Carrier Kit, 24 mm</td>
<td>8</td>
</tr>
</tbody>
</table>

**Culture Tubes**

- Manufactured from optically clear polystyrene
- Threaded plug seal caps prevent leakage
- Cell culture treated tubes supplied racked
- Untreated tubes provided bulk packed
- Sterilized by gamma radiation
- Certified nonpyrogenic

<table>
<thead>
<tr>
<th>Cat. No.</th>
<th>Treated</th>
<th>Size (mm)</th>
<th>Cap Style</th>
<th>Qty/Pk</th>
<th>Qty/Cs</th>
</tr>
</thead>
<tbody>
<tr>
<td>430157</td>
<td>No</td>
<td>16 x 125</td>
<td>Screw Top</td>
<td>25</td>
<td>500</td>
</tr>
<tr>
<td>430172</td>
<td>Yes</td>
<td>16 x 125</td>
<td>Screw Top</td>
<td>50</td>
<td>500</td>
</tr>
</tbody>
</table>

Visit [www.corning.com/lifesciences](http://www.corning.com/lifesciences) for additional product and technical information.
Roller Bottles

Roller Bottles
- Manufactured from virgin polystyrene
- Treated for optimal cell attachment
- One piece seamless construction
- Most bottles have graduations.
- All bottles have printed lot numbers to aid in product traceability.
- Sterilized by gamma radiation
- Certified nonpyrogenic

Roller Bottle Ordering Information

<table>
<thead>
<tr>
<th>Cat. No.</th>
<th>Surface</th>
<th>Surface Area (cm²)</th>
<th>Cap Style</th>
<th>Graduations</th>
<th>Qty/Pk</th>
<th>Qty/Cs</th>
</tr>
</thead>
<tbody>
<tr>
<td>430195</td>
<td>TC</td>
<td>490</td>
<td>Plug Seal</td>
<td>No</td>
<td>2</td>
<td>40</td>
</tr>
<tr>
<td>430699</td>
<td>TC</td>
<td>1,750</td>
<td>Easy Grip</td>
<td>Yes</td>
<td>10</td>
<td>20</td>
</tr>
<tr>
<td>430849</td>
<td>TC</td>
<td>850</td>
<td>Easy Grip</td>
<td>Yes</td>
<td>2</td>
<td>40</td>
</tr>
<tr>
<td>431133</td>
<td>TC</td>
<td>850</td>
<td>Easy Grip</td>
<td>Yes</td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td>431198</td>
<td>TC</td>
<td>850</td>
<td>Easy Grip Vent</td>
<td>Yes</td>
<td>2</td>
<td>40</td>
</tr>
<tr>
<td>430851</td>
<td>TC</td>
<td>850</td>
<td>Easy Grip</td>
<td>Yes</td>
<td>5</td>
<td>40</td>
</tr>
<tr>
<td>431318</td>
<td>TC</td>
<td>850</td>
<td>Easy Grip</td>
<td>No</td>
<td>20</td>
<td>80</td>
</tr>
<tr>
<td>431321</td>
<td>TC</td>
<td>850</td>
<td>Easy Grip</td>
<td>Yes</td>
<td>22</td>
<td>44</td>
</tr>
<tr>
<td>3907</td>
<td>Corning® CellBIND® Surface</td>
<td>850</td>
<td>Easy Grip</td>
<td>Yes</td>
<td>2</td>
<td>40</td>
</tr>
<tr>
<td>431329</td>
<td>Corning CellBIND Surface</td>
<td>850</td>
<td>Easy Grip Vent</td>
<td>Yes</td>
<td>2</td>
<td>40</td>
</tr>
<tr>
<td>431344</td>
<td>Corning CellBIND Surface</td>
<td>850</td>
<td>Easy Grip</td>
<td>Yes</td>
<td>22</td>
<td>44</td>
</tr>
</tbody>
</table>

Expanded Surface Roller Bottles
- Same features as standard roller bottles
- Ribbed design provides twice the surface area with the same exterior dimensions

Expanded Surface Roller Bottle Ordering Information

<table>
<thead>
<tr>
<th>Cat. No.</th>
<th>Surface</th>
<th>Surface Area (cm²)</th>
<th>Cap Style</th>
<th>Graduations</th>
<th>Qty/Pk</th>
<th>Qty/Cs</th>
</tr>
</thead>
<tbody>
<tr>
<td>430852</td>
<td>TC</td>
<td>1,700</td>
<td>Easy Grip</td>
<td>Yes</td>
<td>2</td>
<td>40</td>
</tr>
<tr>
<td>430853</td>
<td>TC</td>
<td>1,700</td>
<td>Easy Grip</td>
<td>Yes</td>
<td>5</td>
<td>40</td>
</tr>
<tr>
<td>431134</td>
<td>Corning CellBIND Surface</td>
<td>1,700</td>
<td>Easy Grip</td>
<td>Yes</td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td>431135</td>
<td>TC</td>
<td>1,700</td>
<td>Easy Grip</td>
<td>Yes</td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td>431191</td>
<td>TC</td>
<td>1,700</td>
<td>Easy Grip Vent</td>
<td>Yes</td>
<td>20</td>
<td>20</td>
</tr>
</tbody>
</table>

Expected Cell Yields and Recommended Medium Volumes

<table>
<thead>
<tr>
<th>Corning Roller Bottles</th>
<th>Approximate Growth Area (cm²)</th>
<th>Average Cell Yield¹</th>
<th>Recommended Medium Volume (mL)</th>
</tr>
</thead>
<tbody>
<tr>
<td>490 cm² roller bottle</td>
<td>490</td>
<td>$4.9 \times 10^7$</td>
<td>100 - 150</td>
</tr>
<tr>
<td>850 cm² roller bottle</td>
<td>850</td>
<td>$8.5 \times 10^7$</td>
<td>170 - 255</td>
</tr>
<tr>
<td>1700 cm² roller bottle</td>
<td>1,700</td>
<td>$1.7 \times 10^8$</td>
<td>340 - 510</td>
</tr>
<tr>
<td>1750 cm² roller bottle</td>
<td>1,750</td>
<td>$1.75 \times 10^8$</td>
<td>350 - 525</td>
</tr>
</tbody>
</table>

¹Assumes an average yield of $1 \times 10^8$ cells/cm² from a 100% confluent culture. Yields from many cell types can be lower than this.
Polyethylene Roller Bottle Caps

Caps are sold separately and are available individually wrapped in either Easy Grip or Easy Grip Vent Cap designs.

<table>
<thead>
<tr>
<th>Cat. No.</th>
<th>Cap Style</th>
<th>Qty/Pk</th>
<th>Qty/Cs</th>
</tr>
</thead>
<tbody>
<tr>
<td>430698</td>
<td>Easy Grip</td>
<td>1</td>
<td>100</td>
</tr>
<tr>
<td>431132</td>
<td>Easy Grip Vent</td>
<td>1</td>
<td>300</td>
</tr>
</tbody>
</table>

Corning is committed to partnering with you, our customer, to provide solutions that increase your efficiency and productivity. We offer the ability to customize packaging and cap design to meet your specific requirements. Minimum order quantities apply. Please call us or contact your local Corning Office for more details. See back cover for contact information.

HYPERFlask™ Cell Culture Vessel

The new Corning HYPERFlask Vessel offers 1720 cm² growth area in the footprint of a traditional 175 cm² flask. This high yield, high performance flask utilizes a multilayered gas permeable growing surface for efficient gas exchange.

<table>
<thead>
<tr>
<th>Cat. No.</th>
<th>Description</th>
<th>Qty/Pk</th>
<th>Qty/Cs</th>
</tr>
</thead>
<tbody>
<tr>
<td>10010</td>
<td>HYPERFlask Vessel, 1720 cm², Corning CellBIND Surface, Bar Code, Sterile</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>10024</td>
<td>HYPERFlask Vessel, 1720 cm², Corning CellBIND Surface, Bar Code, Sterile</td>
<td>4</td>
<td>24</td>
</tr>
</tbody>
</table>

Visit [www.corning.com/lifesciences](http://www.corning.com/lifesciences) for additional product and technical information.
Corning® CellSTACK® Culture Chambers

- Available in Five Sizes
  - 1-Stack with 636 cm² cell growth area
  - 2-Stack with 1,272 cm² cell growth area
  - 5-Stack with 3,180 cm² cell growth area
  - 10-Stack with 6,360 cm² cell growth area
  - 40-Stack with 25,440 cm² cell growth area
- Choice of traditional surface treatment, new Corning CellBIND® Surface for enhanced cell attachment, or Ultra-Low Attachment Surface for reduced cell attachment
  - Great for reducing serum levels
  - Better attachment increases cell yields
  - May eliminate need for expensive coatings
- Greater Chamber Durability
  - Superior mechanical strength and structural integrity
  - Self venting caps prevent pressure build-up during transport
  - 100% leak tested prior to shipping
- Greater Cleanliness
  - Improved assembly procedures reduce particulates
  - Certified nonpyrogenic and sterilized by gamma irradiation
- Continuous Supply Reliability
  - Manufactured in USA under GMP conditions
- Easier to Use
  - Larger openings with threaded closures and vented caps
  - Footprint identical to competitor’s product

### Corning CellSTACK Culture Chambers Ordering Information

<table>
<thead>
<tr>
<th>Cat. No.</th>
<th>Surface</th>
<th>Growth Area (cm²)</th>
<th>Description</th>
<th>Qty/Pk</th>
<th>Pk/Cs</th>
</tr>
</thead>
<tbody>
<tr>
<td>3330</td>
<td>Corning CellBIND Surface</td>
<td>636</td>
<td>CellSTACK-1 Chamber</td>
<td>1</td>
<td>8</td>
</tr>
<tr>
<td>3268</td>
<td>TC</td>
<td>636</td>
<td>CellSTACK-1 Chamber</td>
<td>1</td>
<td>8</td>
</tr>
<tr>
<td>3310</td>
<td>Corning CellBIND Surface</td>
<td>1,272</td>
<td>CellSTACK-2 Chamber</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>3269</td>
<td>TC</td>
<td>1,272</td>
<td>CellSTACK-2 Chamber</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>3311</td>
<td>Corning CellBIND Surface</td>
<td>3,180</td>
<td>CellSTACK-5 Chamber</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>3319</td>
<td>TC</td>
<td>3,180</td>
<td>CellSTACK-5 Chamber</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>3313</td>
<td>TC</td>
<td>3,180</td>
<td>CellSTACK-5 Chamber</td>
<td>1</td>
<td>8</td>
</tr>
<tr>
<td>3320</td>
<td>Corning CellBIND Surface</td>
<td>6,360</td>
<td>CellSTACK-10 Chamber</td>
<td>1</td>
<td>6</td>
</tr>
<tr>
<td>3312</td>
<td>Corning CellBIND Surface</td>
<td>6,360</td>
<td>CellSTACK-10 Chamber</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>3270</td>
<td>TC</td>
<td>6,360</td>
<td>CellSTACK-10 Chamber</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>3271</td>
<td>TC</td>
<td>6,360</td>
<td>CellSTACK-10 Chamber</td>
<td>1</td>
<td>6</td>
</tr>
<tr>
<td>3321</td>
<td>Corning CellBIND Surface</td>
<td>25,440</td>
<td>CellSTACK-40 Chamber</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>3272</td>
<td>TC</td>
<td>25,440</td>
<td>CellSTACK-40 Chamber</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>3303</td>
<td>Ultra-Low Attachment Surface</td>
<td>636</td>
<td>CellSTACK-1 Chamber</td>
<td>1</td>
<td>8</td>
</tr>
</tbody>
</table>
Corning® CellSTACK® Accessories are Simply Better!

Corning offers a variety of accessories to simplify handling and reduce contamination risks when processing CellSTACK Chambers.

For Better Filling
A variety of optional filling caps are available to allow direct aseptic transfer of media and cells via pumping or gravity feed. Several coupling devices are available on these filling caps with or without integrally sealed USP Class VI certified C-Flex® tubing. Optional filling caps with attached filters with hydrophobic membranes provide for gas exchange and faster aseptic venting during liquid transfers. Extra sterile vented or unvented 33 mm replacement caps are also available.

For Better Stacking
Reusable stacking devices fit between CellSTACK Chambers to keep them level and optimize incubator space while providing clearance for gas exchange.

For Better Options
Sometimes, currently available accessories just don’t fit a customer’s needs. This is why Corning will work with you to design a CellSTACK Chamber accessory that will make your work process more efficient and reliable.

For large scale production using CellSTACK-40 Chambers there are automated systems that can save on labor while increasing reliability and efficiency.

Call us to discuss your specific requirements.

Corning CellSTACK Accessories Ordering Information

<table>
<thead>
<tr>
<th>Cat. No.</th>
<th>Description</th>
<th>Qty/ Pk</th>
<th>Qty/ Cs</th>
</tr>
</thead>
<tbody>
<tr>
<td>3331</td>
<td>Stacking device, ABS, nonsterile</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>3332</td>
<td>Universal cap*, with vented overcap, sterile</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>3969</td>
<td>Solid cap, sterile</td>
<td>1</td>
<td>6</td>
</tr>
<tr>
<td>3968</td>
<td>Vent cap, 0.2 mm membrane, sterile</td>
<td>1</td>
<td>6</td>
</tr>
<tr>
<td>3281</td>
<td>Vent cap, 3/8” (9.5 mm) ID tubing, 7 cm length, Pall® Acro 50, PVDF filter, sterile</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>3282</td>
<td>Fill cap, 1/8” (3.2 mm) ID tubing, female luer lock with male luer plug, sterile</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>3283</td>
<td>Fill cap, 3/8” (9.5 mm) ID tubing and 5/16” (7.94 mm) barbed fitting, sterile</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>3284</td>
<td>Vent cap, 3/8” (9.5 mm) ID tubing, 7 cm length, Pall Bacterial Air Vent, sterile</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>3324</td>
<td>Two vented over caps and one solid over cap for the Universal Cap, sterile</td>
<td>5</td>
<td>100</td>
</tr>
<tr>
<td>3333</td>
<td>Fill cap*, 1/4” (6.4 mm) ID tubing, 70 cm length, male MPC coupling with female end cap, sterile</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>3328</td>
<td>Fill cap, female MPC coupling, 1/4” (6.4 mm) ID barbed fitting with male end cap, sterile</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>3329</td>
<td>Fill cap, female MPC coupling, 3/8” (9.5 mm) ID barbed fitting with male end cap, sterile</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>3334</td>
<td>Fill cap, male MPC coupling, 1/4” (6.4 mm) ID barbed fitting with female end cap, sterile</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>3339</td>
<td>Fill cap, male MPC coupling with male end cap, 3/8” (9.5 mm) ID barbed fitting with female end cap, sterile</td>
<td>1</td>
<td>4</td>
</tr>
</tbody>
</table>

*All caps are 33 mm thread caps.

Visit www.corning.com/lifesciences for additional product and technical information.
CellCube® Systems

The CellCube System provides a fast, simple, and compact method for the mass culture of attachment-dependent cells. It uses a tissue culture treated growth surface for cell attachment, and continually perfuses the cells with fresh medium for increased cell productivity. The CellCube System is comprised of four pieces of capital equipment: the system controller, oxygenator, pump tower, and circulation pump, and is designed to use disposable CellCube Modules. Performance data from the CellCube System can be easily scaled to the production system. Please inquire about CellCube System pricing. Corning provides on-site technical support for the CellCube System.

The CellCube Modules provide a traditional tissue culture treated surface or new Corning® CellBIND® Surface for the growth of attachment dependent cells. The CellCube System provides an environment which more closely simulates in vivo conditions and reliably distributes nutrients and oxygen with low differential gradients across all cells within the modules.

CellCube System Ordering Information

<table>
<thead>
<tr>
<th>Cat. No.</th>
<th>Description</th>
<th>Qty/Cs</th>
</tr>
</thead>
<tbody>
<tr>
<td>3040</td>
<td>CellCube 6 Liter Oxygenator, Process Scale</td>
<td>1</td>
</tr>
<tr>
<td>3041</td>
<td>CellCube 6 Liter Oxygenator, Production Scale</td>
<td>1</td>
</tr>
<tr>
<td>3020</td>
<td>CellCube Set Up Kit, Bioprene® Tubing, Process Scale</td>
<td>1</td>
</tr>
<tr>
<td>3021</td>
<td>CellCube Set Up Kit, Bioprene Tubing, Production Scale</td>
<td>1</td>
</tr>
<tr>
<td>3022</td>
<td>CellCube Set Up Kit, Sta-Pure Tubing, Process Scale</td>
<td>1</td>
</tr>
<tr>
<td>3023</td>
<td>CellCube Set Up Kit, Sta-Pure Tubing, Production Scale</td>
<td>1</td>
</tr>
<tr>
<td>3101</td>
<td>CellCube Single Module System 6 Liter Oxygenator, Complete</td>
<td>1</td>
</tr>
<tr>
<td>3139</td>
<td>CellCube Single Module System Secondary Oxygen Probe (25 x 70 mm)</td>
<td>1</td>
</tr>
<tr>
<td>3138</td>
<td>CellCube Single Module System Secondary Oxygen Probe Holder</td>
<td>1</td>
</tr>
<tr>
<td>3144</td>
<td>CellCube Single Module System Oxygen Probe Cable</td>
<td>1</td>
</tr>
<tr>
<td>3165</td>
<td>CellCube Single Module System 12 mm Dissolved Oxygen Probe Membrane Kit</td>
<td>1</td>
</tr>
<tr>
<td>3166</td>
<td>CellCube System 25 mm Dissolved Oxygen Probe Membrane Kit</td>
<td>1</td>
</tr>
<tr>
<td>3136</td>
<td>CellCube Single Module System Stainless Steel Stand</td>
<td>1</td>
</tr>
<tr>
<td>3135</td>
<td>CellCube Single Module System Setup Kit</td>
<td>1</td>
</tr>
<tr>
<td>3200</td>
<td>CellCube 10-Stack Module (8,500 cm²), Tissue Culture Treated</td>
<td>2</td>
</tr>
<tr>
<td>3201</td>
<td>CellCube 25-Stack Module (21,250 cm²), Tissue Culture Treated</td>
<td>1</td>
</tr>
<tr>
<td>3304</td>
<td>CellCube 25-Stack Module (21,250 cm²), Corning CellBIND Surface</td>
<td>1</td>
</tr>
<tr>
<td>3264</td>
<td>CellCube 100-Stack Module (85,000 cm²), Tissue Culture Treated</td>
<td>1</td>
</tr>
<tr>
<td>3302</td>
<td>CellCube 100-Stack Module (85,000 cm²) Corning CellBIND Surface</td>
<td>1</td>
</tr>
</tbody>
</table>

Corning E-Cube™ Culture System

The E-Cube system provides a simple method to determine if your cells will grow in the CellCube module prior to investing in the resources and funding that would be necessary for the larger, automated CellCube system.

Corning E-Cube Culture System Ordering Information

<table>
<thead>
<tr>
<th>Cat. No.</th>
<th>Description</th>
<th>Qty/Pk</th>
<th>Qty/Cs</th>
</tr>
</thead>
<tbody>
<tr>
<td>3286</td>
<td>E-Cube System Kit (without CellCube module)</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>3200</td>
<td>CellCube Module 10-Stack</td>
<td>1</td>
<td>2</td>
</tr>
</tbody>
</table>

Corning E-Cube Culture System Accessories Ordering Information

<table>
<thead>
<tr>
<th>Cat. No.</th>
<th>Description</th>
<th>Qty/Pk</th>
<th>Qty/Cs</th>
</tr>
</thead>
<tbody>
<tr>
<td>430518</td>
<td>1 L Storage Bottle with cap</td>
<td>2</td>
<td>24</td>
</tr>
<tr>
<td>401654</td>
<td>45 mm Cap with 2 stainless steel ports</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>3287</td>
<td>E-Cube Fittings</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>
Spinner Flasks

Corning® Disposable Spinner Flasks

- The Corning disposable spinner flask system comes ready-to-use with paddle and integrated magnet, eliminating the need for time-consuming assembly or cleaning and reassembly.
- Molded from virgin polystyrene and gamma-irradiated, each spinner flask system assures a clean sterile unit. No more concerns with detergent residues or contamination.
- Made of ISO 10993 compliant polystyrene, the vessel is comparable to conventional glass spinner flasks for growth of suspension cell lines and any attachment-dependent cultures using microcarrier beads. The 1L and 3L impellers are made of ISO 10993 compliant polypropylene.
- The paddle size and height is optimized for each vessel size. A unique integrated magnet provides smooth, even rotation at required speeds on slow-speed stirrers. Heat build-up in the vessel is reduced by means of a specially designed flange that raises the vessel off the stir-plate surface for the 125 mL and 500 mL flasks only.

Corning Disposable Spinner Flasks Ordering Information

<table>
<thead>
<tr>
<th>Cat. No.</th>
<th>Description</th>
<th>Capacity (mL)</th>
<th>Center Neck (mm)</th>
<th>Sidearm Neck (mm)</th>
<th>Qty/Cs</th>
</tr>
</thead>
<tbody>
<tr>
<td>3152</td>
<td>Disposable Spinner Flask</td>
<td>125</td>
<td>70</td>
<td>25</td>
<td>12</td>
</tr>
<tr>
<td>3153</td>
<td>Disposable Spinner Flask</td>
<td>500</td>
<td>100</td>
<td>45</td>
<td>12</td>
</tr>
<tr>
<td>3561</td>
<td>Disposable Spinner Flask</td>
<td>1000</td>
<td>-</td>
<td>45</td>
<td>6</td>
</tr>
<tr>
<td>3563</td>
<td>Disposable Spinner Flask</td>
<td>3000</td>
<td>-</td>
<td>45</td>
<td>4</td>
</tr>
<tr>
<td>3569</td>
<td>Disposable Spinner Flask with accessory attached</td>
<td>1000</td>
<td>-</td>
<td>45</td>
<td>6</td>
</tr>
</tbody>
</table>

Replacement Caps and Aseptic Transfer Caps

<table>
<thead>
<tr>
<th>Cat. No.</th>
<th>Description</th>
<th>Capacity (mL)</th>
<th>Sidearm Neck (mm)</th>
<th>Qty/Cs</th>
</tr>
</thead>
<tbody>
<tr>
<td>3567</td>
<td>Vent Cap, 0.2 µm Vent</td>
<td>500, 1000, 3000</td>
<td>45</td>
<td>4</td>
</tr>
<tr>
<td>3565</td>
<td>Side Arm Aseptic Transfer Cap, Dip/Tube w/ 0.2 µm Vent, MLL</td>
<td>500</td>
<td>45</td>
<td>2</td>
</tr>
<tr>
<td>3562</td>
<td>Side Arm Aseptic Transfer Cap, Dip/Tube w/ 0.2 µm Vent, MLL</td>
<td>1000</td>
<td>45</td>
<td>2</td>
</tr>
<tr>
<td>3564</td>
<td>Side Arm Aseptic Transfer Cap, Dip/Tube w/ 0.2 µm Vent, MLL</td>
<td>3000</td>
<td>45</td>
<td>2</td>
</tr>
</tbody>
</table>

Visit [www.corning.com/lifesciences](http://www.corning.com/lifesciences) for additional product and technical information.
ProCulture® Glass Spinner Flask with Angled Sidearms

- Baffles enhance aeration and agitation of contents of the flask.
- Unique impeller design ensures optimal stirring.
- Sidearm designs permit easy access of 25 and 50 mL pipettes
- Visit www.corning.com/lifesciences to view additional Corning spinner flask accessories

ProCulture Spinner Flasks with Angled Sidearms Ordering Information

<table>
<thead>
<tr>
<th>Cat. No.</th>
<th>Description</th>
<th>Capacity</th>
<th>Center Neck (mm)</th>
<th>Sidearm Neck (mm)</th>
<th>Qty/Cs</th>
</tr>
</thead>
<tbody>
<tr>
<td>4500-125</td>
<td>Spinner</td>
<td>125 mL</td>
<td>70</td>
<td>32</td>
<td>1</td>
</tr>
<tr>
<td>4500-250</td>
<td>Spinner</td>
<td>250 mL</td>
<td>70</td>
<td>32</td>
<td>1</td>
</tr>
<tr>
<td>4500-500</td>
<td>Spinner</td>
<td>500 mL</td>
<td>100</td>
<td>45</td>
<td>1</td>
</tr>
<tr>
<td>4500-1L</td>
<td>Spinner</td>
<td>1L</td>
<td>100</td>
<td>45</td>
<td>1</td>
</tr>
<tr>
<td>4500-3L</td>
<td>Spinner</td>
<td>3L</td>
<td>100</td>
<td>45</td>
<td>1</td>
</tr>
<tr>
<td>4500-6L</td>
<td>Spinner</td>
<td>6L</td>
<td>100</td>
<td>45</td>
<td>1</td>
</tr>
<tr>
<td>4500-8L</td>
<td>Spinner</td>
<td>8L</td>
<td>100</td>
<td>45</td>
<td>1</td>
</tr>
<tr>
<td>4500-15L</td>
<td>Spinner</td>
<td>15L</td>
<td>100</td>
<td>45</td>
<td>1</td>
</tr>
<tr>
<td>4500-36L</td>
<td>Spinner</td>
<td>36L</td>
<td>100</td>
<td>45</td>
<td>1</td>
</tr>
<tr>
<td>4502-3L</td>
<td>Spinner</td>
<td>3L</td>
<td>120</td>
<td>45</td>
<td>1</td>
</tr>
<tr>
<td>4502-6L</td>
<td>Spinner</td>
<td>6L</td>
<td>120</td>
<td>45</td>
<td>1</td>
</tr>
<tr>
<td>4502-8L</td>
<td>Spinner</td>
<td>8L</td>
<td>120</td>
<td>45</td>
<td>1</td>
</tr>
<tr>
<td>4502-15L</td>
<td>Spinner</td>
<td>15L</td>
<td>120</td>
<td>45</td>
<td>1</td>
</tr>
<tr>
<td>4502-36L</td>
<td>Spinner</td>
<td>36L</td>
<td>120</td>
<td>45</td>
<td>1</td>
</tr>
<tr>
<td>4504-3L</td>
<td>Spinner</td>
<td>3L</td>
<td>140</td>
<td>45</td>
<td>1</td>
</tr>
<tr>
<td>4504-6L</td>
<td>Spinner</td>
<td>6L</td>
<td>140</td>
<td>45</td>
<td>1</td>
</tr>
<tr>
<td>4504-8L</td>
<td>Spinner</td>
<td>8L</td>
<td>140</td>
<td>45</td>
<td>1</td>
</tr>
<tr>
<td>4504-15L</td>
<td>Spinner</td>
<td>15L</td>
<td>140</td>
<td>45</td>
<td>1</td>
</tr>
<tr>
<td>4504-36L</td>
<td>Spinner</td>
<td>36L</td>
<td>140</td>
<td>45</td>
<td>1</td>
</tr>
</tbody>
</table>

Retrofit Kits are available for converting older Corning® ProCulture Spinner Flasks to fit newer dual-bearing impellers.

ProCulture Spinner Flasks with Vertical Sidearms Ordering Information

<table>
<thead>
<tr>
<th>Cat. No.</th>
<th>Capacity</th>
<th>Center Neck (mm)</th>
<th>Number of Vertical Sidearms</th>
<th>Sidearm Neck (mm)</th>
<th>Qty/Cs</th>
</tr>
</thead>
<tbody>
<tr>
<td>4510-8L</td>
<td>8L</td>
<td>100</td>
<td>4</td>
<td>45</td>
<td>1</td>
</tr>
<tr>
<td>4510-15L</td>
<td>15L</td>
<td>100</td>
<td>4</td>
<td>45</td>
<td>1</td>
</tr>
<tr>
<td>4510-36L</td>
<td>36L</td>
<td>100</td>
<td>6</td>
<td>45</td>
<td>1</td>
</tr>
<tr>
<td>4512-8L</td>
<td>8L</td>
<td>120</td>
<td>4</td>
<td>45</td>
<td>1</td>
</tr>
<tr>
<td>4512-15L</td>
<td>15L</td>
<td>120</td>
<td>4</td>
<td>45</td>
<td>1</td>
</tr>
<tr>
<td>4512-36L</td>
<td>36L</td>
<td>120</td>
<td>6</td>
<td>45</td>
<td>1</td>
</tr>
<tr>
<td>4514-15L</td>
<td>15L</td>
<td>140</td>
<td>4</td>
<td>45</td>
<td>1</td>
</tr>
<tr>
<td>4514-36L</td>
<td>36L</td>
<td>140</td>
<td>6</td>
<td>45</td>
<td>1</td>
</tr>
</tbody>
</table>
Gas Handling Fittings, Vertical Sidearm Flasks

- Used to provide gases into larger spinner flasks with vertical sidearms
- Fittings are comprised of a PET insert with a Viton® O-Ring and a polypropylene sealing cap
- Gas filters are PTFE, 0.2 µm porosity
- The 316 stainless steel tubes are held in place by Noryl® nuts with integrated ferrules
- The fittings are completely autoclavable

<table>
<thead>
<tr>
<th>Cat. No.</th>
<th>Description</th>
<th>Dimension</th>
<th>Qty/Cs</th>
</tr>
</thead>
<tbody>
<tr>
<td>4519-100</td>
<td>Sidearm fitting, gas delivery</td>
<td>¾” Inlet</td>
<td>1</td>
</tr>
<tr>
<td>4519-102</td>
<td>Sidearm fitting, gas delivery</td>
<td>¼” Inlet</td>
<td>1</td>
</tr>
<tr>
<td>4519-104</td>
<td>Sidearm fitting, delivery and vent</td>
<td>⅛” and ⅛”</td>
<td>1</td>
</tr>
<tr>
<td>4519-106</td>
<td>Sidearm fitting, vent cap, 0.2 µm</td>
<td>50 mm filter</td>
<td>1</td>
</tr>
<tr>
<td>4519-177</td>
<td>Sidearm fitting, vent cap, 0.2 µm, Sanitary</td>
<td>50 mm filter</td>
<td>1</td>
</tr>
</tbody>
</table>

Media Handling Fittings, Vertical Sidearm Flasks

- Used to introduce medium aseptically into large spinner flasks with vertical sidearms
- Fittings are comprised of a PET insert with a Viton O-Ring and a polypropylene sealing cap
- Gas filters are PTFE, 0.2 µm porosity
- The 316 stainless steel tubes are held in place by Noryl nuts with integrated ferrules
- The fittings are completely autoclavable

<table>
<thead>
<tr>
<th>Cat. No.</th>
<th>Description</th>
<th>Fits Flask Size</th>
<th>Tubing O.D. (inches)</th>
<th>Qty/Case</th>
</tr>
</thead>
<tbody>
<tr>
<td>4519-112</td>
<td>Sidearm fitting, dual, media handling</td>
<td>8L, 15L</td>
<td>½”</td>
<td>1</td>
</tr>
<tr>
<td>4519-114</td>
<td>Sidearm fitting, dual, media handling</td>
<td>36L</td>
<td>½”</td>
<td>1</td>
</tr>
<tr>
<td>4519-116</td>
<td>Sidearm fitting, dual, media handling</td>
<td>8L, 15L</td>
<td>⅛”</td>
<td>1</td>
</tr>
<tr>
<td>4519-118</td>
<td>Sidearm fitting, dual, media handling</td>
<td>36L</td>
<td>⅛”</td>
<td>1</td>
</tr>
<tr>
<td>4519-120</td>
<td>Sidearm fitting, combo, media handling</td>
<td>8L, 15L</td>
<td>⅛”, ⅛”</td>
<td>1</td>
</tr>
<tr>
<td>4519-122</td>
<td>Sidearm fitting, combo, media handling</td>
<td>36L</td>
<td>⅛”, ⅛”</td>
<td>1</td>
</tr>
<tr>
<td>4519-124</td>
<td>Sidearm fitting, single, media handling</td>
<td>8L, 15L</td>
<td>½”</td>
<td>1</td>
</tr>
<tr>
<td>4519-126</td>
<td>Sidearm fitting, single, media handling</td>
<td>36L</td>
<td>½”</td>
<td>1</td>
</tr>
<tr>
<td>4519-176</td>
<td>Sidearm fitting, dual, media handling, EPDM</td>
<td>8L, 15L</td>
<td>⅛”</td>
<td>1</td>
</tr>
</tbody>
</table>

Gas or Media Handling Fittings, Angled Sidearm Flasks, Dual Style

- Dual angled sidearm fittings can be used for aseptically transferring medium into or out of angled sidearm spinner flasks or for sparging the medium with gases
- Fittings are comprised of a PET insert with a Viton O-ring and a polypropylene sealing cap
- Two 316 stainless steel tubes which extend to the bottom of the flask, are held in place by Noryl nuts with integrated ferrules
- The fittings are completely autoclavable

<table>
<thead>
<tr>
<th>Cat. No.</th>
<th>Description</th>
<th>Flask Size</th>
<th>Tubing O.D. (inches)</th>
<th>Qty/Case</th>
</tr>
</thead>
<tbody>
<tr>
<td>4519-150</td>
<td>SA fitting, Dual</td>
<td>1L</td>
<td>½”</td>
<td>1</td>
</tr>
<tr>
<td>4519-151</td>
<td>SA fitting, Dual</td>
<td>3L</td>
<td>½”</td>
<td>1</td>
</tr>
<tr>
<td>4519-152</td>
<td>SA fitting, Dual</td>
<td>6L</td>
<td>½”</td>
<td>1</td>
</tr>
<tr>
<td>4519-153</td>
<td>SA fitting, Dual</td>
<td>8L</td>
<td>½”</td>
<td>1</td>
</tr>
<tr>
<td>4519-173</td>
<td>SA fitting, Dual</td>
<td>1L</td>
<td>⅛”, ⅛”</td>
<td>1</td>
</tr>
<tr>
<td>4519-121</td>
<td>SA fitting, Dual</td>
<td>8L</td>
<td>⅛”, ⅛”</td>
<td>1</td>
</tr>
<tr>
<td>4519-174</td>
<td>Sidearm fitting, Dual</td>
<td>500 mL</td>
<td>⅛” angled to 125 mL level, ⅛”</td>
<td>1</td>
</tr>
<tr>
<td>4519-154</td>
<td>Sidearm fitting, Dual</td>
<td>1L</td>
<td>⅛”</td>
<td>1</td>
</tr>
<tr>
<td>4519-155</td>
<td>Sidearm fitting, Dual</td>
<td>3L</td>
<td>⅛”</td>
<td>1</td>
</tr>
<tr>
<td>4519-156</td>
<td>Sidearm fitting, Dual</td>
<td>6L</td>
<td>⅛”</td>
<td>1</td>
</tr>
<tr>
<td>4519-157</td>
<td>Sidearm fitting, Dual</td>
<td>8L</td>
<td>⅛”</td>
<td>1</td>
</tr>
<tr>
<td>4519-170</td>
<td>Sidearm fitting, Dual</td>
<td>15L</td>
<td>⅛”</td>
<td>1</td>
</tr>
</tbody>
</table>

Visit www.corning.com/lifesciences for additional product and technical information.
**Gas or Media Handling Fittings, Angled Sidearm Flasks, Combination Style**

- Used to aseptically transfer medium, sparge the cell culture medium directly or add gases to the head space above the cell culture medium
- Fittings are comprised of a PET insert with a Viton® O-ring and a polypropylene sealing cap
- One or two 316 stainless steel tubes extend to the bottom of the flask; the other is a shorter 6” length
- Both tubes are held in place by Noryl® nuts with integrated ferrules
- The fittings are completely autoclavable

<table>
<thead>
<tr>
<th>Cat. No.</th>
<th>Description</th>
<th>Flask Size</th>
<th>Tubing O.D. (inches)</th>
<th>Qty/Case</th>
</tr>
</thead>
<tbody>
<tr>
<td>4519-158</td>
<td>Sidearm fitting, combination</td>
<td>1L</td>
<td>⅝”</td>
<td>1</td>
</tr>
<tr>
<td>4519-159</td>
<td>Sidearm fitting, combination</td>
<td>3L</td>
<td>⅝”</td>
<td>1</td>
</tr>
<tr>
<td>4519-160</td>
<td>Sidearm fitting, combination</td>
<td>6L</td>
<td>⅝”</td>
<td>1</td>
</tr>
<tr>
<td>4519-161</td>
<td>Sidearm fitting, combination</td>
<td>8L</td>
<td>⅝”</td>
<td>1</td>
</tr>
<tr>
<td>4519-162</td>
<td>Sidearm fitting, combination</td>
<td>1L</td>
<td>¾”</td>
<td>1</td>
</tr>
<tr>
<td>4519-163</td>
<td>Sidearm fitting, combination</td>
<td>3L</td>
<td>¾”</td>
<td>1</td>
</tr>
<tr>
<td>4519-164</td>
<td>Sidearm fitting, combination</td>
<td>6L</td>
<td>¾”</td>
<td>1</td>
</tr>
<tr>
<td>4519-165</td>
<td>Sidearm fitting, combination</td>
<td>8L</td>
<td>¾”</td>
<td>1</td>
</tr>
<tr>
<td>4519-171</td>
<td>Sidearm fitting, combination</td>
<td>15L</td>
<td>¾”</td>
<td>1</td>
</tr>
<tr>
<td>4519-166</td>
<td>Sidearm fitting, combination, triple</td>
<td>1L</td>
<td>¾”</td>
<td>1</td>
</tr>
<tr>
<td>4519-167</td>
<td>Sidearm fitting, combination, triple</td>
<td>3L</td>
<td>¾”</td>
<td>1</td>
</tr>
<tr>
<td>4519-168</td>
<td>Sidearm fitting, combination, triple</td>
<td>6L</td>
<td>¾”</td>
<td>1</td>
</tr>
<tr>
<td>4519-169</td>
<td>Sidearm fitting, combination, triple</td>
<td>8L</td>
<td>¾”</td>
<td>1</td>
</tr>
</tbody>
</table>

**Fittings for Insertion Probes, Vertical Sidearm Flasks**

- Used to secure pH, O₂, or temperature sensors in large spinner flasks with vertical sidearms
- Fittings are comprised of a PET insert with a Viton O-ring and a polypropylene sealing cap
- The 316 sensors are held in place by Noryl nuts with integrated ferrules
- The fittings are completely autoclavable

<table>
<thead>
<tr>
<th>Cat. No.</th>
<th>Description</th>
<th>Sensor O.D. (mm)</th>
<th>Qty/Cs</th>
</tr>
</thead>
<tbody>
<tr>
<td>4519-108</td>
<td>Sidearm fitting, sensor, O₂ probes</td>
<td>12</td>
<td>1</td>
</tr>
<tr>
<td>4519-128</td>
<td>Sidearm fitting, sensor, temperature probes</td>
<td>12</td>
<td>1</td>
</tr>
<tr>
<td>4519-110</td>
<td>Sidearm fitting, sensor, pH probes</td>
<td>12</td>
<td>1</td>
</tr>
<tr>
<td>4519-172</td>
<td>Sidearm fitting, sensor, pH or O₂</td>
<td>18</td>
<td>1</td>
</tr>
</tbody>
</table>

**Impeller Assembly for Magnetically-Driven Bioreactor**

Stainless steel impeller shaft with modified impeller blade for use with probes to create a small bioreactor.

<table>
<thead>
<tr>
<th>Cat. No.</th>
<th>Description</th>
<th>Qty/Cs</th>
</tr>
</thead>
<tbody>
<tr>
<td>402648</td>
<td>Impeller assembly, stainless steel, dual bearing, modified for probes, 3L</td>
<td>1</td>
</tr>
<tr>
<td>402649</td>
<td>Impeller assembly, stainless steel, dual bearing, modified for probes, 6L</td>
<td>1</td>
</tr>
<tr>
<td>401392</td>
<td>Impeller assembly, stainless steel, dual bearing, modified for probes, 8L</td>
<td>1</td>
</tr>
<tr>
<td>401661</td>
<td>Impeller assembly, stainless steel, dual bearing, modified for probes, 15L</td>
<td>1</td>
</tr>
<tr>
<td>402650</td>
<td>Impeller assembly, stainless steel, dual bearing, modified for probes, 36L</td>
<td>1</td>
</tr>
</tbody>
</table>
Cap Assembly for Magnetically-Driven Bioreactor

Cap assembly for small bioreactor with various fitting arrangements.

<table>
<thead>
<tr>
<th>Cat. No.</th>
<th>Description</th>
<th>Qty/Cs</th>
</tr>
</thead>
<tbody>
<tr>
<td>402579</td>
<td>Cap Assembly, 120 mm, Glass Filled PBT, 3 (½&quot;), 1 (¼&quot;) fittings</td>
<td>1</td>
</tr>
<tr>
<td>402576</td>
<td>Cap Assembly, 120 mm, Glass Filled PBT, 2 (12 mm), 2 (¼&quot;) fittings</td>
<td>1</td>
</tr>
<tr>
<td>402577</td>
<td>Cap Assembly, 120 mm, Glass Filled PBT, 2 (12 mm), 2 (¼&quot;), 1 (3/8&quot;) fittings</td>
<td>1</td>
</tr>
</tbody>
</table>

Spare Parts for Sidearm Fittings

Securing Caps

<table>
<thead>
<tr>
<th>Corning</th>
<th>Cat. No.</th>
<th>Description</th>
<th>Qty/Cs</th>
</tr>
</thead>
<tbody>
<tr>
<td>1395-32LTC</td>
<td>1395-32LTC</td>
<td>Cap, solid, 32 mm, orange</td>
<td>1</td>
</tr>
<tr>
<td>1395-45LTC</td>
<td>1395-45LTC</td>
<td>Cap, solid, 45 mm, orange</td>
<td>1</td>
</tr>
<tr>
<td>1395-45LTR</td>
<td>1395-45LTR</td>
<td>Drip ring, 45 mm, clear</td>
<td>1</td>
</tr>
<tr>
<td>1395-45LTMC</td>
<td>1395-45LTMC</td>
<td>Cap, vented, securing,</td>
<td>10</td>
</tr>
</tbody>
</table>

Direct Drive Motors

- High torque, low rpm stirrer designed to maintain constant low speed
- Gearhead stirrer delivers 14.5 in-lbs of torque
- Maximum speed is 350 rpm
- Weight of motor is 9 lbs (4.1kg)
- Available with 120VAC 60Hz or 230VAC 50Hz

<table>
<thead>
<tr>
<th>Cat. No.</th>
<th>Description</th>
<th>Qty/Cs</th>
</tr>
</thead>
<tbody>
<tr>
<td>400640</td>
<td>120VAC, 60 Hz Motor</td>
<td>1</td>
</tr>
<tr>
<td>402645</td>
<td>230VAC, 50 Hz Motor</td>
<td>1</td>
</tr>
</tbody>
</table>

Direct Drive Shaft/Cap Assemblies

- For 8L, 15L, or 36L paddle assemblies
- Used on all series 4510 and 4512 Spinner flasks

<table>
<thead>
<tr>
<th>Cat. No.</th>
<th>Description</th>
<th>Qty/Cs</th>
</tr>
</thead>
<tbody>
<tr>
<td>402614</td>
<td>For 100 mm Neck Flasks</td>
<td>1</td>
</tr>
<tr>
<td>400649</td>
<td>For 120 mm Neck Flasks</td>
<td>1</td>
</tr>
</tbody>
</table>

Direct Drive Paddle Assemblies

- For series 4510, 4512, and 4514 Spinner flasks when coupled to a direct drive motor
- Paddle assemblies will couple to 100 mm and 120 mm cap assemblies

<table>
<thead>
<tr>
<th>Cat. No.</th>
<th>Description</th>
<th>Qty/Cs</th>
</tr>
</thead>
<tbody>
<tr>
<td>4515-8L</td>
<td>Paddle assembly only for 8L flask</td>
<td>1</td>
</tr>
<tr>
<td>4515-15L</td>
<td>Paddle assembly only for 15L flask</td>
<td>1</td>
</tr>
<tr>
<td>4515-36L</td>
<td>Paddle assembly only for 36L flask</td>
<td>1</td>
</tr>
</tbody>
</table>
**Erlenmeyer Flasks**

**Corning® Erlenmeyer Flasks**

Corning baffled and plain Erlenmeyer and Fernbach culture flasks are ideal for shaker culture applications and storage. Like all Corning flasks, the Erlenmeyer flasks are certified nonpyrogenic and sterile.

- Polycarbonate construction: USP Class VI material provides excellent optical clarity and mechanical strength
- Sizes range from 125 mL to 3L
- Baffled or plain bottom options in every size
- Molded-in graduations for accuracy
- Vent cap option for continuous gas exchange while ensuring sterility and preventing leakage
- Individually packaged and radiation sterilized for ease of use
- All flasks have the highest Sterility Assurance Level (SAL) of 10^-6
- Certified nonpyrogenic

**Corning Polycarbonate Erlenmeyer Flasks and Caps Ordering Information**

### Baffled Bottom Erlenmeyer Flasks

<table>
<thead>
<tr>
<th>Cat. No.</th>
<th>Description</th>
<th>Sterile</th>
<th>Qty/Cs</th>
</tr>
</thead>
<tbody>
<tr>
<td>431405</td>
<td>Erlenmeyer Flask, Baffled, 125 mL, Vent Cap</td>
<td>Yes</td>
<td>50</td>
</tr>
<tr>
<td>431404</td>
<td>Erlenmeyer Flask, Baffled, 125 mL, Plug Seal Cap</td>
<td>Yes</td>
<td>50</td>
</tr>
<tr>
<td>431407</td>
<td>Erlenmeyer Flask, Baffled, 250 mL, Vent Cap</td>
<td>Yes</td>
<td>50</td>
</tr>
<tr>
<td>431406</td>
<td>Erlenmeyer Flask, Baffled, 250 mL, Plug Seal Cap</td>
<td>Yes</td>
<td>50</td>
</tr>
<tr>
<td>431401</td>
<td>Erlenmeyer Flask, Baffled, 500 mL, Vent Cap</td>
<td>Yes</td>
<td>25</td>
</tr>
<tr>
<td>431408</td>
<td>Erlenmeyer Flask, Baffled, 500 mL, Plug Seal Cap</td>
<td>Yes</td>
<td>25</td>
</tr>
<tr>
<td>431403</td>
<td>Erlenmeyer Flask, Baffled, 1L, Vent Cap</td>
<td>Yes</td>
<td>25</td>
</tr>
<tr>
<td>431402</td>
<td>Erlenmeyer Flask, Baffled, 1L, Plug Seal Cap</td>
<td>Yes</td>
<td>25</td>
</tr>
<tr>
<td>431256</td>
<td>Erlenmeyer Flask, Baffled, 2L, Vent Cap</td>
<td>Yes</td>
<td>6</td>
</tr>
<tr>
<td>431253</td>
<td>Fernbach Culture Flask, Baffled, 3L, Vent Cap</td>
<td>Yes</td>
<td>4</td>
</tr>
</tbody>
</table>

### Plain Bottom Erlenmeyer Flasks

<table>
<thead>
<tr>
<th>Cat. No.</th>
<th>Description</th>
<th>Sterile</th>
<th>Qty/Cs</th>
</tr>
</thead>
<tbody>
<tr>
<td>431143</td>
<td>Erlenmeyer Flask, 125 mL, Vent Cap</td>
<td>Yes</td>
<td>50</td>
</tr>
<tr>
<td>430421</td>
<td>Erlenmeyer Flask, 125 mL, Plug Seal Cap</td>
<td>Yes</td>
<td>50</td>
</tr>
<tr>
<td>431144</td>
<td>Erlenmeyer Flask, 250 mL, Vent Cap</td>
<td>Yes</td>
<td>50</td>
</tr>
<tr>
<td>430183</td>
<td>Erlenmeyer Flask, 250 mL, Plug Seal Cap</td>
<td>Yes</td>
<td>50</td>
</tr>
<tr>
<td>431145</td>
<td>Erlenmeyer Flask, 500 mL, Vent Cap</td>
<td>Yes</td>
<td>25</td>
</tr>
<tr>
<td>430422</td>
<td>Erlenmeyer Flask, 500 mL, Plug Seal Cap</td>
<td>Yes</td>
<td>25</td>
</tr>
<tr>
<td>431147</td>
<td>Erlenmeyer Flask, 1L, Vent Cap</td>
<td>Yes</td>
<td>25</td>
</tr>
<tr>
<td>431146</td>
<td>Erlenmeyer Flask, 1L, Plug Seal Cap</td>
<td>Yes</td>
<td>25</td>
</tr>
<tr>
<td>431255</td>
<td>Erlenmeyer Flask, 2L, Vent Cap</td>
<td>Yes</td>
<td>6</td>
</tr>
<tr>
<td>431252</td>
<td>Fernbach Culture Flask, 3L, Vent Cap</td>
<td>Yes</td>
<td>4</td>
</tr>
</tbody>
</table>

**Shaker Flask Application Tip**

Corning recommends starting with a shaking rate of 75-125 RPM (orbital shaker) and a medium volume of 30-40% of the nominal flask capacity.
Replacement Erlenmeyer Flask Caps

Corning® Polypropylene Erlenmeyer Flask Caps are also available separately. They are sterile, individually packaged and available for the 500 mL and 1L*, 2L and 3L flask sizes.

<table>
<thead>
<tr>
<th>Cat. No.</th>
<th>Description</th>
<th>Sterile</th>
<th>Qty/Cs</th>
</tr>
</thead>
<tbody>
<tr>
<td>431372*</td>
<td>43 mm Vent Cap, 500 mL and 1L Erlenmeyer Flask*</td>
<td>Yes</td>
<td>50</td>
</tr>
<tr>
<td>431339</td>
<td>48 mm Vent Cap, 2L Erlenmeyer Flask</td>
<td>Yes</td>
<td>24</td>
</tr>
<tr>
<td>431364</td>
<td>48 mm Flat Cap, 2L Erlenmeyer Flask</td>
<td>Yes</td>
<td>24</td>
</tr>
<tr>
<td>431340</td>
<td>70 mm Vent Cap, 3L Erlenmeyer Flask</td>
<td>Yes</td>
<td>24</td>
</tr>
<tr>
<td>431363</td>
<td>70 mm Flat Cap, 3L Erlenmeyer Flask</td>
<td>Yes</td>
<td>24</td>
</tr>
</tbody>
</table>

*The 43 mm cap for the 500 mL and 1L sizes are available Made to Order only with a 5 case minimum.

Aseptic Transfer Caps

Corning Erlenmeyer Flask Aseptic Transfer Caps are available separately. They are sterile and arrive individually double-bagged. They are available for the 1L, 2L and 3L flask sizes. The transfer caps have two ports. One port ends in a 0.2 µm Acro 50 mm disk and the other port is C-Flex Tubing ending in either a male luer lock or a male polycarbonate quick connect. The Diptube reaches all the way to the bottom of the flask for easy aseptic transfer of your liquid handling processes.

<table>
<thead>
<tr>
<th>Cat. No.</th>
<th>Description</th>
<th>Sterile</th>
<th>Qty/Cs</th>
</tr>
</thead>
<tbody>
<tr>
<td>431444</td>
<td>43 mm Cap, 1L, Diptube with 0.2 µm Vent, MLL</td>
<td>Yes</td>
<td>5</td>
</tr>
<tr>
<td>431445</td>
<td>43 mm Cap, 1L, Diptube with 0.2 µm Vent, MPC</td>
<td>Yes</td>
<td>5</td>
</tr>
<tr>
<td>431446</td>
<td>48 mm Cap, 2L, Diptube with 0.2 µm Vent, MLL</td>
<td>Yes</td>
<td>6</td>
</tr>
<tr>
<td>431447</td>
<td>48 mm Cap, 2L, Diptube with 0.2 µm Vent, MPC</td>
<td>Yes</td>
<td>6</td>
</tr>
<tr>
<td>431448</td>
<td>70 mm Cap, 3L, Diptube with 0.2 µm Vent, MLL</td>
<td>Yes</td>
<td>4</td>
</tr>
<tr>
<td>431449</td>
<td>70 mm Cap, 3L, Diptube with 0.2 µm Vent, MPC</td>
<td>Yes</td>
<td>4</td>
</tr>
</tbody>
</table>
Cell Scrapers and Lifters

Cell Scrapers and Cell Lifters
- Useful for the manual harvesting of cells
- Blade design minimizes cell damage and ensures even contact with the growth surface
- Cell lifter is useful for harvesting cells (especially stem cells) in dishes
- Scrapers designed for use in flasks
- Individually wrapped
- Sterilized by gamma radiation
- Certified nonpyrogenic

---

### Cell Scraper and Lifter Ordering Information

<table>
<thead>
<tr>
<th>Cat. No.</th>
<th>Description</th>
<th>Blade Length (cm)</th>
<th>Handle Length (cm)</th>
<th>Qty/Pk</th>
<th>Qty/Cs</th>
</tr>
</thead>
<tbody>
<tr>
<td>3008</td>
<td>Cell lifter</td>
<td>1.9</td>
<td>18</td>
<td>1</td>
<td>100</td>
</tr>
<tr>
<td>3010</td>
<td>Small scraper</td>
<td>1.8</td>
<td>25</td>
<td>1</td>
<td>100</td>
</tr>
<tr>
<td>3011</td>
<td>Large scraper</td>
<td>3.0</td>
<td>39</td>
<td>1</td>
<td>100</td>
</tr>
</tbody>
</table>
**Technical Appendix**

**CORNING® CELL CULTURE SURFACES**

**Introduction**

For over eighty years Corning has been developing products and surfaces for cell culture. Corning currently offers six polystyrene-based surfaces (Table 1) for growing cells including the most recent technology revolution, the patented Corning CellBIND® surface (U.S. Patent 6,617,152):

Most of these early plastic vessels were made from polystyrene, a long carbon chain polymer with benzene rings attached to every other carbon. Polystyrene was chosen because it has excellent optical clarity, is easy to mold and is relatively inexpensive. However, it also has one significant drawback: it is a very hydrophobic (nonwettable) polymer to which cells have difficulty attaching. Fortunately, the surface of polystyrene can be easily modified by a variety of chemical (sulfuric acid) and physical (corona discharge, gas-plasma or irradiation) methods. Using these methods, hydroxyl, ketone, aldehyde, carboxyl and amine groups can readily be grafted onto the polymer (Figure 1). These groups modify the surface characteristics changing the uncharged hydrophobic surface into a more ionic hydrophilic surface. Polystyrene can also be modified through chemical reactions to allow the covalent attachment of a variety of reactive groups that can be used for the subsequent covalent immobilization of biomolecules. For additional information, please check the References.

**Corning CellBIND® Surface**

The Corning CellBIND culture surface, the first novel cell culture surface treatment in over 20 years, is designed to improve cell attachment under difficult conditions, such as reduced-serum or serum-free medium, resulting in higher cell yields. It is also useful for growing “difficult” cells such as primary cultures or transfected cells over expressing proteins. Developed by Corning scientists, this patented technology (U.S. Patent 6,617,152) uses a novel microwave plasma process for treating the culture surface. This process improves cell attachment by incorporating significantly more oxygen into the cell culture surface than traditional plasma or corona discharge treatments, rendering it more hydrophilic (wettable) and increasing the stability of the surface.

Unlike biological coatings, the Corning CellBIND surface is a nonbiological surface that requires no special handling or storage. Because the polymer is treated, rather than coated, the surface is more consistent and stable. This enhanced cell performance has already led to a major biotechnology company choosing Corning roller bottles with the Corning CellBIND surface for producing a new FDA approved protein therapeutic.

Corning CellBIND surface benefits:
- Quickly adapts cells to reduced serum or serum-free conditions
- May eliminate the need for tedious, time-consuming, expensive and low stability biological coatings
- Stable at room temperature, requires no refrigeration or special handling
- Gives more consistent and even cell attachment for difficult to attach cell lines, especially transfected cells
- Reduces premature cell detachment from confluent cultures especially in roller bottles and during cell-based assays

The Corning CellBIND surface is available on flasks, multiple well plates, CellSTACK® Culture Chambers, roller bottles, 96 well plates, 384 well plates, and dishes.

![Surface treatment](image-url)

**Figure 1.** Polystyrene can be surface modified by the addition of a variety of different chemical groups, by breaking the carbon chain backbone, or by opening the benzene ring (not shown).

### Table 1. Corning Cell Culture Surfaces

<table>
<thead>
<tr>
<th>Corning Surface</th>
<th>Binding Interaction</th>
<th>Sample Properties</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corning CellBIND Surface modified polystyrene surface</td>
<td>Hydrophilic and ionic (negatively charged)</td>
<td>Improves cell attachment and binding to polystyrene</td>
</tr>
<tr>
<td>Standard Tissue culture treated polystyrene</td>
<td>Hydrophilic and ionic (negatively charged)</td>
<td>Allows cell attachment and binding to polystyrene</td>
</tr>
<tr>
<td>Untreated polystyrene</td>
<td>Hydrophobic</td>
<td>Significantly reduces the attachment of most cells</td>
</tr>
<tr>
<td>Ultra Low Attachment coated polystyrene</td>
<td>Hydrophilic and nonionic</td>
<td>Hydrogel layer prevents the attachment of almost all cells</td>
</tr>
<tr>
<td>Poly-D-lysine coated polystyrene</td>
<td>Hydrophilic and ionic (positively charged)</td>
<td>Improves cell attachment and binding to polystyrene</td>
</tr>
<tr>
<td>Ultra-Web™ Synthetic Surface</td>
<td>Hydrophilic and ionic interactions (positively charged) on a 3D surface</td>
<td>Promotes more <em>in vivo</em>-like morphology</td>
</tr>
</tbody>
</table>

Visit [www.corning.com/lifesciences](http://www.corning.com/lifesciences) for additional product and technical information.
Ultra-Web™ Synthetic Surfaces

Ultra-Web Synthetic Surfaces are composed of randomly orientated electrospun polyamide nanofibers with an average fiber diameter of ~180 nm. This creates a culturing substrate that mimics structural components within the basement membrane or extracellular matrix.

Ultra-Web synthetic surface is available with two surface chemistries:
- Untreated electrospun polyamide nanofibers with an uncharged slightly hydrophilic surface
- Polyamine treated electrospun polyamide nanofibers with a positively charged surface for enhanced cell attachment or binding and covalently linking biomolecules

Ultra-Web Synthetic Surface Applications:
- Ideal for culturing liver, neuronal, kidney and stem cell lines or primary cultures where current surfaces do not provide the necessary culture performance or function
- Replacement for poly-lysine or animal-derived biological coatings
- Ideal substrate for binding cell attachment and growth factors to create more in vivo-like culture environments
- Compatible with cell-based luminescence-reporter gene and FLIPR calcium flux assays
- Promotes more in vivo-like morphology (spheroid and dome formation)

Ultra-Web Synthetic Surface Benefits:
- Synthetic surfaces are more stable and consistent lot to lot than biological coatings
- Cells grow on the nanofiber surface, not in it, for easy harvesting
- Easy to view cells using phase contrast microscopy
- Ready to use and room temperature stable

Ultra-Low Attachment Coated Polystyrene Surface

The Corning Ultra-Low Attachment surface is a covalently bound hydrogel layer that is hydrophilic and neutrally charged. Since proteins and other biomolecules passively adsorb to polystyrene surfaces through either hydrophobic or ionic interactions, this hydrogel surface naturally inhibits nonspecific immobilization via these forces, thus inhibiting subsequent cell attachment. This surface is very stable, noncytotoxic, biologically inert and nondegradable. Corning offers the Ultra-Low Attachment surfaces on dishes, plates, flasks, and CellSTACK® Culture Chamber 1-Stack.

This Ultra-Low Attachment surface has been shown to successfully inhibit attachment of anchorage dependent MDCK, VERO, and C6 cells grown for a period of time equal to that necessary to obtain confluent cell growth on the control surface (standard tissue culture treated polystyrene; Figure 2). This surface has also been shown to inhibit the attachment and activation of macrophages and neutrophils.

Ultra-Low Attachment culture vessels are useful for:
- Studying tissue-specific functions of certain cancer cells (i.e., MCF-7 breast cancer cells)

Figure 2. Single cell derived colonies of C6 glioma cells grow as flattened attached colonies in standard tissue culture treated surface (left panel) but form unattached spherical colonies on the ultra low attachment surface (right panel).

- Preventing stem cells from attachment-mediated differentiation
- Selectively culturing tumor or virally transformed cells as unattached colonies (substitute for soft agar assays)

Poly-D-lysine Coated Surface

Some assays and procedures require enhanced binding of cells to polystyrene. Corning poly-D-lysine (PDL) microplates are coated with PDL (molecular weight range of 70 to 150 kDa) by a proprietary method. This synthetic polymeric coating creates a uniform net positive charge on the plastic surface which, for some cell types, can enhance cell attachment, growth and differentiation, especially in serum-free and low serum conditions. PDL surfaces often improve attachment and growth of primary neurons, glial cells, neuroblastomas, and a variety of transfected cell lines, including HEK-293. Corning offers poly-D-lysine coated 96 and 384 well microplates.

Standard Tissue Culture Treated Polystyrene Surface

Standard Corning® polystyrene cell culture vessels are surface modified using either corona discharge (flasks, dishes and microplates) or gas-plasma (roller bottles and culture tubes). These processes generate highly energetic oxygen ions which graft onto the surface polystyrene chains (Figure 1) so that the surface becomes hydrophilic and negatively charged when placed in medium. Corning offers the standard tissue culture treated surface on flasks, dishes, multiple well plates, CellSTACK® Culture Chambers, roller bottles and culture tubes.

Untreated Polystyrene Surface

Natural, unmodified polystyrene surfaces are hydrophobic and only bind cells and biomolecules through passive hydrophobic interactions. Corning offers untreated polystyrene culture dishes and microplates for growing cells in stationary suspension or other applications where reduced cell attachment is desired. However, these untreated vessels are sterilized by low dose gamma irradiation, which slightly increases the wettability of the surface. Since some transformed cell lines (CHO-K1, for example) and macrophages will attach and grow on these hydrophobic surfaces, Corning also offers an Ultra-Low Attachment Surface (see below) for use in situations where cell attachment must be kept to an absolute minimum.
### CHARACTERISTICS OF CORNING® PLASTICWARE

<table>
<thead>
<tr>
<th></th>
<th>Polystyrene</th>
<th>Polyethylene (High Density)</th>
<th>Polypropylene</th>
<th>Polycarbonate</th>
<th>Nylon</th>
<th>P.T.F.E. (Teflon*)</th>
<th>Polyethylene Terephthalate (PET)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>PHYSICAL CHARACTERISTICS</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Basic Properties</td>
<td>Biologically inert, hard, excellent optical qualities</td>
<td>Biologically inert, high chemical resistance toughness</td>
<td>Biologically inert, high chemical resistance, exceptional resistance</td>
<td>Clear, very tough, inert, high temperature transmission</td>
<td>Tough, heat resistant, machinable, high moisture vapor slippery surface</td>
<td>Biologically and chemically inert, high resistant</td>
<td>Biologically inert, hard, tough, excellent optical qualities</td>
</tr>
<tr>
<td>Clarity</td>
<td>Clear</td>
<td>Opaque</td>
<td>Translucent</td>
<td>Clear</td>
<td>Opaque</td>
<td>Opaque</td>
<td>Clear</td>
</tr>
<tr>
<td>Autoclave Results</td>
<td>Melts</td>
<td>May</td>
<td>Withstands distort</td>
<td>Withstands several cycles</td>
<td>OK one cycle</td>
<td>OK</td>
<td>Melts</td>
</tr>
<tr>
<td>Heat Distortion Point</td>
<td>147-175°F 64-80°C</td>
<td>250°F 121°C</td>
<td>275°F 135°C</td>
<td>280-290°F 138-143°C</td>
<td>300-356°F 150-180°C</td>
<td>250°F 121°C</td>
<td>250°F 70°F</td>
</tr>
<tr>
<td>Burning Rate</td>
<td>Slow</td>
<td>Slow</td>
<td>Slow</td>
<td>Self-extinguishing</td>
<td>Self-extinguishing</td>
<td>None</td>
<td>–</td>
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<tr>
<td><strong>EFFECTS OF LABORATORY REAGENTS</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Weak Acids</td>
<td>None</td>
<td>None</td>
<td>None</td>
<td>None</td>
<td>None</td>
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<td>Oxidizing acids attack</td>
<td>Oxidizing acids attack</td>
<td>May be attacked</td>
<td>Attacked</td>
<td>None</td>
<td>Oxidizing acids attack</td>
</tr>
<tr>
<td>Weak Alkalies</td>
<td>None</td>
<td>None</td>
<td>None</td>
<td>None</td>
<td>None</td>
<td>None</td>
<td>None</td>
</tr>
<tr>
<td>Strong Alkalies</td>
<td>None</td>
<td>None</td>
<td>None</td>
<td>Slowly attacked</td>
<td>None</td>
<td>None</td>
<td>Attacked</td>
</tr>
<tr>
<td>Organic Solvents</td>
<td>Soluble in aromatic chlorinated hydrocarbons</td>
<td>Resistant below 80°C</td>
<td>Resistant below 80°C</td>
<td>Soluble in chlorinated hydrocarbons, partly soluble in aromatics</td>
<td>Resistant</td>
<td>Resistant</td>
<td>Soluble in aromatic or chlorinated hydrocarbons</td>
</tr>
<tr>
<td><strong>GAS PERMEABILITY OF THIN WALL PRODUCTS</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>O₂</td>
<td>Low</td>
<td>High</td>
<td>High</td>
<td>Very low</td>
<td>Very low</td>
<td>–</td>
<td>Very low</td>
</tr>
<tr>
<td>N₂</td>
<td>Very low</td>
<td>Low</td>
<td>Low</td>
<td>Very low</td>
<td>Very low</td>
<td>–</td>
<td>Very low</td>
</tr>
<tr>
<td>CO₂</td>
<td>High</td>
<td>Very high</td>
<td>Very high</td>
<td>Low</td>
<td>–</td>
<td>–</td>
<td>Low</td>
</tr>
</tbody>
</table>

Portions of this table courtesy of Modern Plastics Encyclopedia. Most data are from tests by A.S.T.M. methods. Tables show averages or ranges. Many properties vary with manufacturer, formulation, testing laboratory, and the specific operating conditions.

*Obtained from a table which lists gas permeability in CC/100 sq. inches per 24 hrs./mil.
CHEMICAL COMPATIBILITY OF CORNING® PLASTICWARE

<table>
<thead>
<tr>
<th></th>
<th>PS</th>
<th>PP</th>
<th>PVC</th>
<th>CA</th>
<th>PC</th>
<th>CN</th>
<th>NY</th>
<th>MCE</th>
<th>PTFE</th>
<th>PET</th>
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<td><strong>Acids</strong></td>
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<tr>
<td>Hydrochloric acid (25%)</td>
<td>G</td>
<td>G</td>
<td>G</td>
<td>N</td>
<td>R</td>
<td>R</td>
<td>N</td>
<td>O</td>
<td>R</td>
<td>R</td>
</tr>
<tr>
<td>Hydrochloric acid (concentrated)</td>
<td>F</td>
<td>G</td>
<td>F</td>
<td>N</td>
<td>R</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>R</td>
<td>O</td>
</tr>
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<td>Nitric acid (concentrated)</td>
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<td>P</td>
<td>N</td>
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<tr>
<td>Nitric acid (25%)</td>
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<td>G</td>
<td>F</td>
<td>N</td>
<td>R</td>
<td>L</td>
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<td>O</td>
<td>R</td>
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<td>Butanol</td>
<td>G</td>
<td>G</td>
<td>G</td>
<td>R</td>
<td>R</td>
<td>R</td>
<td>R</td>
<td>R</td>
<td>R</td>
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<td>R</td>
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<td>R</td>
<td>R</td>
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<td>Dimethylformamide</td>
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<td>G</td>
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<td>N</td>
<td>R</td>
<td>N</td>
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<tr>
<td>Ammonium hydroxide (25%)</td>
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<td>G</td>
<td>G</td>
<td>R</td>
<td>N</td>
<td>R</td>
<td>R</td>
<td>O</td>
<td>N</td>
<td>O</td>
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<tr>
<td>Ammonium hydroxide (1N)</td>
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<td>G</td>
<td>G</td>
<td>N</td>
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<td>R</td>
<td>R</td>
<td>O</td>
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<td>R</td>
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<td>Toluene</td>
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<td>G</td>
<td>P</td>
<td>R</td>
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<td>R</td>
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<td>P</td>
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<td>R</td>
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<td>N</td>
<td>N</td>
<td>R</td>
<td>N</td>
<td>R</td>
<td>O^*</td>
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<td><strong>Halogenated Hydrocarbons</strong></td>
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<td>R</td>
<td>R</td>
<td>N</td>
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<td>Methylene chloride</td>
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<td>P</td>
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<td>N</td>
<td>R</td>
<td>R</td>
<td>N</td>
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<tr>
<td><strong>Ketones</strong></td>
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<td>Acetone</td>
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<td>G</td>
<td>P</td>
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<td>O</td>
<td>N</td>
<td>R</td>
<td>N</td>
<td>R</td>
<td>R</td>
</tr>
<tr>
<td>Methyl ethyl ketone</td>
<td>P</td>
<td>G</td>
<td>P</td>
<td>N</td>
<td>O</td>
<td>N</td>
<td>R</td>
<td>O</td>
<td>R</td>
<td>R</td>
</tr>
</tbody>
</table>

^*Can be used with aqueous solutions containing up to 20% DMSO.
R = Recommended, L = Limited Resistance, N = Not Recommended, O = Testing Advised, F = Fair, G = Good, P = Poor, PP = Polypropylene, PVC = Polyvinyl Chloride, CA = Cellulose Acetate, PC = Polycarbonate, PTFE = Polytetrafluoroethylene PS = Polystyrene, CN = Cellulose Nitrte, NY = Nylon, MCE = Mixed Cellulose Esters, PET = Polyethylene Terephthalate.

CHARACTERISTICS OF CORNING CENTRIFUGE TUBES

The following information is provided to serve as a general guideline for determining suitability of Corning centrifuge tubes for your applications. In addition, Corning recommends following the procedures outlined by the centrifuge manufacturer, as well as conducting a trial run to determine proper conditions before beginning any critical applications.

Corning centrifuge tubes are tested for leakage. They should not break or leak if used in a properly balanced rotor with suitable carriers, holders, and adapters that fully support the tubes when run in accordance with the guidelines in this section. These tubes are intended for one-time use only; reuse is not recommended as breakage or leakage may occur.

The recommended working temperature range for Corning centrifuge tubes is 0 to 40°C. The suitability of these tubes for storage below 0°C depends on both the solution and the storage conditions. In general, the polypropylene and PET tubes are more resistant to stress at low temperatures than polystyrene. It is strongly recommended that a trial run be performed under actual conditions to test the suitability of the tubes for frozen storage.

Suggestions for Safe Centrifugation

- **Caution:** When centrifuging pathogenic organisms, clinical specimens known or suspected of being infectious, or any other potentially biohazardous materials, approved safety containment systems should be used. Contact your centrifuge manufacturer for appropriate accessories or recommendations.
- Read protocols and instruction manuals carefully. Do not confuse speed or revolutions per minute (RPM) with relative centrifugal force (RCF). Instructions for centrifuging a sample at a given RPM and time are incomplete unless the rotor or radius is specified. Protocols should always state the time and RCF value for centrifuging a sample.
Proper balancing and distribution of the load in a centrifuge is critical for optimum performance and to prevent damage to the tubes or centrifuge. Opposing buckets or loads should always be balanced within the range specified by the manufacturer. Tubes should always be distributed in the buckets with respect to the center of rotation as well as the pivotal axis of the bucket. Failure to do this may prevent the bucket from achieving a horizontal position during the centrifugation run. Uneven separations or tube failure may result.

These centrifuge tubes are intended for use by persons knowledgeable in safe laboratory practices. Failure can result from surface damage, exceeding the specified RCF values, using unsuitable support systems, improper temperatures, or incompatible chemicals.

The RCF ratings for Corning® disposable centrifuge tubes have been established at room temperature using tubes filled to nominal capacity with water and spun in a horizontal rotor centrifuge for 5 minutes. The centrifuge must be equipped with the recommended carriers, adapters, and cushions that fully support the tubes. If an angle head rotor is used or proper support is not provided, RCF values will be lower. Use of liquid other than water may also lower RCF values. Please consult your centrifuge specifications and the nomogram table (page 47) to determine speeds at which maximum RCF is achieved.

### Chemical Compatibility of Disposable Plastic Centrifuge Tubes

The mechanical strength, flexibility, color, weight and dimensional stability of all plastic centrifuge tubes are affected to varying degrees by the chemicals with which they come in contact. Specific operating conditions, especially temperature, RCF, rotor type, carrier design, and run length will also affect tube performance.

---

#### Physical Properties of Disposable Plastic Centrifuge Tubes

<table>
<thead>
<tr>
<th></th>
<th>Clear Polypropylene</th>
<th>New Polyethylene Terephthalate</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Recommended Working Temp</strong></td>
<td>0–40°C</td>
<td>0–40°C</td>
</tr>
<tr>
<td><strong>Heat Distortion Point</strong></td>
<td>121°C</td>
<td>70°C</td>
</tr>
<tr>
<td><strong>Flexibility</strong></td>
<td>Moderate</td>
<td>Rigid</td>
</tr>
<tr>
<td><strong>Transparency</strong></td>
<td>Clear</td>
<td>Clear</td>
</tr>
<tr>
<td><strong>Maximum RCF:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15 mL Tube</td>
<td>12,000 x g</td>
<td>3,600 x g</td>
</tr>
<tr>
<td>50 mL Tube</td>
<td>15,500 x g</td>
<td>3,600 x g</td>
</tr>
<tr>
<td>250 mL Tube</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>500 mL Tube</td>
<td>–</td>
<td>–</td>
</tr>
</tbody>
</table>

*At room temperature for 24 hours.

#### Chemical Resistance of Disposable Plastic Centrifuge Tubes*

<table>
<thead>
<tr>
<th>Chemical Class</th>
<th>Polyethylene Terephthalate</th>
<th>Polypropylene</th>
<th>Polyethylene Caps</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acids (weak)</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Acids</td>
<td>3</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Alcohols</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Aldehydes</td>
<td>3&lt;sup&gt;a&lt;/sup&gt;</td>
<td>2&lt;sup&gt;a&lt;/sup&gt;</td>
<td>1</td>
</tr>
<tr>
<td>Bases</td>
<td>3</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Esters</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Hydrocarbons:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aliphatic</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Aromatic</td>
<td>3</td>
<td>3&lt;sup&gt;b&lt;/sup&gt;</td>
<td>3</td>
</tr>
<tr>
<td>Halogenated</td>
<td>3</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Ketones</td>
<td>2&lt;sup&gt;c&lt;/sup&gt;</td>
<td>2</td>
<td>2</td>
</tr>
</tbody>
</table>

*At room temperature for 24 hours.

1 = Recommended; 2 = Suitable for most applications. However, a trial run under specific operating conditions is recommended; 3 = Not recommended. Note: a = Formaldehyde, rated 1; b = Phenol, rated 1; c = Acetone, rated 1.

---

Visit [www.corning.com/lifesciences](http://www.corning.com/lifesciences) for additional product and technical information.
Nomogram for Computing Relative Centrifugal Force

To calculate the RCF value at any point along the tube or bottle, measure the radius, in mm, from the center of the centrifuge spindle to the particular point. Draw a line from the radius value on the right hand column to the appropriate centrifuge speed on the left-hand column. The RCF value is the point where the line crosses the center column. The nomogram is based on the formula:

$$ RCF = \left(11.17 \times 10^{-7}\right) RN^2 $$

*where:*

- R = Radius in mm from centrifuge spindle to point in tube bottom
- N = Speed of spindle in RPM
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MS Series Analytical and Precision Balances, METTLER TOLEDO®

Supplier: Mettler Toledo

Features FACT® Fully Automated Calibration Technology
- Capacities from 120 g to 8200 g
- Readabilities from 0.1 mg to 0.1 g
- Built-in RS-232 Interface

The NewClassic MS line of balances ranges from high-resolution analytical to precision models. FACT® technology provides fully automatic, motorized calibration with an internal weight. In addition to basic operations such as weighing, taring, and calibration, the MS balances are also equipped with functions such as piece counting, percent weighing, and dynamic weighing. All models have programmable Smart Keys for shortcut access to preferred applications as well. DeltaRange® balances (97035-640 and 97035-644) feature a moveable fine range with ten times the readability anywhere in the weighing range, just by taring.

Balance housings are constructed of die-cast aluminum and supplied with transparent protective covers. Weighing pans are constructed from chromium-nickel steel. All models are protected against dust and water, and have an IP54 in-use rating. Built-in RS-232 and USB interfaces allow for easy communication exchange. The HCD (high contrast display) with large numbers, clear symbols, and an intuitive menu enables users to operate the balance quickly and easily. To allow for quick and easy cleaning, the QuickLock draft shield can be dismantled in a few simple steps, without moving the balance, and the separate glass panels can be cleaned in a dishwasher.

UL listed and CSA certified.

Ordering Information: The 2-place readability models do not include draft shields. QuickLock draft shields are only supplied with models featuring 3-place readability or better. Optional Gold and Silver calibration service packages are offered to assure continual reliability and maintain optimum balance performance. The Gold service package is suitable for many regulated and unregulated balance uses requiring documentation to support installation, including a NIST traceable certificate. The Silver service package is suitable for many unregulated balance uses requiring no significant documentation to support installation. Contact your representative for package specifics.

Analytical Balances

<table>
<thead>
<tr>
<th>Model</th>
<th>Capacity</th>
<th>Dimensions</th>
<th>Linearity</th>
<th>Pan Size</th>
<th>Readability</th>
<th>Repeatability (Std. Dev.)</th>
<th>Stabilization Time</th>
<th>Supplier No.</th>
<th>VWR Catalog Number</th>
<th>Unit</th>
<th>Price</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>MS204S</td>
<td>220 g</td>
<td>20.4W x 34.7L x 34.5H cm (8 x 13 1/16 x 13 1/32&quot;)</td>
<td>0.2 mg</td>
<td>9 cm (3 1/2&quot;) dia.</td>
<td>0.1 mg</td>
<td>0.1 mg</td>
<td>2 s</td>
<td>11144917</td>
<td>97035-622</td>
<td>Each</td>
<td>$4,797.01</td>
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<tr>
<td>MS304S</td>
<td>320 g</td>
<td>20.4W x 34.7L x 34.5H cm (8 x 13 1/16 x 13 1/32&quot;)</td>
<td>0.3 mg</td>
<td>9 cm (3 1/2&quot;) dia.</td>
<td>0.1 mg</td>
<td>0.1 mg</td>
<td>3 s</td>
<td>11144920</td>
<td>97035-624</td>
<td>Each</td>
<td>$5,432.35</td>
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<td>MS104S</td>
<td>120 g</td>
<td>20.4W x 34.7L x 34.5H cm (8 x 13 1/16 x 13 1/32&quot;)</td>
<td>0.2 mg</td>
<td>9 cm (3 1/2&quot;) dia.</td>
<td>0.1 mg</td>
<td>0.1 mg</td>
<td>2 s</td>
<td>11144914</td>
<td>97035-620</td>
<td>Each</td>
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Precision Balances

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<th>Dimensions</th>
<th>Linearity</th>
<th>Pan Size</th>
<th>Readability</th>
<th>Repeatability (Std. Dev.)</th>
<th>Stabilization Time</th>
<th>Supplier No.</th>
<th>VWR Catalog Number</th>
<th>Unit</th>
<th>Price</th>
<th>Quantity</th>
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</thead>
<tbody>
<tr>
<td>MS1602S</td>
<td>1620 g</td>
<td>19.4W x 34.7L x 9.6H cm (7 11/16 x 13 1/16 x 3 5/32&quot;)</td>
<td>0.02 g</td>
<td>17 x 20 cm (6 23/32 x 7 11/16&quot;)</td>
<td>0.01 g</td>
<td>0.01 g</td>
<td>1.5 s</td>
<td>11144956</td>
<td>97035-634</td>
<td>Each</td>
<td>$2,595.61</td>
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<td>Accuracy</td>
<td>Order Code</td>
<td>Price</td>
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</tr>
<tr>
<td>MS1003S</td>
<td>1020 g</td>
<td>28 x 23 x 14 cm</td>
<td>0.02 g</td>
<td>1 mg</td>
<td>2 s</td>
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<td>17 x 20 x 9 cm</td>
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SteamScrubber Dishwasher -- 6921-09A
Product Details
in: Labware Washers

Product Overview
Labconco laboratory glassware washers have specialized features to meet the laboratory’s demand for superior cleaning and convenience. SteamScrubber Glassware Washers have top and bottom racks that accommodate accessory inserts for a wide variety of glassware shapes and sizes, primarily beakers and other wide-mouth glassware. FlaskScrubber Glassware Washers have a spindle rack that holds up to 36 pieces of primarily narrow-neck glassware such as volumetric flasks. All racks are interchangeable among washers.

- LED displays program selected or details of the program.
- Flexible cycle options allow you to change wash and dry cycle duration and number of rinses.
- Upper and lower rotating wash arms with adjustable height center tower distribute up to 60 gallons (227 liters) of water per minute.
- Tower adjusts to accommodate various glassware heights.
- Built-in forced air drying system
- Dual heaters boost water and glassware temperatures: With minimum inlet temperature of 120° F (49° C), the sump heater elevates water temperature approximately 20° F (11° C)
- Dry or liquid detergent dispenser

Specifications

<table>
<thead>
<tr>
<th>Product Category</th>
<th>Labware Washers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Configuration</td>
<td>Undercounter</td>
</tr>
<tr>
<td>Heating</td>
<td>Steam</td>
</tr>
<tr>
<td>Applications</td>
<td>General Purpose Labware</td>
</tr>
</tbody>
</table>

Operating Specifications
- Water Temperature: 49 to 60 C (120 to 140 F)

External Dimensions
- Length: 24.1 inch (612 mm)
- Width: 27.4 inch (696 mm)
- Height: 34.1 inch (866 mm)

Features
- Drying

User Interface Options
- User Interface: Digital Front Panel
- Display: None

For more information:

More Info on Supplier Site  |  Email Supplier  |  Request a Quote
# Oakton™ DO 110 Portable Dissolved Oxygen Meter

Dual display of dissolved oxygen and temperature readings, plus RS-232 output

---

Include:
- **Meter**/Probe option includes meter, DO/temperature probe with 10 ft. submersible cable; software on CD-ROM, assembled membrane cap housing, 60mL electrolyte, and batteries.
- **Meter Kit** option includes meter, DO/temperature probe with 10 ft. submersible cable; software on CD-ROM, one assembled membrane cap housing, 60mL electrolyte, batteries, and hard plastic carryin
g case.

**Required Accessories:**
- Optional AC Adapter (13-300-126) for use on 110VAC 60Hz.

- **Dual-readout LCD**
- **Galvanic probe design** for immediate dissolved oxygen readings—no meter warmup
- **Memory stores up to 100 readings** with temperatures in °C or °F
- **RS-232 output** to printer or computer (cable optional)
- **Independent 100%, zero and offset adjustment** capabilities for high accuracy over entire measurement range
- **Key in barometric pressure and salinity;** meter calculates salinity correction from 0.0 to 50.0ppt, barometric pressure correction from 500 to 1499mmHg
- **Easy-to service, low maintenance galvanic probe** with replaceable cap assembly
- **Displays probe diagnostics, slope, zero offset, and millivolt values**
- **HOLD function, Ready indicator,** and automatic shutoff
- **Splash-resistant membrane keypad** helps protect meter components

---

<table>
<thead>
<tr>
<th>Catalog No.</th>
<th>Description</th>
<th>Price per Unit</th>
<th>Quantity &amp; Availability</th>
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</thead>
<tbody>
<tr>
<td>15-500-101</td>
<td>Model DO 110 portable dissolved oxygen meter/probe</td>
<td>Each for $743.37</td>
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</tbody>
</table>

---

**View Specifications**

---

*OAKTON™ DO 110 Meter Instructions*
Oakton DO 110 Portable Dissolved Oxygen Meter - Fisher Scientific

15-500-102

Model DO 110 portable dissolved oxygen meter kit

Accessories

Each for $779.92

Quantity:

Check Availability

Feedback

Report a content error

Related Products

Catalog No: 09-326-2A

Fisher Scientific Replacement Probes for Traceable™ Conductivity and TDS Meters

Replacement Probe, For Meter: 09-326-2

Price:

Each for $276.50

Quantity:

Check Availability

Add to Cart

View product Group or See similar Items

Catalog No: 13642225

Thermo Scientific™ Orion™ DuraProbe 4-Electrode Conductivity Cells

Cable length: 1.5m; 1 µS/cm to 200 mS/cm

Price:

Each for $528.18

Each for $501.77

Instant Savings (5%)

Quantity:

Check Availability

Add to Cart

View product Group or See similar Items

Back to Top
Great ideas stem from inquiry!
Science, technology, engineering, and mathematics (STEM) are essential to each other in order to develop products to meet our needs. In fact, it is difficult to separate each of these disciplines from one another when teaching real-world applications. The STEM electrophoresis kit is a unique introductory electrophoresis laboratory with true integration of STEM through the assembly of a horizontal agarose gel electrophoresis cell. Perform actual dye electrophoresis using the STEM electrophoresis kit with the IDEA kit — inquiry dye electrophoresis activity.

Features and Benefits
- Inquiry-based hands-on laboratory
- Kit can be completed in two 45-min laboratory sessions
- Visible results
- STEM integration

Applications and Uses
This kit offers learning opportunities for all levels of instruction:
- For secondary and college level instruction, students will learn about the various components of a horizontal gel electrophoresis cell and what their critical properties are in order to achieve optimal separation results
- For middle school instruction, students will get their first experience with a key biotechnology technique

More Information
- The IDEA kit — inquiry dye electrophoresis activity is designed to run with the STEM electrophoresis kit
- The STEM electrophoresis teacher demonstration kit provides sufficient materials for 2 student workstations
- The STEM electrophoresis classroom kit provides sufficient materials for 8 student workstations with up to 4 students per workstation
- The STEM electrophoresis engineering module is configured for 2 student workstations
STEM Electrophoresis Kit

Overview

Description

STEM Electrophoresis Teacher Demonstration Kit
166-5080EDU
Introductory kit, includes IDEA kit reagent refill pack (#166-5076EDU), electrophoresis cell, electrodes, electrical leads, combs, curriculum, for 2 student workstations; education use only

List Price: $123.75
EDU Price: $99.00

STEM Electrophoresis Classroom Kit
166-5090EDU
Introductory kit, includes IDEA kit reagent refill pack (#166-5076EDU), electrophoresis cell, electrodes, electrical leads, combs, curriculum, for 8 student workstations; education use only

List Price: $331.25
EDU Price: $265.00

STEM Electrophoresis Kit Starter Pack
166-5095EDU
Introductory kit, includes IDEA kit reagent refill pack (#166-5076EDU), electrophoresis cell, electrodes, electrical leads, combs, fixed-volume pipets, tips, curriculum, for 8 student workstations; education use only

List Price: $531.25
EDU Price: $425.00

What is this?
## STEM Electrophoresis Kit

### Overview

**STEM Kit Quick Guide**

**STEM Kit Flowchart**

**Lab Preparation Checklist**

**Lab Preparation Sheet**

---

### Description

<table>
<thead>
<tr>
<th>STEM Electrophoresis Kit</th>
<th>List Price:</th>
<th>EDU Price:</th>
<th>What is this?</th>
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<tbody>
<tr>
<td>Teacher Demonstration Kit</td>
<td>$123.75</td>
<td>$99.00</td>
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<tr>
<td>Classroom Kit</td>
<td>$331.25</td>
<td>$265.00</td>
<td><a href="#">What is this?</a></td>
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<tr>
<td>Starter Pack</td>
<td>$531.25</td>
<td>$425.00</td>
<td><a href="#">What is this?</a></td>
</tr>
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</table>

**Teacher Demonstration Kit**

166-5080EDU

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**Classroom Kit**

166-5090EDU

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**Starter Pack**

166-5095EDU

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---

STEM Electrophoresis Kit

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- The STEM electrophoresis engineering module is configured for 2 student workstations
STEM Electrophoresis Kit

Overview

**Overview**

1. **STEM Kit Quick Guide**
2. **Lab Preparation Checklist**
3. **Lab Preparation Checklist (Printable)**
4. **STEM Kit Flowchart**
5. **Lab Preparation List**

Description

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- **List Price:** $531.25
- **EDU Price:** $425.00
**Fisherbrand™ Glass-Disposal Boxes**

Disposal boxes keep glass separate from other waste

- Sturdy, corrugated cardboard
- With tough 2mm-thick polyethylene liner
- Identifying graphics with instructions
- Unique integral lid provides added safety

**View Specifications**

### Items | Specifications
---|---
**Catalog No.**

12-009-7B

**Description**

*Benchtomp model; 8L x 8W x 10 in. H (20 x 20 x 25cm)*

**Price per Unit**

Pack of 6 for $79.28

**Quantity & Availability**

Check Availability

**17-988-448**

**Intermediate model; 12Lx 12W x 20 in. H (30 x 30 x 51cm)**

**Price per Unit**

Pack of 6 for $139.00

Pack of 6 for $125.10

**Instant Savings (10%)**

**Quantity & Availability**

Check Availability
Items from this product group that did not meet all your search criteria are listed below

12 009 7A  
**Floor model; 12L x 12W x 27 in. H**  
(30 x 30 x 69cm)  
**Pack of 6 for $122.90**  

Feedback

[Report a content error]

Back to Search Results

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Integrity® Xpansion™
Multiplate Bioreactor for Cell-Based Product Manufacturing

ATMI LifeSciences
The Source of Bioprocess Efficiency™
Introduction

The Xpansion™ Multiplate Bioreactor is part of the ATMI LifeSciences Integrity® single-use bioreactor family. The Xpansion system is especially developed for fragile adherent cell culture applications such as stem cell culture.

The Xpansion Multiplate Bioreactor is industrialized for safe, large-scale production of traditional 2-D cell cultures. Its multiplate structure promotes a large cell growth surface area (up to 122,400 cm²). Its compact efficient design enables the elimination of the gas phase between the plates. This gas phase is replaced by an automatically controlled aeration system which provides advanced gas diffusion.

Control is automatic via disposable pH and DO sensors. Temperature monitoring and agitation control are also included. Xpansion bioreactors offer the possibility of monitoring cell morphology and density by a specific holographic microscope.

Features

- USP class VI certified materials
- Designed for adherent cell culture applications
- Completely single-use closed bioreactor from vessel to sensor for sterility and contamination risk reduction
- Multiplate, 2-D cell-culture design enables easy transfer from traditional multitray stacks
- Cell culture reproducibility and traceability by monitoring culture parameters (pH, DO, temperature) and real-time controls
- Monitoring of cell morphology and density by holographic microscope
- Upstream and downstream processing flexibility: reduction of numbers of operations, complexity and risks related to operations (e.g., seeding, medium exchange, harvest)
- Designed for use in a complete closed system from seeding to harvest
Xpansion System Structure
The Xpansion system includes a single-use bioreactor, a docking station and a controller.

Single-Use Bioreactor with Stacked Multiplate Design
Comprised of stacked hydrophilized polystyrene radial plates, the Xpansion Multiplate Bioreactor is designed to promote cell growth on the top of each plate. Each plate has a hole in the center. The stacking of these plates forms the central column which allows circulation of the medium in the bioreactor and gas exchange.

The plates are covered by an outer tube, a head plate on the top and a base plate on the bottom. On the head plate, there are:

- Two sensor connectors: one for pH, one for DO (dissolved oxygen) and four optional
- Three windows for easy viewing under a specialized holographic microscope
- Two vent filters
- Two gas filters (in and out) for aeration system
- One thermowell port
- One sampling port

In the bottom side of the bioreactor, there are:

- Two fluid operation ports (e.g., inoculation, harvest, etc.)
- One magnetic impeller

Materials
<table>
<thead>
<tr>
<th></th>
<th>Description</th>
</tr>
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<tbody>
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<td>1</td>
<td>Gas in &amp; out Silicone tubing ID 1/4&quot;, Midisart BV 0.20µm hydrophobic filters (PTFE, Polyester, Polypropylene)</td>
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<td>2</td>
<td>Vent 1 &amp; 2 Silicone tubing ID 1/4&quot;, Midisart BV 0.20µm hydrophobic filters (PTFE, Polyester, Polypropylene)</td>
</tr>
<tr>
<td>3</td>
<td>Sampling port Silicone tubing ID 1/4&quot;, luer female connector Clear Polystyrene</td>
</tr>
<tr>
<td>4</td>
<td>Headplate Clear Polystyrene</td>
</tr>
<tr>
<td>5</td>
<td>Cell surface plates Cell culture plasma treated clear Polystyrene</td>
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<tr>
<td>6</td>
<td>Aeration support Polypropylene &amp; Polycarbonate</td>
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<td>7</td>
<td>Aeration tubing Silicone ID 0.58&quot;, OD 0.77”</td>
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<td>8</td>
<td>Outer tube Polyvinyl chloride</td>
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<td>9</td>
<td>Stirrer cover Clear Polystyrene</td>
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<td>10</td>
<td>Impeller UHMWPE</td>
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<td>11</td>
<td>Bearing PEEK</td>
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<tr>
<td>12</td>
<td>Base Clear Polystyrene</td>
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<td></td>
<td>Liquid in/out tubing Silicone tubing ID 3/8&quot;, CPC MPC male on which connects Silicone tubing ID 1/4&quot;, luer female connector or Silicone tubing ID 1/4&quot;, 0.20µm hydrophobic filters</td>
</tr>
</tbody>
</table>

Sealing material resin
**Docking Station**

The bioreactor is based on a docking station that includes a magnetic drive stirring unit. The magnetic agitation system is a quiet operation which is compatible with the magnetic impeller.

Control of agitation speed is integrated in the controller. The setpoint is defined via the screen on the front side of the controller.

**Controller**

The controller is on a separate skid with measurement/control hardware and a gassing system with a digital control.

Features of the Xpansion controller include:

- Graphical user interface with color display and touch screen operation with two security levels: Administrator and Operator
- Integrated amplifiers for temperature, disposable DO and pH sensors
- Integrated control loops for DO and pH
- Agitation control (speed range from 5 up to 250 rpm)
- Temperature monitoring
- Calibration of pre-calibrated DO and pH sensors: Sensor patches come precalibrated. Calibration data are transferred via a USB key to the controller
- In-process DO and pH recalibration is possible
- Trend display for up to four process values (pH, DO, T, Q: flow rate)

**Controller Gas Module**

The controller is connected to the user’s gas supply line. Its “gas outlet” is connected to the “gas in” filter of the bioreactor. Gas composition to be injected in the bioreactor is regulated by controller solenoid gas valves. The flow rate of the mixed gas is adjusted by a massflow controller (0-200ml/min).

The controller gas module contains:

- One gas diffuser outlet
- Four solenoid valves of Air (1x), N₂ (1x), O₂ (1x), and CO₂ (1x)
- One Mass Flow Controller for gas mixing flow control
- Control via pH/DO controller

**Data Management**

Xpansion Multiplate Bioreactor systems have one Ethernet port for data communication/acquisition. It could be linked to Egraph (optional software provided by ATMI). Egraph is installed on a host PC and provides data acquisition for all process values.
Performance

**Standard Cell Environment Preservation**
As in multitray stacks, cells adhere and grow on hydrophilized polystyrene plates and are harvested using a cell dissociation reagent. Because of its specific design, the system maintains the same environment as T-flasks or multitray stacks, and enables implementation of a process easily-adapted from these traditional methods.

**Cell Culture Parameters (pH, DO) Control and Temperature Monitoring**
Xpansion Multiplate Bioreactor head plate includes patches ports for optical noninvasive measurement of pH and dissolved oxygen (DO). The determination of pH and DO are based upon the principle of fluorescence for contamination risk elimination. Depending on the DO and pH measurement, gas regulation is activated via the controller according to users’ requirements.

Temperature is measured for monitoring via a PT100 reusable sensor installed in a thermowell of the bioreactor. The heating is done via an incubator or in a warm room.

Each measure (pH, DO and T) is associated with an alarm.

**Aeration System**
Gas aeration occurs depending on pH and DO control limits set by the users. Gas composition control depends on pH and DO measurement in the bioreactor. The gas coming from the controller enters via the "gas in" filter of the bioreactor and passes through very thin silicone tubing placed in the central column. The gas inlet and outlet include pre-installed hydrophobic aeration filters. Gases diffuse through the tubing.

---

### Optical pH Sensor Performance Specifications

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<th>Specification</th>
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<td>Accuracy</td>
<td>±0.1 @ pH 6.5 – 8.5</td>
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<tr>
<td>Precision</td>
<td>±0.1 @ pH 7.0</td>
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<tr>
<td>Response time (t90)</td>
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<tr>
<td>Calibration</td>
<td>Shipped pre-calibrated, optional one point user recalibration</td>
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<tr>
<td>Materials</td>
<td>USP Class VI certified</td>
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</table>

### Optical DO Sensor Performance Specifications

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<th>Parameter</th>
<th>Specification</th>
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<td>Accuracy</td>
<td>+/- 2% airsat @ DO 15% airsat - 75% airsat</td>
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<tr>
<td>Precision</td>
<td>+/- 0.5% @ airsat</td>
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<td>Response time (t90)</td>
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<tr>
<td>Materials</td>
<td>USP Class VI certified</td>
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</tbody>
</table>
**Homogenization by Medium Circulation**

Medium circulation is coupled with the aeration system which depends on pH and DO control. The medium could also circulate in the bioreactor independently of gas aeration according to users’ requirements. Each plate contains 16 radial channels supporting media flow rate. The liquid goes up through the first plate channel, flows horizontally over the plate, then goes up to reach the second plate, and so on.

**Cell Morphology and Density Monitoring**

Cell density and morphology are monitored via a specialized holographic microscope developed by Ovizio and integrated through collaboration with ATMI. Ovizio’s technology provides a platform to observe cells on multiple layers with very high image quality and automatically calculates cell confluency.

**Technical Specifications**

<table>
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<tr>
<th>Bioreactors</th>
<th>Xpansion MP 10</th>
<th>Xpansion MP 50</th>
<th>Xpansion MP 100</th>
<th>Xpansion MP 200</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of plates</td>
<td>10</td>
<td>50</td>
<td>100</td>
<td>200</td>
</tr>
<tr>
<td>Cell culture surface</td>
<td>6,120cm² (949in²)</td>
<td>30,600cm² (4,743in²)</td>
<td>61,200cm² (9,486in²)</td>
<td>122,400cm² (18,972in²)</td>
</tr>
<tr>
<td>Ratio of media volume / surface area</td>
<td>0.26ml/cm²</td>
<td>0.18ml/cm²</td>
<td>0.18ml/cm²</td>
<td>0.18ml/cm²</td>
</tr>
<tr>
<td>Volume of the bioreactor</td>
<td>1.6L</td>
<td>5.6L</td>
<td>11.2L</td>
<td>21.9L</td>
</tr>
<tr>
<td>Volume of the central column</td>
<td>26ml</td>
<td>132ml</td>
<td>263ml</td>
<td>527ml</td>
</tr>
<tr>
<td>Overall weight</td>
<td>2.5kg (5.6 lbs.)</td>
<td>6.9kg (15.2 lbs.)</td>
<td>12.5kg (27.5 lbs.)</td>
<td>23.4kg (50.7 lbs.)</td>
</tr>
<tr>
<td>Overall height</td>
<td>29cm (11.4”)</td>
<td>47cm (18.5&quot;)</td>
<td>55cm (21.6&quot;)</td>
<td>81cm (31.9&quot;)</td>
</tr>
<tr>
<td>Minimum space requirement for the bioreactor and docking station (HxWxD)</td>
<td>49cm x 48cm x 40cm (19” x 19” x 16&quot;)</td>
<td>67cm x 48cm x 40cm (26” x 19” x 16&quot;)</td>
<td>75cm x 48cm x 40cm (30” x 19” x 16&quot;)</td>
<td>99cm x 48cm x 40cm (39” x 19” x 16&quot;)</td>
</tr>
<tr>
<td>Plate surface</td>
<td>612cm² (94.9in²)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Plate thickness</td>
<td>0.1cm (0.04&quot;)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Distance between two plates</td>
<td>0.16cm (0.06&quot;)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Volume between two plates</td>
<td>98ml</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Volume of the head space</td>
<td>50ml</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sterilization</td>
<td>Irradiated to dose exceeding 25KGy</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

See the Xpansion System Video at this location: http://www.atmi.com/lifesciences/products/bioreactors/xpansion.html
LS Columns

Overview

LS Columns are designed for positive selection of cells. They are also suitable for the depletion of strongly magnetically labeled cells.

LS Columns can be used with the following separators:
- MidiMACS™ Separator
- QuadroMACS™ Separator
- VarioMACS™ Separator, in combination with an LS Column Adapter
- SuperMACS™ II Separator
- MultiMACS Cell24 Separator Plus, in combination with the Single Column Adapter

Column capacity

For lymphoid cells from blood, bone marrow or tissue:
Up to $10^8$ magnetically labeled cells from up to $2 \times 10^9$ total cells.

For the capacity of cells from other tissues, e.g., neural tissues, please refer to the data sheet provided with the particular MACS Cell Separation Reagent.

For use with the MultiMACS Cell24 Separator Plus:
Up to $10^8$ magnetically labeled cells from up to $1 \times 10^9$ total cells.

Details

Background information

The matrix of the LS Columns is composed of ferromagnetic spheres, which are covered with a cell-friendly coating allowing fast and gentle separation of cells. When placed in the magnetic field of a MACS® Separator, the spheres amplify the magnetic field by 10,000-fold, thus inducing a high gradient within the column. This is crucial for isolation of cells which are only minimally labeled with MACS® MicroBeads, leaving enough epitopes free for concurrent antibody staining. The space between the spheres is several times larger than primary and most cultured cells. This allows the cells to freely flow through the column. Magnetically labeled cells are held in suspension within the column and do not actually "bind" the column matrix. This suspension minimizes stress on the cells and allows for efficient sterile washing by avoiding cell aggregation.
LS Columns can be used to separate material less than 30 µm in size. The columns are individually packed in a sterile way.

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**Gallery**

**Figure 1**

LS Column

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**Related Items**

**LS Column Adapter Kit**
130-041-408

The LS Column Adapter is required to insert LS Columns and 13 mL collection tubes into the VarioMACS™ or SuperMACS™ Separator and is also suitable for inserting LD Columns or Whole Blood Columns into the VarioMACS or SuperMACS Separator. The LS Column Adapter is not suitable for use with the SuperMACS II Separator.
**LS Column Adapter**
130-090-544

The LS Column Adapter is required to insert LS Columns and 13 mL collection tubes into the VarioMACS™ or SuperMACS™ Separator and is also suitable for inserting LD Columns or Whole Blood Columns into the VarioMACS or SuperMACS Separator. The LS Column Adapter is not suitable for use with the SuperMACS II Separator.

**Pre-Separation Filters (30 µm)**
130-041-407

Pre-Separation Filters are designed for the easy removal of cell aggregates or large particles from single-cell suspensions to ensure effective magnetic or fluorescent cell labeling, and thus optimal flow within cell separation columns and flow cytometer.

**MidiMACS Starting Kit (LS)**
130-042-301

The MidiMACS™ Separator allows the performance of cell separations in combination with LS Columns, LD Columns, or Whole Blood Columns:
- LS Columns for positive selection or depletion
- LD Columns for depletion
- Whole Blood Columns for positive selection of cells directly from whole blood

Up to three MidiMACS Separators can be attached to a MultiStand.

**QuadroMACS Starting Kit (LS)**
130-091-051

The QuadroMACS™ Separator allows the convenient performance of up to four simultaneous separations in combination with LS, LD or Whole Blood Columns:
- LS Columns for positive selection or depletion
• LD Columns for depletion
• Whole Blood Columns for positive selection of cells directly from whole blood
Simultaneous separations might be desired for processing of multiple samples or for the separation of large samples split into portions.

Mini & MidiMACS Starting Kit (MS, LS)
130-042-501
A Mini & MidiMACS™ Starting Kit provides indispensable equipment for MACS® Cell Separations. The Mini & MidiMACS Starting Kit includes a MiniMACS Separator, a MidiMACS Separator, a MultiStand to attach the separators, MACS Columns, and a cell separation reagent of choice.
The decision for one or the other Mini & MidiMACS Starting Kit depends on the preference for LS Columns or LD Columns.
The MiniMACS Separator is used for smaller cell samples, which are separated over MS Columns, whereas larger samples are processed using the MidiMACS Separator in combination with LS or LD Columns.

<table>
<thead>
<tr>
<th>Product</th>
<th>Order no.</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>LS Columns</td>
<td>130-042-401</td>
<td>$360.00</td>
</tr>
<tr>
<td>LS Columns</td>
<td>130-041-306</td>
<td>$400.00</td>
</tr>
</tbody>
</table>

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OctoMACS™ Separator and Starting Kits

Overview

The OctoMACS™ Separator allows the performance of up to eight simultaneous separations in combination with MS Columns, Large Cell Columns, or M Columns:
- MS Columns for positive selection or depletion of cells
- Large Cell Columns for positive selection of large cells, e.g., megakaryocytes
- M Columns for isolation of molecules, e.g., RNA

Simultaneous separations might be desired for processing of multiple samples or for the separation of large samples split into portions.

Details

Background information

The OctoMACS™ Separator contains a powerful permanent magnet that induces a high-gradient magnetic field within MACS® Columns – a field strong enough to retain cells labeled with even small amounts of MACS MicroBeads.

Gallery

Figure 1

The OctoMACS™ Separator
The OctoMACS™ Separator

Figure 2

The OctoMACS™ Separator attached to a MultiStand, holding eight MS Columns. The OctoMACS Acrylic Tube Rack facilitates fraction collection.

Related Items

**MS Columns**
130-042-201

MS Columns are designed for positive selection of cells. They are also suitable for depletion of strongly magnetically labeled cells.

MS Columns can be used with the following separators:
- MiniMACS™ Separator
- OctoMACS™ Separator
- VarioMACS™ Separator, in combination with MS Column Adapter
- SuperMACS™ II Separator

**Large Cell Columns**
130-042-202

Large Cell Columns are designed for positive selection of large human or animal cells, for example megakaryocytes. In general, cell suspensions should not contain clumps, aggregates or particles >50 µm. The flow rate of the columns is controlled with a flow resistor that is supplied with the columns.

Large Cell Columns can be used with the following separators:
- MiniMACS™ Separator
- OctoMACS™ Separator
**MACS MultiStand**
130-042-303

The MultiStand is used for setting up the µMACS™, thermoMACS™, MiniMACS™, MidiMACS™, OctoMACS™, and QuadroMACS™ Separator.

**OctoMACS Acrylic Tube Rack**
130-090-448

The OctoMACS™ Acrylic Tube Rack is especially designed for use with the OctoMACS Separator allowing to process up to eight samples in parallel. The OctoMACS Acrylic Tube Rack holds up to 24 collection tubes with a capacity of 5 mL.

<table>
<thead>
<tr>
<th>Product</th>
<th>Order no.</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>OctoMACS Starting Kit</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Components:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• OctoMACS Separator (130-042-109)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• MACS MultiStand (130-042-303)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• MS Columns (130-042-201)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• OctoMACS Acrylic Tube Rack (130-090-448)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• One 2 mL unit of MACS MicroBeads, one MicroBead Kit, or one MACS Cell Isolation Kit</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Data sheet</td>
<td>130-042-108</td>
<td>$1,850.00</td>
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<tr>
<td><strong>OctoMACS Separator</strong></td>
<td></td>
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<tr>
<td>Content: 1 piece</td>
<td>130-042-109</td>
<td>$1,095.00</td>
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</tbody>
</table>
- Solvent PLS
- Pump Transfer Skids
- Custom PLS
- Chemical Collection
- Solvent Collection
- Process Chilled Water
- Chemical Dispense
- Custom Process Skids
  - Acid Dilution
  - Sulfuric Acid Treatment
  - Heat Exchangers
  - Filtration
- Water Recycling (IX)
- Vacuum Distillation
- Control Panel Fabrication
- Custom PP Fabrication

Sign Up for Our Newsletter

Sign Up

OMEGA Custom Waste Neutralization Packages
Wastech offers a complete family of Omega acid and caustic waste neutralization solutions. These include custom designed systems with fabricated tanks and standard designs with molded tanks. Standard single-stage OMEGA acid waste treatment systems may be ordered for 10 gpm, 15 gpm, 20 gpm, and 30 gpm. Standard control panels for relay control or PLC control are available as separate items for neutralization.

The Wastech Zeus™ software package for PLC control is available for single-stage or two-stage neutralization operations. Please see our OMEGA neutralization system features.

For custom applications, Wastech engineers will work with the customer to develop a specification, including mechanical, electrical and control designs. Wastech will select components, provide a layout for the space allowed, and address operational issues. Standard OMEGA specifications are available for consulting engineers. Wastech will fabricate special tank configurations up to 1000 gallons in PP or will work with FRP or HDPE fabricators for a custom size. Wastech designs can handle strong acids, concentrated acids, superacids such as Oleum or Chlorosulfonic Acid. Large OMEGA Systems for waste neutralization are available with capacities to 500 gpm.

As a waste treatment supplier, Wastech understands how to incorporate the neutralization or pH adjustment step into a complete waste treatment design for fluoride removal and heavy metal precipitation.

Accessories such as flow meter additions, heat exchangers, on-line analytical measurement, communication issues, data logging, redundant sensing, tank storage and level monitoring, wireless communication, actuated valves, Seismic Zone 4 designs, and pumping requirements are all routine changes.

Most customers want to build acid and caustic waste neutralization packages themselves on-site to
save money; however, once they understand what Wastech offers, they realize that the Wastech package actually has a lower installed cost. Reasons are as follows:

1. Lower labor costs by using Wastech's factory labor instead of "prevailing wage" trades on site. On-site work will typically require use of mechanical and electrical trades.
2. Fewer parts delivered to the site that can be lost.
3. Faster installation with one power connection and simple inlet and outlet piping hookups.
4. Simple startup with a Wastech engineer on site.
5. No submittal hassles – Wastech drawings accepted the first time, usually without comments.
6. One phone call if something doesn't work.

**Acid Neutralization Options**

*Options can make all the difference!* Wastech OMEGA neutralization packages are only limited by your imagination. For more information, see [www.wastechengineering.com/neut_custom.html](http://www.wastechengineering.com/neut_custom.html).

1. Both active and passive systems are available:
   a. Active uses metering pumps with NaOH (caustic) or H₂SO₄ (sulfuric acid).
   b. Passive uses CaCO₃ (calcium carbonate or limestone chips).
2. The system can be a batch treatment system or a continuous treatment system.
3. One, two or three-stage active systems are possible (each with a separate set of metering pumps).
4. Surge tanks or equalization tanks can be included.
5. CO₂ gas neutralization for high pH applications instead of liquid acid (gas forms carbonic acid when combined with water).
6. Strong acid (0-2 pH) neutralization for laboratories.
7. Limestone systems for passive solutions.
8. Custom tanks for combined sampling and reaction tanks in a small footprint.
Wastech OMEGA neutralization packages can be designed with relay controls or PLC software featuring the Zeus™ control package. See OMEGA Neutralization System Features.

Relay control uses a pH controller to accept the sensor input and turn on or off relay to the metering pump based upon setpoints. GF Signet or Rosemount are normal choices, but any controller specified by the customer can be used.

PLC control requires a display screen and PLC software. When the project involves temperature, flow rate, totalizer, multiple tanks, actuated valves and other inputs, a PLC is the perfect low-cost solution. Over the years, Wastech has developed a PLC control program that handles all neutralization designs. This program allows data logging, internet monitoring, and alarm communication to beepers or cell phones.

### Packaged OMEGA Neutralization Packages

<table>
<thead>
<tr>
<th>Part Number</th>
<th>Flow Rate (GPM)</th>
<th>Approx. Length</th>
<th>Approx. Width</th>
<th>Approx. Height</th>
<th>Inlet Size (gravity)</th>
<th>Outlet Size</th>
<th>Approx. Weight</th>
</tr>
</thead>
</table>
Pump Technology Comparison

**Precision, versatility, and ease of use make Masterflex® peristaltic pump technology the preferred solution to increasing numbers of applications in the processing industry and in industrial applications. The following comparisons prove that under real-world conditions, Masterflex sets the standard for excellence.**

### Rotary Lobe Pumps vs Masterflex

**Application:** A university research facility needs to pump cell media into a system containing cells (the cells are living off of the media in the system). This system is used to simulate a human circulatory system for research purposes; therefore a constant flow rate needs to be maintained.

**Rotary Lobe Pump Disadvantages**
- Difficult to pump precise flow rates
- Does not self-prime
- Cannot handle particulates
- Difficult to clean

**Masterflex Advantages**
- Easily maintains a precise, constant flow rate
- Excellent self-priming capabilities
- Able to handle shear-sensitive particulates/fluids
- Easy to change out tubing and clean/sterilize pump

### Centrifugal Pumps vs Masterflex

**Application:** A food manufacturer needs to pump a high-viscosity glue (60,000 to 90,000 cp) into a labeler machine. The pump must be food-grade compatible. The glue is placed on a roller and then onto a palette, which places a thin layer of glue onto a bottle. The label is then placed onto the bottle by a separate machine.

**Centrifugal Pump Disadvantages**
- Does not handle high viscosities
- Difficult to clean
- Internal pump parts are not food-grade compatible
- Limited automated capabilities

**Masterflex Advantages**
- Handles high viscosities well
- Easy to change out tubing and clean pump—less maintenance
- Washdown models allow for quick and easy cleaning
- Tubing is food-grade compatible
- Has more automated capabilities

### Flexible Impeller Pumps vs Masterflex

**Application:** A research laboratory needs to pump dilute sulfuric acid and a copper sulfate solution continuously (24 hours a day) for five days in a row. They need to recirculate these two chemicals at 60°C for a cell lab. They need to be able to vary the flow rate with a maximum flow of 15 LPM at 15 psi.

**Flexible Impeller Pump Disadvantages**
- Does not handle higher pressures at higher flow rates well
- Difficult to find chemically compatible internal pump parts
- Cannot run dry
- Variable flow control is difficult
- Difficult to clean

**Masterflex Advantages**
- Handles higher pressures at higher flow rates
- Chemically compatible with a variety of tubing formulations
- Runs dry
- Easy to control flow with a variable-speed pump drive
- Easy to change out tubing and clean pump

**Precision, versatility, and ease of use make Masterflex® peristaltic pump technology the preferred solution to increasing numbers of applications in the processing industry and in industrial applications. The following comparisons prove that under real-world conditions, Masterflex sets the standard for excellence.**
**Pump Technology Comparison**

### Diaphragm Pumps vs Masterflex

**Application:** A manufacturer needs to pump ethylene glycol from a 55-gallon drum into six smaller containers. Once these six containers are filled with the ethylene glycol, they are used to lubricate needles for their process.

#### Diaphragm Pump Disadvantages
- Cannot handle high viscosities—the flow would be reduced by 75% due to the 450-cp viscosity of ethylene glycol
- Requires routine maintenance and difficult to clean
- Numerous replacement parts: diaphragms and internal valves

#### Masterflex Advantages
- Handles high viscosities well—improved customer’s flow rate
- Fluid does not contact internal pump parts—only the tubing
- Easy tubing replacement; reduced maintenance time
- Excellent self-priming capabilities

### Air-Operated Double Diaphragm Pumps vs Masterflex

**Application:** A cheese manufacturer needs to pump oil from a 55-gallon drum into small containers. Once placed in these containers, the oil is mixed with blocks of cheese and spices to create different flavors of cheeses. This company used an air-operated double diaphragm pump but was having difficulty with its operation.

#### Air-Operated Double Diaphragm Pump Disadvantages
- Difficult to control the flow rate
- Cavitation of the pump caused air bubbles within the flow path
- Difficult to clean and maintain sterility of internal parts of pump

#### Masterflex Advantages
- Easy to control flow with variable-speed drives—reduces manual operation
- Reduced cavitation problems
- Easy to change out tubing
- Easy to maintain sterility of tubing and fluid path
- Offer food-grade tubing
- No valves to clean or maintain

### Drum Pumps vs Masterflex

**Application:** A pharmaceutical customer needs to pump a disinfecting agent from a drum into an 8-gallon tank. They had been using a hand pump in the past but in order to reduce time and maintenance they would like an automated system.

#### Drum Pump Disadvantages
- **Hand Pump**
  - Manual, hard labor
  - Not fast or efficient
  - Risk of chemicals splashing on operator
- **Motorized Drum Pump**
  - Poor self-primers
  - Doesn’t remove all of the fluid in the drum
  - Most models don’t run dry
  - Very few automated features

#### Masterflex Advantages
- More efficient and fast at pumping fluids—reduces labor
- Excellent self-priming capabilities
- Empties entire tank/drum
- Runs dry
- Excellent chemical compatibility
- More automated features to program fluid flow—improved accuracy
**How Masterflex Tubing Pumps Work**

Precision, versatility, and ease of use make Masterflex peristaltic pump technology the preferred solution to increasing numbers of applications in the processing industry and in the lab.

1. A pump head consists of only two parts: the rotor and the housing. The tubing is placed in the tubing bed—between the rotor and housing—where it is occluded (squeezed).
2. The rollers on the rotor move across the tubing, pushing the fluid. The tubing behind the rollers recovers its shape, creates a vacuum, and draws fluid in behind it.
3. A “pillow” of fluid is formed between the rollers. This is specific to the ID of the tubing and the geometry of the rotor. Flow rate is determined by multiplying speed by the size of the pillow. This pillow stays fairly constant except with extremely viscous fluids.

**Flow Rates**

- **What flow rates are attainable?**
  Depending on which series you select, our systems deliver flow rates from 0.0005 mL/min to 37 LPM.
- **What flow precision can I expect?**
  You can obtain a flow precision of up to ±0.5% with calibrated flow systems. For other systems, ±3% precision is possible for general transfer applications.
- **Are measured volumes repeatable?**
  Yes. Volumes are repeatable with accuracies of ±0.25% or better using calibrated systems.
- **What is the effect of viscosity on flow?**
  All flow rates are based on water. Increasing the fluid viscosity will decrease the flow rate.

**Pump Heads**

- **What is the maximum pressure?**
  The maximum pressure using L/S® High-pressure tubing is 100 psi (6.8 bar); nominal pressure is 25 psi (1.7 bar).
- **What is the maximum inlet pressure?**
  Typically 40 psi (2.7 bar), depending on tubing ID, wall thickness, and formulation.
- **What is the maximum suction lift?**
  The maximum suction lift is 8.8 m H₂O (29 ft H₂O).
- **Are check valves required?**
  No. Our unique designs eliminate this need.
- **Can Masterflex pumps run dry?**
  Yes. They can pump gases, liquids, or mixed phases.

**Tubing**

- **Is the tubing important?**
  Yes. The tubing is the pump chamber. The elasticity of the tubing provides suction lift; its strength provides pressure handling ability; its flexibility determines pumping life; its bore determines the flow rate; and its wall thickness determines pumping efficiency.

**Drives**

- **Why are drives also offered separately from pump heads in the L/S® and I/P® series?**
  The modular concept lets you customize your system for flexibility and economy.
- **Can a single drive run more than one pump head?**
  In many cases, two to four pump heads can be stacked in any combination up to the max torque capability of the drive.

**Frequently Asked Questions About Masterflex Tubing Pumps**

- **What flow rates are attainable?**
  Depending on which series you select, our systems deliver flow rates from 0.0005 mL/min to 37 LPM.
- **What flow precision can I expect?**
  You can obtain a flow precision of up to ±0.5% with calibrated flow systems. For other systems, ±3% precision is possible for general transfer applications.
- **Are measured volumes repeatable?**
  Yes. Volumes are repeatable with accuracies of ±0.25% or better using calibrated systems.
- **What is the effect of viscosity on flow?**
  All flow rates are based on water. Increasing the fluid viscosity will decrease the flow rate.

**Chemical Resistance**

It depends on the tubing formulation you select. To determine chemical resistance of the tubing formulations, such as Chem-Durance®, go to ColeParmer.com/mflexchem.

**How long will the tubing last?**

Tubing life depends on pump speed and pressure, tubing material and chemical compatibility, and abrasiveness of the liquid (media) being pumped.

**How does pump speed affect tubing life?**

To put it simply, the lower the speed, the longer the life of the tubing.

**What tubing formulation gives longest life?**

In order, Norprene®, PharMed® BPT, PharmaPure®, Tygon® LFL, silicone, BioPharm Plus, C-FLEX®, Tygon®, and Viton® last the longest.

**Is tubing available that is compatible for food and sterile applications?**

Yes. Some tubing formulations meet NSF specifications, 3A, FDA, and USDA requirements for food handling. Many can be sterilized.

1PTFE-pump head can operate at pressures up to 100 psi.
2Except the PTFE-pump head which can overheat when run dry.
To maximize tubing life
- Run larger tube sizes at slower speeds
- Select longer-life material (see “Tubing Selection Hints”)
- Reduce pressure in system
- Stop pump periodically, move tubing 20 to 25 cm (8 to 10 inches) forward
- Reduce occlusion if possible

To pump viscous fluids
- Choose tubing at least one size larger than the flow rate requires
- Keep drive speed below 300 rpm, the slower the motor, the better the flow
- Pressurize the inlet
- Use adjustable occlusion pumps: over-occlude to prime; reduce occlusion for longer life

To pump abrasive fluids
- Keep soft particle sizes <25% of tube ID
- Keep hard particle sizes <5% of tube ID
- Keep drive speed below 300 rpm
- Use adjustable occlusion pumps: over-occlude to prime; reduce occlusion for longer life

To reduce pulsation
- Use a pulse dampener
- Use adjustable occlusion pump: reduce occlusion and apply back pressure
- Use dual (stacked) heads with offset rollers and unify channels
- Add extra discharge tubing to system
- Run smaller tube sizes at higher speeds
- Use a pump head with a higher number of rollers

To check tubing compatibility
- Go to ColeParmer.com/mflexchem for detailed compatibility information
- Always pretest unfamiliar chemicals before using with desired tubing
- Request a Free Masterflex® Tubing Test Kit today!

Tubing selection hints
- Best clarity: Tygon® formulations, silicone (platinum-cured)
- USP Class VI: Silicones, C-FLEX®, PharMed® BPT, PharmaPure®, STA-PURE®, CHEM-SURE®, Tygon® Chemical, Tygon® LFL, Chem-Durance® Bio
- High purity: CHEM-SURE®, PharmaPure®
- Pressure/vacuum: Norprene®, Norprene® HP, PharMed® BPT, PharMed® BPT HP, PharmaPure®

Top Reasons to Choose Masterflex Tubing Pumps

1. Simplicity
Masterflex pumps are easy to use. In most cases, they can be installed within minutes. With few moving parts, they’re easy to maintain.

2. Contamination-Free Pumping
Since peristaltic pumps confine the fluid to the tubing, the pump cannot contaminate the fluid and the fluid cannot contaminate your pump. To pump a different fluid, simply change the tubing.

3. Economy
Feature-for-feature, you will not find a lower priced tubing pump on the market. For economical liquid transfer, Masterflex offers the best value; in both initial cost and in long-term operating expense.

4. Accuracy
Each component of a Masterflex tubing pump is designed to strict standards and then rigorously tested; you can be confident of extremely accurate flow delivery.

5. Selection
Masterflex drives, coupled with interchangeable pump heads and tubing, offer wide flow ranges and more than 10,000 possible pump combinations. Our pumps are designed for a wide variety of environments, from basic laboratory to industrial process to field use applications.

6. Durability
A Masterflex tubing pump system does not have direct contact with the pumped fluid, so it has a longer service life than other pumps.

7. Versatility
One of the biggest advantages of variable-speed pumping is the wide variety of applications a single pump can handle. Masterflex pumps enhance this advantage by offering many different pump heads for each drive. By interchanging the components, you effectively customize the pump for your changing needs.

8. Application Assistance
Contact your Masterflex distributor for expert product and technical assistance on any Masterflex tubing pump system.

9. OEM Adaptability
Masterflex pumps are ideal for a wide variety of original equipment manufacturing (OEM) applications.
**I/P Modular Pump**

**Applications**
- Printing
- Laboratory research
- Polishing/lapping
- Chemical recirculation
- Sterile fluid transfer
- Pumping from 55-gallon drums
- Filtration

**Benefits**
- Place components where convenient—separate by up to 6 feet
- Easy tubing changes
- Purge tubing before or after pumping
- Forward/off/reverse switch lets you reverse while maintaining speed setting

**I/P Modular Pump with Wall-Mount Controller**

**Applications**
- pH control
- Process control
- Food applications
- Dispensing culture media
- Dye dispensing
- Plating
- Corrosive fluid transfer
- Slurry pump

**Benefits**
- Ideal for wet or hostile environments
- Easy tubing changes
- Forward/off or reverse (reverse direction while maintaining speed setting)
- Control drive speed remotely (4 to 20 mA)
- Purge tubing before or after pumping

**I/P Process Pumps**

**Applications**
- Media transfer
- Filling/emptying large carboys and bags
- Pumping dyes and pigments
- Pumping fermentation chemicals
- Sewage and sludge sampling

**Benefits**
- Brushless, maintenance-free motor for continuous-duty applications
- Light enough to carry with one hand
- Displays percent speed from 5 to 100% for repeatable control
- Sealed, IP55-rated housing sprays or wipes down for easy cleaning
- Powerful enough to drive two Easy-Load® pump heads for twice the flow rate

---

**Catalog number** | **Flow range¹ (LPM)** | **Pump head included** | **Tubing included** | **Tubing sizes accepted** | **Drive included** | **Drive speed range (rpm)** | **Drive IP rating** | **Power (50/60 Hz)** |
---|---|---|---|---|---|---|---|---|
**I/P Modular pump**
MK-77962-00 | 0.2 to 8.0 | I/P Easy-Load® 77601-10 | Tygon® LFL I/P 73 06429-73; 10 ft (3 m) | I/P 26, I/P 73, I/P 82 | 07591-00 07591-07 | 20 to 650 | Controller: IP22 Motor: IP34 90 to 130 VAC, 3.0 A 180 to 260 VAC, 1.5 A |
MK-77962-07 | 0.2 to 8.0 | I/P Easy-Load® 77601-10 | Tygon® LFL I/P 73 06429-73; 10 ft (3 m) | I/P 26, I/P 73, I/P 82 | 07591-07 | 20 to 650 | Controller: IP22 Motor: IP34 90 to 130 VAC, 3.0 A 180 to 260 VAC, 1.5 A |
**I/P Modular pump with wall-mount controller**
MK-77962-10 | 0.2 to 8.0 | I/P Easy-Load® 77601-10 | Tygon® LFL I/P 73 06429-73; 10 ft (3 m) | I/P 26, I/P 73, I/P 82 | 07591-10 07591-15 | 20 to 650 | Controller: IP55 Motor: IP34 90 to 130 VAC, 3.0 A 180 to 260 VAC, 1.5 A |
MK-77962-15 | 0.2 to 8.0 | I/P Easy-Load® 77601-10 | Tygon® LFL I/P 73 06429-73; 10 ft (3 m) | I/P 26, I/P 73, I/P 82 | 07591-15 | 20 to 650 | Controller: IP55 Motor: IP34 90 to 130 VAC, 3.0 A 180 to 260 VAC, 1.5 A |
**I/P Process pumps**
MK-77963-10 | 0.4 to 8.0 | I/P Easy-Load® 77601-10 | Tygon® LFL I/P 73 06429-73; 10 ft (3 m) | I/P 26, I/P 73, I/P 82 | 77410-10 | 33 to 650 | IP55 90 to 130 VAC, 4.5 A; 220 to 260 VAC, 2.6 A |
MK-77963-20 | 0.9 to 17.0 | I/P High-Performance 77600-62 | Tygon® LFL I/P 88 06429-88; 3 ft (1 m) | I/P 70, I/P 88, I/P 89 | 77410-10 | 33 to 650 | IP55 90 to 130 VAC, 4.5 A; 220 to 260 VAC, 2.6 A |

¹Flow range with included tubing; extend the flow range of these systems with additional sizes of tubing; order separately on page 9.
I/P Process Pumps with Remote Capability

Applications
- Purificationfiltrationmedialtransfer
- Automated process
- Pumpinganti-foamingagents
- Food and pharma process pump
- Chemical feemand meting
- Wastewater process pump

Benefits
- Remote control capability via fluid-resistant I/O connector on back of drive (requires 77300-32 remote cable kit)
- Analog outputs include "pump ready" signal (order 77300-32 remote cable kit below)
- Displays percent speed from 5 to 100% for precise, repeatable control
- Sealed, IP55-rated housing sprays or wipes down for easy cleaning
- Brushless, maintenance-free motor for continuous-duty applications

I/P Digital Modular Pump

Applications
- Yogurtdispensing pump
- Flavor concentrate/food additive dispenser
- Photochemical dispenser
- Shampoodispenser

Benefits
- Modular format lets you separate drive and controller up to 25 feet
- Remote control capabilities allow easy integration into a system (order connector 0795-52 below)
- Reverse dispensing
- Ideal for wet environments
- Start/stop foot switch

I/P Digital Modular Pump with Wall-Mount Controller

Applications
- Transfer cell culture media
- Flavor concentrate/food additive dispenser
- Photochemical dispenser

Benefits
- Ideal for wet environments
- Repetitive dispensing
- Separate drive and controller
- Convenient components placement
- Handheld remote offers remote control operation
- Analog remote control of speed/start/stop and direction (requires 77300-32; order below)

<table>
<thead>
<tr>
<th>Catalog number</th>
<th>Flow range1 (LPM)</th>
<th>Pump head included</th>
<th>Tubing included</th>
<th>Tubing sizes accepted</th>
<th>Drive included</th>
<th>Drive speed range (rpm)</th>
<th>Drive IP rating</th>
<th>Power (50/60 Hz)</th>
</tr>
</thead>
<tbody>
<tr>
<td>MK-77965-00</td>
<td>0.4 to 8.0</td>
<td>I/P Easy-Load®</td>
<td>Tygon® LFL I/P 73, 06429-73, 10 ft (3 m)</td>
<td>I/P 26, I/P 73, I/P 82</td>
<td>77411-00</td>
<td>33 to 650</td>
<td>IP55</td>
<td>90 to 130 VAC, 4.5 A; 220 to 260 VAC, 2.5 A</td>
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<tr>
<td>MK-77965-10</td>
<td>0.9 to 17.0</td>
<td>I/P High-Performance 77600-62</td>
<td>Tygon LFL I/P 88, 06429-88, 3 ft (1 m)</td>
<td>I/P 70, I/P 88, I/P 89</td>
<td>07592-20-27</td>
<td>20 to 650 Motor: IP24</td>
<td>IP56</td>
<td>90 to 130 VAC, 4.4 A; 190 to 260 VAC, 2.2 A</td>
</tr>
</tbody>
</table>

1Flow range with included tubing; extend the flow range of these systems with additional sizes of tubing; order on page 9.

MK-07592-83 Handheld remote for 77970-30,-37 only
MK-07595-43 Washdown foot switch for 77965-00,-10, and 77970-30,-37
MK-77300-32 Remote cable kit for 77965-00,-10, and 77970-30,-37
MK-07595-52 DB15 male connector for 77970-20,-27. Use to create your own cable.
**I/P Digital Process Pumps**

**Applications**
- Pharma and cosmetics process pump
- Sanitary food/dairy process pump
- Automated process pump
- Dosing/metering additives
- Pilot scale fermentation
- Bulk media transfer and dispensing
- Large-volume buffer transfer

**Benefits**
- Brushless motor virtually eliminates maintenance—no motor brushes to replace
- Full-featured digital dispenser
- Programmed calibration ensures dispense accuracy
- Four-digit display shows rpm, flow rate, dispense volume, and copy number
- Programmable dispense interval for automated dispensing
- Analog remote control of speed, start/stop, and direction (order remote accessories below)
- Sealed, stainless steel housing for easy washdown in sanitary process environments
- Tach output for precise speed control and feedback

**I/P Air-Powered Pump**

**Applications**
- Transfer of hazardous materials
- Transfer of printing inks
- Production fermentation

**Benefits**
- Safe where electrical power not advisable
- Operates from your compressor
- Easy tubing changes
- High horsepower in a compact size
- Cooler operation
- Smooth-starting, low-maintenance motor

**I/P Hazardous-Duty Pump**

**Applications**
- Transfer of chemicals where hazardous vapors are present
- Transfer of heat-sensitive fluids
- Production fermentation

**Benefits**
- Ideal where electricity is unsafe
- Easy tubing changes
- Variable-speed for wide flow ranges

**Features**
- 1/4-hp continuous-duty drive
- ±10% drive speed accuracy

<table>
<thead>
<tr>
<th>Catalog number</th>
<th>Flow range† (LPM)</th>
<th>Pump head included</th>
<th>Tubing included</th>
<th>Tubing sizes accepted</th>
<th>Drive included</th>
<th>Drive speed range (rpm)</th>
<th>Drive IP rating</th>
<th>Power (50/60 Hz)</th>
</tr>
</thead>
<tbody>
<tr>
<td>MK-77964-00</td>
<td>0.01 to 8.0</td>
<td>I/P Easy-Load®</td>
<td>Tygon® LFL I/P 73 06429-73, 10 ft (3 m)</td>
<td>I/P 26, I/P 73, I/P 82</td>
<td>77420-00</td>
<td>1 to 650</td>
<td>IP66</td>
<td>90 to 130 VAC, 4.5 A; 220 to 260 VAC, 2.5 A</td>
</tr>
<tr>
<td>MK-77964-10</td>
<td>0.02 to 17.0</td>
<td>I/P High-Performance</td>
<td>Tygon LFL I/P 88 06429-88, 3 ft (1 m)</td>
<td>I/P 70, I/P 88, I/P 89</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

†Flow range with included tubing; extend the flow range of these systems with additional sizes of tubing; order on page 9.

**Catalog number**
- MK-07592-83 Handheld remote
- MK-07595-43 Washdown foot switch, momentary start/stop; 1.8-m (6-ft) cable
- MK-77420-01 Caster kit for easy movement of the drive
- MK-77300-32 Remote cable kit

**Features**
- 1/4-hp continuous-duty drive
- ±10% drive speed accuracy

<table>
<thead>
<tr>
<th>Catalog number</th>
<th>Flow range† (LPM)</th>
<th>Pump head included</th>
<th>Tubing included</th>
<th>Tubing sizes accepted</th>
<th>Drive included</th>
<th>Drive speed range (rpm)</th>
<th>Drive IP rating</th>
<th>Power</th>
</tr>
</thead>
<tbody>
<tr>
<td>MK-77980-00</td>
<td>1.2 to 8.0</td>
<td>I/P Easy-Load®</td>
<td>Tygon® LFL I/P 73 06429-73, 10 ft (3 m)</td>
<td>I/P 26, I/P 73, I/P 82</td>
<td>07589-30</td>
<td>10 to 430</td>
<td>IP21</td>
<td>115 VAC, 60 Hz</td>
</tr>
<tr>
<td>MK-77981-10</td>
<td>0.12 to 5.3</td>
<td>I/P Easy-Load®</td>
<td>Tygon® LFL I/P 73 06429-73, 10 ft (3 m)</td>
<td>I/P 26, I/P 73, I/P 82</td>
<td>07583-50</td>
<td>10 to 650</td>
<td>IP34</td>
<td>3 to 25 cfm (0.08 to 0.7 m³/min) at 20 to 100 psi (1.4 to 6.9 bar)</td>
</tr>
</tbody>
</table>

†Flow range with included tubing; extend the flow range of these systems with additional sizes of tubing; order on page 9.

**Note:** For safe operation of Masterflex® air-powered pumps, ground pump carefully to protect from static electricity.
Masterflex® I/P® Pump Tubing

**I/P Precision and High-Performance Precision Pump Tubing**

- Ensure optimal Masterflex pump performance
- Custom extruded for precise fit and long life in Masterflex pumps
- Lot-to-lot consistency provides superior accuracy and repeatability

Masterflex/I/P pump tubing is manufactured to extremely close tolerances that match our I/P pump heads, ensuring accurate, repeatable flow and long tubing life. Our tubing is factory-tested and optically inspected to provide the best performance from your peristaltic pump.

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<table>
<thead>
<tr>
<th>Pump tubing cross sections</th>
<th>I/P Precision pump tubing</th>
<th>I/P High-performance precision pump tubing</th>
</tr>
</thead>
<tbody>
<tr>
<td>I/P 25</td>
<td>MK-96410-26</td>
<td>MK-96510-70</td>
</tr>
<tr>
<td>I/P 73</td>
<td>MK-96410-73</td>
<td>MK-96510-88</td>
</tr>
<tr>
<td>I/P 82</td>
<td>MK-96410-82</td>
<td>MK-96510-89</td>
</tr>
<tr>
<td>I/P 70</td>
<td>MK-96510-70</td>
<td>MK-96510-88</td>
</tr>
<tr>
<td>I/P 88</td>
<td>MK-96510-88</td>
<td>MK-96510-89</td>
</tr>
<tr>
<td>I/P 89</td>
<td>MK-96510-88</td>
<td>MK-96510-89</td>
</tr>
</tbody>
</table>

**Inside diameter (nominal)**
- 0.25” (6.4 mm) for I/P 25
- 0.37” (9.5 mm) for I/P 73
- 0.5” (12.7 mm) for I/P 82
- 0.37” (9.5 mm) for I/P 70
- 0.5” (12.7 mm) for I/P 88
- 0.5” (12.7 mm) for I/P 89

**Hose barb size (nominal)**
- ½” (12.7 mm) for I/P 25
- ½” (12.7 mm) for I/P 73
- ½” (12.7 mm) for I/P 82
- ½” (12.7 mm) for I/P 70
- ½” (12.7 mm) for I/P 88
- ½” (12.7 mm) for I/P 89

**Flow range (approximate)**
- 0.20 to 4.0 LPM for I/P 25
- 0.01 to 4.0 LPM for I/P 73
- 0.01 to 4.0 LPM for I/P 82
- 0.02 to 13.0 LPM for I/P 70
- 0.02 to 13.0 LPM for I/P 88
- 0.02 to 17.0 LPM for I/P 89

**Maximum pressure**, **continuous**
- 25 psi (1.7 bar) for I/P 25
- 25 psi (1.7 bar) for I/P 73
- 25 psi (1.7 bar) for I/P 82
- 25 psi (1.7 bar) for I/P 70
- 25 psi (1.7 bar) for I/P 88
- 25 psi (1.7 bar) for I/P 89

**Maximum pressure**, **intermittent**
- 40 psi (2.7 bar) for I/P 25
- 40 psi (2.7 bar) for I/P 73
- 40 psi (2.7 bar) for I/P 82
- 40 psi (2.7 bar) for I/P 70
- 40 psi (2.7 bar) for I/P 88
- 40 psi (2.7 bar) for I/P 89

**Maximum vacuum**
- 26” Hg (660 mm Hg) for I/P 25
- 26” Hg (660 mm Hg) for I/P 73
- 26” Hg (660 mm Hg) for I/P 82
- 26” Hg (660 mm Hg) for I/P 70
- 26” Hg (660 mm Hg) for I/P 88
- 26” Hg (660 mm Hg) for I/P 89

---

**Pump tubing formulation**

<table>
<thead>
<tr>
<th>Silicone (platinum cured)</th>
<th>25 ft (7.6 m) per pack</th>
<th>10-ft/pk</th>
</tr>
</thead>
<tbody>
<tr>
<td>Silicone (peroxide cured)</td>
<td>25 ft (7.6 m) per pack</td>
<td>10-ft/pk</td>
</tr>
<tr>
<td>BioPharm silicone (platinum)</td>
<td>25 ft (7.6 m) per pack</td>
<td>10-ft/pk</td>
</tr>
<tr>
<td>BioPharm Plus silicone (platinum)</td>
<td>25 ft (7.6 m) per pack</td>
<td>10-ft/pk</td>
</tr>
<tr>
<td>C-FLEX®</td>
<td>25 ft (7.6 m) per pack</td>
<td>10-ft/pk</td>
</tr>
<tr>
<td>PharMed® BPT</td>
<td>25 ft (7.6 m) per pack</td>
<td>10-ft/pk</td>
</tr>
<tr>
<td>PharmaPure®</td>
<td>25 ft (7.6 m) per pack</td>
<td>10-ft/pk</td>
</tr>
<tr>
<td>STA-PURE®</td>
<td>25 ft (7.6 m) per pack</td>
<td>10-ft/pk</td>
</tr>
<tr>
<td>CHEM-SURE®</td>
<td>25 ft (7.6 m) per pack</td>
<td>10-ft/pk</td>
</tr>
<tr>
<td>Tygon® LFL</td>
<td>25 ft (7.6 m) per pack</td>
<td>10-ft/pk</td>
</tr>
<tr>
<td>Tygon® Food (B-44-AX)</td>
<td>50 ft (15.2 m) per pack</td>
<td>10-ft/pk</td>
</tr>
<tr>
<td>Tygon® lab (R-360)</td>
<td>50 ft (15.2 m) per pack</td>
<td>10-ft/pk</td>
</tr>
<tr>
<td>Tygon® fuel &amp; lubricant (F-4040-A)</td>
<td>50 ft (15.2 m) per pack</td>
<td>10-ft/pk</td>
</tr>
<tr>
<td>Tygon® chemical (F-4010)</td>
<td>50 ft (15.2 m) per pack</td>
<td>10-ft/pk</td>
</tr>
<tr>
<td>Narprene® (A 80 O)</td>
<td>50 ft (15.2 m) per pack</td>
<td>10-ft/pk</td>
</tr>
<tr>
<td>Narprene® Food (A 80 O)</td>
<td>50 ft (15.2 m) per pack</td>
<td>10-ft/pk</td>
</tr>
<tr>
<td>Chem-Durance®</td>
<td>50 ft (15.2 m) per pack</td>
<td>10-ft/pk</td>
</tr>
<tr>
<td>Chem-Durance® Bio</td>
<td>50 ft (15.2 m) per pack</td>
<td>10-ft/pk</td>
</tr>
<tr>
<td>Viton®</td>
<td>25 ft (7.6 m) per pack</td>
<td>10-ft/pk</td>
</tr>
<tr>
<td>FDA Viton®</td>
<td>25 ft (7.6 m) per pack</td>
<td>10-ft/pk</td>
</tr>
</tbody>
</table>

---

**Flow range**

<table>
<thead>
<tr>
<th>Silicone (platinum cured)</th>
<th>0.20 to 4.0 LPM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Silicone (peroxide cured)</td>
<td>0.20 to 4.0 LPM</td>
</tr>
<tr>
<td>BioPharm silicone (platinum)</td>
<td>0.20 to 13.0 LPM</td>
</tr>
<tr>
<td>BioPharm Plus silicone (platinum)</td>
<td>0.20 to 13.0 LPM</td>
</tr>
<tr>
<td>C-FLEX®</td>
<td>0.20 to 13.0 LPM</td>
</tr>
<tr>
<td>PharMed® BPT</td>
<td>0.20 to 13.0 LPM</td>
</tr>
<tr>
<td>PharmaPure®</td>
<td>0.20 to 13.0 LPM</td>
</tr>
<tr>
<td>STA-PURE®</td>
<td>0.20 to 13.0 LPM</td>
</tr>
<tr>
<td>CHEM-SURE®</td>
<td>0.20 to 13.0 LPM</td>
</tr>
<tr>
<td>Tygon® LFL</td>
<td>0.20 to 13.0 LPM</td>
</tr>
<tr>
<td>Tygon® Food (B-44-AX)</td>
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<tr>
<td>Chem-Durance®</td>
<td>0.20 to 13.0 LPM</td>
</tr>
<tr>
<td>Chem-Durance® Bio</td>
<td>0.20 to 13.0 LPM</td>
</tr>
<tr>
<td>Viton®</td>
<td>0.20 to 13.0 LPM</td>
</tr>
<tr>
<td>FDA Viton®</td>
<td>0.20 to 13.0 LPM</td>
</tr>
</tbody>
</table>

**Recommended for use with Easy-Load® pump head only.**

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**ColeParmer.com**

9
B/T Fixed-Speed Pumps

**Applications**

- Bulk fluid pumping
- High-volume tank transfer and filling
- Transfer shear-sensitive and viscous fluids
- Process vat pumping

**Benefits**

- Integrated pump interlock—shuts pump down when head is opened
- IP55 rated for spraydown in wet or challenging environments
- Gentle enough for pumping shear-sensitive and viscous fluids
- Load tubing with ease
- Aluminum frame for durability
- Simple to set up and operate

<table>
<thead>
<tr>
<th>Catalog number</th>
<th>Flow range† (LPM)</th>
<th>Pump head included</th>
<th>Tubing included</th>
<th>Tubing sizes accepted</th>
<th>Drive speed range (rpm)</th>
<th>Drive IP rating</th>
<th>Power (50/60 Hz)</th>
</tr>
</thead>
<tbody>
<tr>
<td>MK-77111-00</td>
<td>37</td>
<td>Rapid-Load®</td>
<td>Tygon® LFL B/T 91 06429-91; 3 ft (1 m)</td>
<td>B/T 87, B/T 91</td>
<td>321</td>
<td>IP55</td>
<td>115 VAC, 8.0 A</td>
</tr>
<tr>
<td>MK-77111-07</td>
<td>30.7</td>
<td></td>
<td></td>
<td></td>
<td>266</td>
<td></td>
<td>220 VAC, 4.0 A</td>
</tr>
</tbody>
</table>

†Flow range with included tubing; extend the flow range of these systems with additional sizes of tubing; order on page 13.

**LIQUI-SENSE® Emergency Cutoff System**

**Monitor pumps and fluid systems for leaks, fluid level, and flow—24 hours a day**

- Shuts down process automatically—eliminating downtime, system damage, and fluid loss
- Customize your system with one of three sensor types: float switch, liquid detector pad, or out-of-fluid sensor

Customize your monitoring system by using the Liqui-Sense controller with up to two sensors and two pumps. The controller turns the process pump off and the backup pump on when triggered by an alarm condition.

**Catalog number**  
**Power**  
**Relay**  
**Socket**

<table>
<thead>
<tr>
<th>MK-77096-00</th>
<th>115 VAC, 50/60 Hz</th>
<th>10.0 A</th>
<th>U.S Standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>MK-77096-05</td>
<td>230 VAC, 50/60 Hz</td>
<td>6.3 A</td>
<td>IEC 320F</td>
</tr>
</tbody>
</table>

**MK-07187-30 Nylon float switch** for unattended level monitoring and empty-tank pump cutoff. Float switch has ½" NPT(M) threaded mount; requires cable 77095-02

**MK-77095-00 Liquid detector pad** monitors pumps, valves, seals, and tubing for leaks. Includes 3½-ft (1-m) long cable with RJ12 connections

**MK-77095-02 Connecting cable, 3½-ft (1-m) long**

**MK-77095-50 Out-of-liquid sensor** detects air in translucent fluids and translucent tubing. Max tubing ID is ½" (1.3 cm). Includes interface box and cable with RJ12 connections

ColeParmer.com
**B/T Variable-Speed Pump**

**Applications**
- Drain tanks and drums quickly
- High-viscosity fluid transfer
- Large-volume chemical addition
- Shear-sensitive fluid transfer

**Benefits**
- Easy to clean with epoxy-powder coating
- Housing prevents chemical corrosion
- Easy tubing changes
- Rugged housing for durability
- Washdown IP56-rated housing
- Detachable controller mounts up to 16 ft (4.9 m) away for convenient placement

<table>
<thead>
<tr>
<th>Catalog number</th>
<th>Flow range† (LPM)</th>
<th>Pump head included</th>
<th>Tubing included</th>
<th>Tubing sizes accepted</th>
<th>Drive speed range (rpm)</th>
<th>Drive IP rating</th>
<th>Power (50/60 Hz)</th>
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</thead>
<tbody>
<tr>
<td>MK-77111-60</td>
<td>0.67 to 37</td>
<td>Rapid-Load®</td>
<td>Tygon® LFL B/T 91 06429-91; 3 ft (1 m)</td>
<td>B/T 87, B/T 91</td>
<td>12 to 321</td>
<td>IP56</td>
<td>115 VAC, 5.0 A</td>
</tr>
<tr>
<td>MK-77111-67</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>230 VAC, 2.5 A</td>
</tr>
</tbody>
</table>

†Flow range with included tubing; extend the flow range of these systems with additional sizes of tubing; order on page 13.

---

**B/T Air-Powered Variable-Speed Pump**

**Applications**
- Transfer of volatile solvents
- Media transfer
- Production fermentation
- Transfer of printing inks

**Benefits**
- Safe where electrical power should not be used
- Operates from your compressor
- Easy tubing changes
- Cooler operation
- Smooth-starting, low-maintenance motor
- ATEX Zone 2 rated; rated to E Ex II 3G c IIC T6

<table>
<thead>
<tr>
<th>Catalog number</th>
<th>Flow range† (LPM)</th>
<th>Pump head included</th>
<th>Tubing included</th>
<th>Tubing sizes accepted</th>
<th>Drive speed range (rpm)</th>
<th>Drive IP rating</th>
<th>Power</th>
</tr>
</thead>
<tbody>
<tr>
<td>MK-77111-80</td>
<td>1.9 to 37</td>
<td>Rapid-Load®</td>
<td>Tygon® LFL B/T 91 06429-91; 3 ft (1 m)</td>
<td>B/T 87, B/T 91</td>
<td>35 to 321</td>
<td>IP56</td>
<td>12 cfm (0.34 m³) at 40 psi (2.7 bar) minimum</td>
</tr>
</tbody>
</table>

†Flow range with included tubing; extend the flow range of these systems with additional sizes of tubing; order on page 13.

---

ColeParmer.com
B/T Digital Pump with Wall-Mount Controller

**Applications**
- Caustic detergents
- Car wash chemicals
- Polishing slurry pump
- Lubricator for ball bearings
- Pumping glue

**Benefits**
- One-handed opening and closing for easy tubing changes
- Swing-away cover for CIP or SIP protocols
- Quiet yet rugged operation
- Separate controller/drive connected by a 16-ft (4.9-m) cable
- Displays flow rate, dispense volume, copy, rpm
- IP56-rated controller and drive protect against dust and water

<table>
<thead>
<tr>
<th>Catalog number</th>
<th>Flow range (LPM)</th>
<th>Pump head included</th>
<th>Tubing included</th>
<th>Tubing sizes accepted</th>
<th>Drive speed range (rpm)</th>
<th>Drive IP rating</th>
<th>Power (50/60 Hz)</th>
</tr>
</thead>
<tbody>
<tr>
<td>MK-77111-40</td>
<td>0.67 to 37</td>
<td>Rapid-Load® Tygon®</td>
<td>B/T 87, B/T 91</td>
<td>12 to 321</td>
<td>Controller: IP56</td>
<td>Motor: IP56</td>
<td>90 to 130 VAC, 5.0 A</td>
</tr>
<tr>
<td>MK-77111-47</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>190 to 260 VAC, 2.5 A</td>
</tr>
</tbody>
</table>

*Flow range with included tubing; extend the flow range of these systems with additional sizes of tubing; order on page 13.

**B/T Rapid-Load Pump Heads**
- Convert your existing motor into a high-capacity Masterflex® B/T pump
- Accept B/T PerfectPosition™ pump tubing sizes B/T 87 and B/T 91
- Compatible with standard 56C frame or IEC 72/ISO 71 motors with B5 motor flange
- Complete with mounting hardware and 3 ft (1 m) of Tygon LFL B/T 91 tubing 06429-91
- Order additional tubing separately on page 13.

<table>
<thead>
<tr>
<th>Catalog number</th>
<th>Motor mount</th>
<th>Motor size</th>
<th>rpm</th>
<th>IP rating</th>
<th>Mounting type</th>
<th>Dimensions (L x W x H)</th>
<th>Power specifications depend on the type of motor selected (min 1/2 hp, max 1800 rpm required)</th>
</tr>
</thead>
<tbody>
<tr>
<td>MK-77111-50</td>
<td>NEMA Type 56C</td>
<td>Motor size, rpm, and IP rating (up to IP56)</td>
<td></td>
<td></td>
<td>Direct-coupled</td>
<td>20&quot; x 15 1/2&quot; x 12 1/2&quot; (51 x 40 x 31.8 cm)</td>
<td></td>
</tr>
<tr>
<td>MK-77111-55</td>
<td>IEC 72/ISO 71 with B5 flange</td>
<td></td>
<td></td>
<td></td>
<td>Direct-coupled</td>
<td>20&quot; x 15 1/2&quot; x 12 1/2&quot; (51 x 40 x 31.8 cm)</td>
<td></td>
</tr>
</tbody>
</table>

**Handheld remote controller,** with 25-ft (7.6-m) cable
**Remote cable,** 25 ft (7.6 m) for remote capabilities
**Mounting bracket for digital controller**
B/T PerfectPosition™ Pump Tubing

Ensure optimal performance from your Masterflex Pump

- PerfectPosition tubing retention marks indicate the exact placement of tubing in the pump head to provide the best performance and life of the tubing
- Custom extruded to fit 77111-series Masterflex B/T pumps and pump heads
- Engineered for long life in peristaltic pump applications

These Masterflex® B/T® tubing sizes 87 and 91 are optimized to provide better performance in higher-pressure applications. Each tubing size is manufactured to extremely close tolerances that match our B/T pump heads. These tight tolerances ensure accurate, repeatable flow, and long tubing life. Plus, the PerfectPosition tubing retention marks indicate the best placement of the tubing within the pump head.

Choose from a variety of tubing formulations below to allow for optimal performance in the most challenging applications.

More info FREE TUBING TEST KIT!
Find out which tubing formulations work best with chemicals you are using

Includes 17 FREE pump tubing samples, formulation descriptions, testing and ordering instructions.

Request a tubing test kit today!

### Tubing Specifications

<table>
<thead>
<tr>
<th>Pump tubing size</th>
<th>PerfectPosition™ pump tubing</th>
</tr>
</thead>
<tbody>
<tr>
<td>B/T 87</td>
<td>B/T 91</td>
</tr>
<tr>
<td>Inside diameter (nominal)</td>
<td>0.5&quot; (12.7 mm)</td>
</tr>
<tr>
<td>Hose barb size</td>
<td>1/2&quot; (12.7 mm)</td>
</tr>
<tr>
<td>Flow range (approximate)†</td>
<td>0.67 to 17.7 LPM (0.17 to 4.7 GPM)</td>
</tr>
<tr>
<td>with 12 to 321 rpm drive</td>
<td></td>
</tr>
<tr>
<td>Maximum pressure‡, continuous</td>
<td>25 psi (1.7 bar)</td>
</tr>
<tr>
<td></td>
<td>40 psi (2.7 bar)</td>
</tr>
<tr>
<td>Maximum vacuum‡</td>
<td>26 Hg (660 mm Hg)</td>
</tr>
<tr>
<td>Suction lift‡</td>
<td>29 ft H₂O (8.8 m H₂O)</td>
</tr>
</tbody>
</table>

† Determined under the following conditions: 0 psi at inlet, 0.5 psi at outlet; water temperature at 72°F (22°C). ‡ Actual performance varies depending on tubing formulation—values shown are for firm tubing.

### Pump Tubing Formulations

<table>
<thead>
<tr>
<th>Pump tubing formulation</th>
<th>B/T 87</th>
<th>B/T 91</th>
</tr>
</thead>
<tbody>
<tr>
<td>Silicone (platinum-cured)</td>
<td>MK-96510-87</td>
<td>MK-96510-91</td>
</tr>
<tr>
<td>Silicone (peroxide-cured)</td>
<td>MK-96406-87</td>
<td>MK-96406-91</td>
</tr>
<tr>
<td>BioPharm silicone (platinum-cured)</td>
<td>MK-96424-87</td>
<td>MK-96424-91</td>
</tr>
<tr>
<td>BioPharm Plus silicone (platinum-cured)</td>
<td>MK-96444-87</td>
<td>MK-96444-91</td>
</tr>
<tr>
<td>C-FLEX®</td>
<td>MK-96424-87</td>
<td>MK-96424-91</td>
</tr>
<tr>
<td>PharMed® BPT</td>
<td>MK-06508-87</td>
<td>MK-06508-91</td>
</tr>
<tr>
<td>PharmaPure®</td>
<td>MK-06435-87</td>
<td>MK-06435-91</td>
</tr>
<tr>
<td>Chem-Durance® Bio</td>
<td>MK-06442-87</td>
<td>MK-06442-91</td>
</tr>
<tr>
<td>Norprene® food (A 60 F)</td>
<td>MK-06402-87</td>
<td>MK-06402-91</td>
</tr>
<tr>
<td>Tygon® LFL</td>
<td>MK-06423-87</td>
<td>MK-06423-91</td>
</tr>
<tr>
<td></td>
<td>MK-06430-87</td>
<td>MK-06430-91</td>
</tr>
</tbody>
</table>

Tygon® LFL
**Masterflex® Quick Selection Guide**

### Pharmaceutical
- **For harvesting cell media through ultrafiltration, choose...**
  - I/P® Process pumps for fast flow rates, up to 19 LPM
- **For pumping chemicals for fermentation control, choose...**
  - I/P Process pumps for repeatable digital speed control
  - I/P or B/T Air-powered pump for locations where use of electricity is unsafe
- **For dispensing tablet-coating gels and mixtures, choose...**
  - I/P or B/T Modular digital pump for digital accuracy and convenient placement of pump components
- **For dispensing or dosing of solution and media such as agar, organic, saline solution, choose...**
  - I/P Modular dispensing pumps for remote operation and accurate dispensing
- **For sampling for validation processes, choose...**
  - I/P Process pumps for repeatable digital speed and sealed IP55-rated housing

### Industrial & Manufacturing
- **For pumping dyes in textile manufacturing, choose...**
  - I/P Process pumps for maintenance-free brushless, continuous-duty motors with repeatable control
- **For pumping adhesives for envelope manufacturing, choose...**
  - I/P or B/T Fixed-speed pumps for easy-to-clean, sealed IP55-rated enclosure and reversible motor for line purge or bidirectional pumpings
- **For feeding solutions and additives to multiple process lines, choose...**
  - I/P Fixed-speed multichannel pumps for reversible motor for line purge or bidirectional pumping, and minimal downtime and cleanup
- **For polishing/lapping, choose...**
  - I/P or B/T Modular analog pumps for convenient placement of splash- and fire-resistant controller and chemical-resistant motor

### Chemical
- **For chemical sampling of 55-gallon drums, choose...**
  - I/P or B/T Modular analog pumps for reversing fluid direction while maintaining speed setting and modular convenience
- **For acid/base delivery and pH control, choose...**
  - I/P Modular dispensing digital pumps for remote operation and greater accuracy with calibration
  - I/P Process pumps with remote capability for quick flow adjustment via the precise three-turn speed control
- **For transfer of chemicals in hazardous locations, choose...**
  - I/P or B/T Air-powered pump for locations where use of electricity is unsafe

### Food & Beverage
- **For dispensing flavor concentrates and food additives, choose...**
  - I/P Modular digital pump for accurate, repetitive dispensing and remote operation
  - I/P Process pumps with remote capability for easy-to-clean IP55-rated housing
- **For food processing, choose...**
  - I/P or B/T Modular digital pump for accurate, repetitive dispensing of viscous solutions
- **For food label application, choose...**
  - B/T Variable-speed washdown pump for quick and easy cleaning

### Printing
- **For transfer of printing inks, choose...**
  - I/P Process pumps for maintenance-free brushless, continuous-duty motors with repeatable control
  - I/P or B/T Air-powered pump for locations where use of electricity is unsafe
- **For dispensing photochemicals, choose...**
  - I/P Modular digital pump for splash-resistant design and convenient placement of pump components

### Water/Wastewater Treatment
- **For dosing reagents, surfactants, and antifoaming reagents, choose...**
  - I/P Process pumps with remote capability for repeatable control and IP55-rated steel enclosure
- **For sewage and sludge sampling, choose...**
  - I/P Process pumps for easy-to-clean, sealed IP55-rated housing and maintenance-free brushless motor
Appendix F: MSDS and Vendor Spec Sheets

BioSafety Cabinets

Thermo Scientific™ Herasafe™ KS Class II, Type A2 Biological Safety Cabinets

Maximum safety, comfort and convenience

Herasafe KS Class II biohazard safety cabinets deliver maximum safety, comfort and convenience. Featuring an advanced design for easy operation and maximum safety, Herasafe KS cabinets may be used whenever protection is of paramount importance.

Safety and Protection

- HEPA filters guarantee maximum filtration efficiency of 99.99% at the most penetrating particle size (MPPS)
- Pressure sensor monitoring ensures safe airflow across the entire work surface
- SmartFlow™ digital technology maintains constant airflow during normal filter loading or temporary airflow obstruction due to foreign objects
- Digital Airflow Verification immediately alerts to any airflow obstruction

Performance and Operation

- Interior eye-level display on rear wall for "at-a-glance" monitoring of safety parameters
- Performance factor (PF) indicates: cabinet is safe, cabinet is safe but time for service, cabinet should not be used
- Display parameters include airflow at velocity, cabinet malfunction, time of day, operating time of optional UV-C lights, total operating hours, timer for delayed start
- Stepped function
- Handheld control for use inside cabinet eliminates glove changes before changing cabinet settings

Construction

- Motorized front window with adjustable 25cm working aperture slopes 10°
- DC motor technology uses energy efficiently with lever head output
- Aerosol light window sealing for additional protection when cabinet is in stand-by mode
- Frames front and side glass window yields unobstructed view of the total work area
- Scratch-resistant stainless-steel work surface with indentations that trap spilled liquids

Specifications

<table>
<thead>
<tr>
<th>Specifications</th>
<th>Class</th>
<th>Filtration Type</th>
<th>Efficiency</th>
<th>Baffling Opening</th>
<th>Load Bearing Capacity</th>
<th>Outlets</th>
<th>Ports</th>
<th>Service Features</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class</td>
<td>II (K2)</td>
<td>H14 HEPA EN 1822</td>
<td>99.99% at 0.3um particle size</td>
<td>240cm; 77.3mm max.</td>
<td>25kg (one-place work surfaces); 25kg (single segmented work surface)</td>
<td>1 duplex, each side wall</td>
<td>4 access (2 on each side wall)</td>
<td>Up to 4 installed through access ports, up to 8 additional hardware installed on top wall</td>
</tr>
<tr>
<td>-------</td>
<td>-------------------------------</td>
<td>-------------------------</td>
<td>-----------------------------------------------</td>
<td>----------</td>
<td>------------------</td>
<td>------------</td>
<td>----------------</td>
<td>----------</td>
</tr>
<tr>
<td>K82</td>
<td>31.5 x 39.2 x 62.2 in. (80 x 100 x 158.6cm)</td>
<td>18.3 x 35.4 x 30.7 in. (46.5 x 90 x 78cm)</td>
<td>254cfm; 300cfm</td>
<td>7AC</td>
<td>210w (nominal output); 45w (reduced flow mode)</td>
<td>375 lb. (170kg)</td>
<td>419 lb. (190kg)</td>
<td>51027116</td>
</tr>
<tr>
<td>K82/12</td>
<td>31.5 x 39.2 x 62.2 in. (80 x 100 x 158.6cm)</td>
<td>18.3 x 35.4 x 30.7 in. (46.5 x 90 x 78cm)</td>
<td>265cfm; 441cfm</td>
<td>7AC</td>
<td>270w (operating output); 45w (reduced flow mode)</td>
<td>441 lb. (200kg)</td>
<td>495 lb. (225kg)</td>
<td>51027117</td>
</tr>
<tr>
<td>K82/15</td>
<td>31.5 x 39.2 x 62.2 in. (80 x 100 x 158.6cm)</td>
<td>18.3 x 35.4 x 30.7 in. (46.5 x 90 x 78cm)</td>
<td>420cfm; 690cfm</td>
<td>1100</td>
<td>300w (operating output); 75w (reduced flow mode)</td>
<td>527 lb. (240kg)</td>
<td>572 lb. (260kg)</td>
<td>51027118</td>
</tr>
<tr>
<td>K82/18</td>
<td>31.5 x 39.2 x 62.2 in. (80 x 100 x 158.6cm)</td>
<td>18.3 x 35.4 x 30.7 in. (46.5 x 90 x 78cm)</td>
<td>510cfm; 684cfm</td>
<td>1210</td>
<td>450w (operating output); 105w (reduced flow mode)</td>
<td>617 lb. (280kg)</td>
<td>664 lb. (310kg)</td>
<td>51027120</td>
</tr>
</tbody>
</table>
Incubators

**Fisher Scientific™ Isotemp™ CO₂ Incubators**

6.5 cu. ft. (184L) Water-Jacketed and Direct-Heat Models with TC or IR sensors

**Selection, high capacity, heavy-duty design**
- Choice of Water-Jacketed (WJ) and Direct-Heat (DH) technology
- Reliability you can depend on for growing cells
- Select Thermal Conductivity (TC) or infrared (IR) sensors to serve your applications
- High-impact, high-strength plastic body
- Heavy-duty stainless-steel shelves support full load of samples
- Precise temperature control and stability of all culture parameters

**Ease of Use**
- Easy-to-clean polished stainless-steel interior with smooth corners
- Shelves and supports are easily removed without tools
- Sterilizable glass covers provided with each model and sample port
- Easy-to-read display and alarm settings

### Specifications

<table>
<thead>
<tr>
<th>Item</th>
<th>Specifications</th>
</tr>
</thead>
</table>
| **Description** | Water-Jacketed (WJ) models surround cells with 12 gallons of 37°C water
- Triple wall construction and large water volume provide superior stability, temperature and humidity control.
- Most temperature for extended periods - critical during power failures.
- Fast temperature recovery keeps culture conditions steady.

Direct-Heat (DH) models let you culture with confidence
- Meeting standards all sides of chamber wall.
- Powerful air circulation acts uniformly and fast recovery time.
- Precise airflow keeps cells at optimum growth temperature.
- Interchangeable interior is excellent.

**Dimensions:** 28L x 28.85W x 37.5H in (723 x 730 x 953 mm); 120-240V, 60 Hz. |

**Warranty:** One year parts and labor on Incubator.

### Sensor Models

<table>
<thead>
<tr>
<th>Sensor</th>
<th>Cat. No.</th>
<th>Availability</th>
<th>Quantity</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Water-Jacketed (WJ) Models</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TC</td>
<td>12-086-20</td>
<td>N/A</td>
<td></td>
<td>$6,039.07</td>
</tr>
<tr>
<td>IR</td>
<td>12-077-20</td>
<td></td>
<td></td>
<td>$7,165.00</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Sensor</th>
<th>Cat. No.</th>
<th>Availability</th>
<th>Quantity</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Direct-Heat (DH) Models</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TC</td>
<td>12-086-22</td>
<td>N/A</td>
<td></td>
<td>$6,039.00</td>
</tr>
<tr>
<td>IR</td>
<td>12-077-22</td>
<td></td>
<td></td>
<td>$7,165.09</td>
</tr>
</tbody>
</table>
# Benchtop Centrifuge

**Thermo Scientific™ Sorvall™ Primo™/Primo R Benchtop Centrifuges**

Compact, multi-purpose centrifuges for microfuge, high-speed and general purpose applications. Available with or without refrigeration.

---

## Description

**Operating Features**
- Digital display, frame, and control panel
- Adjustable speed settings
- Variable speed control
- Programmable timer
- Digital display, frame, and control panel
- Adjustable speed settings
- Variable speed control
- Programmable timer
- Memo relay current settings
- With optional microtiter configuration, accept tubes from 2.0 to 100mL.

**Safety Features**
- Dual braking mechanism (dual brake clutch with lid interlock)
- Autodefective overload protection
- Electronic safety interlock system
- Maintenance-free独立 drive, return to safety

**Self-stabilized Primo III**
- Delivers uniform temperature control from 0°C to +40°C for temperature-sensitive samples

**Specifications & Ordering Information**

<table>
<thead>
<tr>
<th>Specifications</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capacity</td>
<td>3000L (0L x 100L)</td>
</tr>
<tr>
<td>Display</td>
<td>Digital</td>
</tr>
<tr>
<td>Speed Control</td>
<td>Variable 300 to 15,000rpm, x 10rpm</td>
</tr>
<tr>
<td>Max. Speed</td>
<td>20,000rpm</td>
</tr>
<tr>
<td>Rev. 60°C</td>
<td>31,000 to 21,000 x 6</td>
</tr>
<tr>
<td>Memory</td>
<td>Memo relay current settings</td>
</tr>
<tr>
<td>Timer</td>
<td>3 min., 35 min., plus continuous run</td>
</tr>
</tbody>
</table>

**Acceleration/Braking Profiles**
- 0.9

**Temperature Range (Primo III only)**
- 0°C to +40°C

**Primo III (x, y, z)**
- x: 34.7 x 18.4 x 34.4 (113.6 x 55.5 x 31.5cm) |
- y: 21.9 x 11.8 x 35.6 (55.5 x 30.0 x 35.6cm) |
- z: 18.4 x 10.0 x 35.6 (46.0 x 25.0 x 35.6cm) |

**Primo II Weight**
- 38.2 lb (17.3 kg)

**Primo III Weight**
- 53.2 lb (24.5 kg)
Refrigerated Microcentrifuges

Fisher Scientific™ accuSpin™ Micro 17/Micro 17R Microcentrifuges
Compact, economical high-speed microcentrifuges, ideal for nucleic acid research and other microtiter volume separations

- Includes: Rotor and biocentrifuge lid
- Capacity: 48 x 1.5/2.0-ml tubes
- Maximum speed: 15,000 rpm, 17,000 x g
- Refrigerated or non-refrigerated
- Ventilated or refrigerated models
- Easy-to-read tachometer with digital display
- Adjustable 90-minute timer and quick-set feature for short runs
- Memory recalls last setting for repetitive runs
- Supplied with rotor and biocentrifuge lid

**Specifications**

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Capacity</strong></td>
<td>48 x 1.5/2.0-ml tubes</td>
</tr>
<tr>
<td><strong>Max. Speed</strong></td>
<td>15,000 rpm, 17,000 x g</td>
</tr>
<tr>
<td><strong>Max. RCF</strong></td>
<td>17,000 to 17,386 x g</td>
</tr>
<tr>
<td><strong>Timer</strong></td>
<td>1 to 99 min.</td>
</tr>
<tr>
<td><strong>Temperature Range</strong></td>
<td>-20°C to +4°C</td>
</tr>
<tr>
<td><strong>Height Level</strong></td>
<td>&gt;±0.0A</td>
</tr>
</tbody>
</table>

**Micro 17R**
- Refrigerated
- Temperature range: -20°C to +4°C

**Specifications & Ordering Information**
- Replacement: Micro 17R (F-17-034-17R, 10135-17R, 417), and optional 44 x FC Pad (135-175-417) available separately.
- Warranty: 1 year, parts and labor

**120V 60Hz**

**Model**
- Ventilated

**Dimensions**
- 17.625 x 18.75 in x 16.25 in

**Cat. No.**
- —
**Refrigerator Units**

**Fisher Scientific Isotemp General Purpose Series Lab Refrigerators**

Reliable cold storage for general-purpose applications. Isotemp® General Purpose series refrigerators and freezers offer the dependability and safety required for your daily lab applications.

- Capacities from 12 cu. ft. to 72 cu. ft.
- Range of sizes: from single-door to large capacity, three-door upright
- Inner cabinet storage: choice of porcelain or stainless steel interiors
- Available with or without chart recorders

**Performance**
- Refrigerator cabinet temperature range: 1 to 12°C (factory setpoint 4°C)
- Digital temperature controller with intuitive interface
- Excellent temperature stability: ±3°C and cabinet uniformity of ±2°C
- High-density, Finnamic™ insulation
- Automatic defrost

**Security**
- Keyed-on/off switch
- Optional chart recorder
- High-floor, visual/audible alarms
- Choice of solid or glass locatable doors
- Easily accessible contacts for backup monitoring
- Door alarm (except sliding glass doors)
- Control panel with key lock

**Quality**
- Dual-pane glass or stainless steel doors
- High-quality stainless steel exterior
- Choice of painted or stainless steel interior
- Casters for easy mobility with leveling for better stability
- Quiet refrigeration system
- Standard access port

**Specifications**

<table>
<thead>
<tr>
<th>Capacity</th>
<th>Interior D x W x H</th>
<th>Exterior L x W x H</th>
<th>Chart Recorder</th>
<th>Door(s)/Shelves</th>
<th>Electrical Requirements</th>
<th>Weight</th>
<th>Cat. No.</th>
<th>Availability</th>
<th>Quantity</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>23 cu. ft.</td>
<td>28.5x24x61.75 in.</td>
<td>30x27x78 in. (Add 1 3/4” to Depth for handle)</td>
<td>No</td>
<td>Glass door, single Gray – 4 Wire</td>
<td>115V/60Hz; 5-15P; 5.5A</td>
<td>300 lb.</td>
<td>11-674-232</td>
<td>N/A</td>
<td>[ ]</td>
<td>Each for $2,342.14</td>
</tr>
<tr>
<td>23 cu. ft.</td>
<td>28.5x24x61.75 in.</td>
<td>30x27x78 in. (Add 1 3/4” to Depth for handle)</td>
<td>No</td>
<td>Glass door, single Gray – 4 Wire</td>
<td>115V/60Hz; 5-15P; 5.5A</td>
<td>300 lb.</td>
<td>11-674-233</td>
<td>N/A</td>
<td>[ ]</td>
<td>Each for $7,289.20</td>
</tr>
<tr>
<td>23 cu. ft.</td>
<td>28.5x24x61.75 in.</td>
<td>30x27x78 in. (Add 1 3/4” to Depth for handle)</td>
<td>No</td>
<td>Glass door, single Gray – 4 Wire</td>
<td>115V/60Hz; 5-15P; 5.5A</td>
<td>300 lb.</td>
<td>11-674-234</td>
<td>N/A</td>
<td>[ ]</td>
<td>Each for $2,544.14</td>
</tr>
<tr>
<td>23 cu. ft.</td>
<td>28.5x24x61.75 in.</td>
<td>30x27x78 in. (Add 1 3/4” to Depth for handle)</td>
<td>Yes</td>
<td>Glass door, single Gray – 4 Wire</td>
<td>115V/60Hz; 5-15P; 5.5A</td>
<td>300 lb.</td>
<td>11-674-235</td>
<td>N/A</td>
<td>[ ]</td>
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<tr>
<td>27 cu. ft.</td>
<td>28.5x24x61.75 in.</td>
<td>30x30x78 in. (Add 1 3/4” to Depth for handle)</td>
<td>No</td>
<td>Glass door, single Gray – 4 Wire</td>
<td>115V/60Hz; 5-15P; 5.5A</td>
<td>380 lb.</td>
<td>11-674-245</td>
<td>N/A</td>
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<tr>
<td>27 cu. ft.</td>
<td>28.5x24x61.75 in.</td>
<td>30x30x78 in. (Add 1 3/4” to Depth for handle)</td>
<td>Yes</td>
<td>Glass door, single Gray – 4 Wire</td>
<td>115V/60Hz; 5-15P; 5.5A</td>
<td>300 lb.</td>
<td>11-674-241</td>
<td>N/A</td>
<td>[ ]</td>
<td>Each for $7,824.00</td>
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</tbody>
</table>
Freezer Units

Fisher Scientific™ Isotemp™ Basic -86°C Ultra-Low Temperature Freezers

Basic monitoring and alarm electronics

- Programmable microprocessor control provides reliable sample protection, excellent energy efficiency, and low noise levels.
- Temperature control from -86°C to -50°C, adjustable in 1°C increments
- Capabilities: 17.2, 20.2, 24.4 cu. ft. (487, 572, 691L)
- Manual defrost

Microprocessor Control
- Continuously monitors sensors to ensure proper performance
- Easy-to-read LED mounted on door
- Touchpad data entry
- Key-operated main power and alarm switch
- Control setpoint in 1°C increments; alarm setpoints in 5°C increments
- Temperature deviation or power failure triggers audible/visual alarms
- Alarm battery Low indicator
- Time Delay feature delays restart after power failure
- Battery backup supplies conditioned in case of power failure

<table>
<thead>
<tr>
<th>Catalog No.</th>
<th>Description</th>
<th>Price per Unit</th>
<th>Quantity &amp; Availability</th>
<th>Add Item(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>E1350A</td>
<td>Capacity: 13 cu. ft. (365 L), Holds 240 boxes, 115V/1Ø/60Hz, 16A</td>
<td>$10,812.00</td>
<td>Each</td>
<td>![Add to Cart](Add to Cart)</td>
</tr>
<tr>
<td>E1350B</td>
<td>Capacity: 13 cu. ft. (365 L), Holds 240 boxes, 220V/3Ø/50Hz, 16A</td>
<td>$10,812.00</td>
<td>Each</td>
<td>![Add to Cart](Add to Cart)</td>
</tr>
<tr>
<td>E1350C</td>
<td>Capacity: 13 cu. ft. (365 L), Holds 240 boxes, 220V/3Ø/50Hz, 16A</td>
<td>$10,812.00</td>
<td>Each</td>
<td>![Add to Cart](Add to Cart)</td>
</tr>
<tr>
<td>E1350A</td>
<td>Capacity: 17.3 cu. ft. (499 L), Holds 320 boxes, 115V/1Ø/60Hz, 16A</td>
<td>$11,295.56</td>
<td>Each</td>
<td>![Add to Cart](Add to Cart)</td>
</tr>
<tr>
<td>E1350B</td>
<td>Capacity: 17.3 cu. ft. (499 L), Holds 320 boxes, 220V/3Ø/50Hz, 16A</td>
<td>$11,295.56</td>
<td>Each</td>
<td>![Add to Cart](Add to Cart)</td>
</tr>
</tbody>
</table>
**Spectrophotometer**

**Thermo Scientific™ NanoDrop™ Lite Spectrophotometer**

A compact microvolume instrument with the accuracy and convenience of the NanoDrop

The NanoDrop Lite performs basic microvolume measurements. Its compact design, with built-in controls and software, make the NanoDrop Lite small enough to fit on any benchtop. The patented sample retention system allow sample to be pointed directly onto the optical measurement surface. After measurement the sample is wiped off the measurement surface with a lint free swab.

**View Specifications**

![Image](image-url)

(2 item(s) in product group)

### Specifications

#### Description

- Measures nucleic acid concentration at 260nm and purity using the 260/280 ratio
- Measures purified protein concentration at 280nm
- Employ the unique NanoDrop microvolume sampling technology
- Delivers the accuracy and reproducibility expected from NanoDrop instruments
- Uses built-in controls and software—no computer required
- Offers an optional printer for cryogenic labels

**Certifications:** UL/Ce and CE

**Warranty:** One year

<table>
<thead>
<tr>
<th>Specifications</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Instrument Control</td>
<td>Local control</td>
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<tr>
<td>Minimum Sample Size</td>
<td>1µL</td>
</tr>
<tr>
<td>Sample Number</td>
<td>1</td>
</tr>
<tr>
<td>Pathlength</td>
<td>2.56mm</td>
</tr>
<tr>
<td>Light Source</td>
<td>Light-emitting diodes</td>
</tr>
<tr>
<td>Detector Type</td>
<td>Silicon photodiode</td>
</tr>
<tr>
<td>Wavelength Range</td>
<td>280 and 260nm</td>
</tr>
<tr>
<td>Spectral Resolution</td>
<td>&lt; 0.0nm</td>
</tr>
<tr>
<td>Typical Measurement Reproducibility</td>
<td>±0.02</td>
</tr>
<tr>
<td>Absorbance Accuracy</td>
<td>±0.5% at 1 Absorbance</td>
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</tbody>
</table>
Osmometer

**Advanced™ Model 2020 Multi-Sample Osmometer**

Designed to process a 20μL sample with a 90-second test time

Determines the osmolarity of solutions using freezing point depression. Ideal for serum, urine or other bodily fluids in clinical applications; and media or formulations in pharmaceutical, biotech or industrial applications.

- Up to 20 samples at one time
- 20μL sample size
- Stat capability — interrupt a sequence to run a test without affecting the workflow
- Multi-sample osmometer provides accurate osmolarity measurements using the freezing-point method to determine total concentration
- Offers on-board data management, automated sample handling and flexible reporting options with multi-language capability, statistical analysis and automated calibration

**Accessories for Model 2020**

| Supplies | 22-048-792, 22-048-701, NCD54736 |
| Calibrant Standards | 22-048-746 and 22-048-752 |
| Standards | 22-048-749, 22-048-780, 22-048-791, and 22-048-211 |
| Parts and Accessories | 22-048-076, 22-048-507, and NCB197877 |
Bag Holders

**Bel-Art Scienceware™ Claves™ Biohazard Bag Holders**

Keep bags open and ready to use.

- Economical, lightweight stainless steel frame
- Highly visible polypropylene bottom tray for easy identification as a biohazard containment system
- Tray serves as containment within case of bag leakage
- Autoclavable at 121°C (250°F) and dishwasher safe
- Assembly is easy and permanent
- Medium and large models can be used with autoclavable polypropylene cover (Mfr. No. F13192-0102) to improve sanitation

View Specifications

(3 items) in product group

**Specifications**

**Description**

- Economical, lightweight stainless steel frame
- Highly visible polypropylene bottom tray for easy identification as a biohazard containment system
- Tray serves as containment within case of bag leakage
- Autoclavable at 121°C (250°F) and dishwasher safe
- Assembly is easy and permanent
- Medium and large models can be used with autoclavable polypropylene cover (Mfr. No. F13192-0102) to improve sanitation

<table>
<thead>
<tr>
<th></th>
<th></th>
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<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
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</thead>
<tbody>
<tr>
<td>Small</td>
<td>01-825A, 01-825-5, 01-827B, 01-814-1, 01-815A</td>
<td>30 x 61cm (12 x 24 in.)</td>
<td>13192-0001</td>
<td>01-816-10</td>
<td>NA</td>
<td></td>
<td>Each for $48.00</td>
</tr>
<tr>
<td>Medium</td>
<td>01-826B, 01-826-6, 01-827C, 01-814-2, 01-815B</td>
<td>61 x 152cm (24 x 30 in.)</td>
<td>13192-0002</td>
<td>01-816-11</td>
<td>NA</td>
<td></td>
<td>Each for $73.00</td>
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<tr>
<td>Large</td>
<td>01-820C, 01-826-7, 01-831A, 01-827D, 01-814-3, 01-832A, 01-819C</td>
<td>61 x 91cm (24 x 36 in.)</td>
<td>13192-0003</td>
<td>01-816-12</td>
<td>NA</td>
<td></td>
<td>Each for $78.00</td>
</tr>
</tbody>
</table>

Add Items to Cart
### Lab Scale

**Fisher Science Education™ Analytical Balances**

Dependable mass measurement for solution preparations.

*Includes:* AC adapter
- Simple three-button operation
- Weighing units: Grams and Newtons
- Large, 3 in H (22.8cm) weighing chamber with three sliding glass doors accommodate flasks and beakers
- Sealed front panel and molded spill ring for fast, easy cleanup
- Integrated security bracket
- Large LCD display
- Stainless steel weighing pan
- RS-232 interface
- Electrical requirements: 120VAC 60Hz

**View Specifications**

#### Items Specifications

<table>
<thead>
<tr>
<th>Description</th>
<th>Capacity</th>
<th>Readability</th>
<th>Linearity</th>
<th>Repeatability</th>
<th>Tare</th>
<th>Stabilization Time</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0g</td>
<td>0.1ng</td>
<td>0.2mg</td>
<td>0.1mg</td>
<td>Full capacity by subtraction</td>
<td>4 sec.</td>
</tr>
<tr>
<td></td>
<td>100g</td>
<td>0.1ng</td>
<td>0.2mg</td>
<td>0.1mg</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>200g</td>
<td>0.1ng</td>
<td>0.2mg</td>
<td>0.1mg</td>
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</table>

#### Weighing Modes
- g, N

#### Platform Size
- 3.6 in. (90mm)

#### Overall W x H x D
- 8.6 x 12.3 x 13.6 in. (217.7 x 318.3 x 34.3 cm)

#### Cat. No.
- SK790A
- SK790B
- SK790C

#### Quantity
- NA
- NA
- NA

#### Price
- --
- --
- --

#### Catalog No.

<table>
<thead>
<tr>
<th>Catalog No.</th>
<th>Description</th>
<th>Price per Unit</th>
<th>Quantity &amp; Availability</th>
<th>Add Item(s)</th>
</tr>
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<tbody>
<tr>
<td>SK790A</td>
<td>Capacity: 0g</td>
<td>Each for $1,794.00</td>
<td>N/A</td>
<td>N/A</td>
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<tr>
<td>SK790B</td>
<td>Capacity: 100g</td>
<td>Each for $1,941.00</td>
<td>N/A</td>
<td>N/A</td>
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<tr>
<td>SK790C</td>
<td>Capacity: 200g</td>
<td>Each for $2,295.00</td>
<td>N/A</td>
<td>N/A</td>
</tr>
</tbody>
</table>

⚠️ Due to product restrictions, we cannot sell this product online. Please call Customer Service at 1-800-765-7000 or send an email to CS.Walworth@thermofisher.com for assistance.
### Petri Dishes
**Fisher Scientific™ Sterile Polystyrene Petri Dish**

- Made from virgin polystyrene
- 60 x 15mm
- Non-vented
- Without screwing ring
- 500/pk

### pH Meters
**Fisher Science Education™ pH Meters**

- pH Mode: 0.00 to 14.00pH with resolution of 0.01 and accuracy of ±0.01 pH
- Temperature Mode (with ATC probe): 0.0 to 100°C with resolution of 0.1°C and accuracy of 0.3°C
- mV Mode: (0000, 20000 and 50000 only) -1000.0 to +1000.0 with a resolution of 0.1 and an accuracy of 0.1 mV within ±1.5 mV
- mV mode also features recorder output
- Simple push-button standardization with auto-buffer recognition
- Icons clearly show current meter status
- Three-point calibration with percent slope calculation
- Simple user interface

---

<table>
<thead>
<tr>
<th>Description</th>
<th>Cat. No.</th>
<th>Availability</th>
<th>Quantity</th>
<th>Price</th>
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</thead>
<tbody>
<tr>
<td>60 x 15mm</td>
<td></td>
<td>N/A</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Case of 500 for $172.84</td>
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<table>
<thead>
<tr>
<th>Catalog No.</th>
<th>Description</th>
<th>Price per Unit</th>
<th>Quantity &amp; Availability</th>
<th>Add Item(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>890524</td>
<td>Meter only, pH/temp modes</td>
<td>Each for $447.00</td>
<td>Check Availability</td>
<td>Add to Cart</td>
</tr>
<tr>
<td>890526</td>
<td>Meter with electrode, pH/temp modes</td>
<td>Each for $469.00</td>
<td>Check Availability</td>
<td>Add to Cart</td>
</tr>
<tr>
<td>890527</td>
<td>Meter with electrode, pH/Temp/Temp modes</td>
<td>Each for $776.00</td>
<td>Check Availability</td>
<td>Add to Cart</td>
</tr>
</tbody>
</table>
Microscopes

Fisher Scientific™ Stereomaster™ Zoom Microscopes

The highest level of optical clarity with a wide variety of configurations

Sensitive optical elements produce high-resolution, three-dimensional images. Large magnification range, easily increased via supplementary lenses. Illumination options let you customize to match your needs.

Includes:

- Dual caps and covers
- High-quality zoom optics; parfocal zoom for continuous changing of magnification without refocusing
- Total magnification ranges of 7X to 45X or 8.5X to 60X wide angle
- Supplementary lenses and additional eyepieces available to produce different magnification ranges
- 88mm working distance with standard configuration
- Smooth-turning, side-mounted control knobs, rack and pinion focusing mechanism
- Eyepieces: 10X super-widefield eyepieces, adjustable for interpupillary distance and diplopia differences
- Head: binocular and trinocular models available, with optional 10X eyepieces, heads rotateable 360°
- Finish: chemical-resistant baked-on paint with slip resistant to resist fingerprints and smudges

View Specifications

(13 item(s) in product Group)

## Specifications

### Description

- High-quality zoom optics; parfocal zoom for continuous changing of magnification without refocusing
- Total magnification ranges of 7X to 45X or 8.5X to 60X wide angle
- Supplementary lenses and additional eyepieces available to produce different magnification ranges
- 88mm working distance with standard configuration
- Smooth-turning, side-mounted control knobs, rack and pinion focusing mechanism
- Eyepieces: 10X super-widefield eyepieces, adjustable for interpupillary distance and diplopia differences
- Head: binocular and trinocular models available, with optional 10X eyepieces, heads rotateable 360°
- Finish: chemical-resistant baked-on paint with slip resistant to resist fingerprints and smudges

### With Multipurpose Stand

- Ideal for general laboratory use
- Stand: illumination: has oversized focusing knobs, frosted-glass stage plate, removable stage clips, high-intensity variable-halogen upper and lower illumination. ON/OFF switch allows for use of either or both lamps at once
- Dimensions: trinocular configuration: 10.5L x 7W x 17 in H (27 x 18 x 43cm)

### With Zoom Stand

- Stand: has 25 in. (65cm) extension range, tilt adjustment, rack and pinion focusing mechanism, levers for quick and positive adjustment
- Illumination: available with integrated 100w fiber-optic illumination system; 360° annular ring lamp provides shadowless illumination exactly on point of inspection. Removable bolt-on light source features two-speed hem for ultraviolet operation
- Dimensions: 105 x 20W x 17 in H (26 x 43 x 43cm)

### With Industrial Pole Stand

- Large work surface, with or without Illuminator
- Stand: ideal for large or tall objects. Heavy-duty, two-dimension design; oversize enameled work surface, rack and pinion focusing mechanism, levers for quick and positive adjustment
- Illumination: optional dual light guides, each with goose-necked shaft; variable 150w fiber-optic light source; two-speed hem for ultraviolet use; bolts on for convenience
- Dimensions: 105 x 170W x 17 in H (26 x 43 x 43cm)

### Specifications & Ordering Information:

For 110V/50/60Hz

<table>
<thead>
<tr>
<th>Body</th>
<th>Total Magnification</th>
<th>Light Source</th>
<th>Cat. No.</th>
<th>Availability</th>
<th>Quantity</th>
<th>Price</th>
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</thead>
<tbody>
<tr>
<td>Binocular</td>
<td>7X to 45X</td>
<td>Dual halogen lamps</td>
<td>10-505-1</td>
<td>N/A</td>
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<td>$494.11</td>
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<tr>
<td></td>
<td>7X to 45X</td>
<td>Dual halogen lamps</td>
<td>10-505-2</td>
<td>N/A</td>
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<td>$254.93</td>
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<tr>
<td></td>
<td>8.5X to 60X</td>
<td>Dual halogen lamps</td>
<td>10-505-153</td>
<td>N/A</td>
<td></td>
<td>$124.93</td>
</tr>
</tbody>
</table>
VICell Counter

Automated viability solutions

VI-CELL™ SERIES
Cell Viability Analyzers
Part of the Cell Lab family
The Beckman Coulter Vi-CELL automates the widely accepted trypan blue dye exclusion method for cell viability that has historically been performed manually with a light microscope and hemacytometer. In minutes, the Vi-CELL system measures 15 to 30 times the volume of the hemacytometer method with a more comprehensive number of parameters enhancing statistical reliability of the results.

The Vi-CELL Series features the following key benefits:

- Automated viability analysis using the trypan blue standard.
- Rapid, reliable and objective results over manual hemacytometer methods.
- Cell Imaging provides critical information not available using conventional methods.
- Enhanced Image resolution provides cellular detail 10x better than other image viability analyzers.

**Theory and Function**

**Trypan Blue Dye Exclusion Method**

The Vi-CELL utilizes the widely accepted trypan blue dye exclusion method to determine cellular viability. When cells die their membranes become permeable, thus allowing for the uptake of the trypan blue dye. As a result, the dead or non-viable cells become darker than the viable cells. It is this contrast that is measured to determine viability.

**Instrument Operation**

The Vi-CELL, while simple to use, represents the very latest in cutting edge image analysis technology and fluidics management. At the heart of the Vi-CELL is our customized liquid handling system. This system, which allows sample aspiration, reagent handling, and subsequent instrument cleaning, is fully automated. Once the cellular suspension has been aspirated and mixed with the trypan blue, it is pumped to the flow cell for imaging.

The Vi-CELL will analyze up to 100 images for a determination of cellular viability. This whole process and the subsequent cleaning cycle takes approximately 2.5 minutes.

**Imaging Technology**

In the Vi-CELL system a proprietary algorithm is utilized to determine which cells have absorbed the trypan blue dye and which have not. The first step is to digitize the collected video image and transform this from a continuous smooth image into an array of distinct elements or pixels. The Vi-CELL provides enhanced magnification and an effective pixel area size resulting in superior image resolution. Each element is assigned a “gray level” or brightness value from 0 (black) to 255 (white).

Thresholds within the software then determine which cells have absorbed trypan blue dye and which have not. Those cells that have lower gray values appear “dark” and are determined to be non-viable. Those with high “gray levels” are determined to be viable.
Sample Analysis
has never been so simple,
it’s as easy as ... 

**Step 1:**
Load your sample.

**Step 2:**
Log-in your sample.

**Step 3:**
View your results.

Stored Run Results

<table>
<thead>
<tr>
<th>Sample ID</th>
<th>15mMBMC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cell type</td>
<td>CHO</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Cell count</th>
<th>34</th>
<th>4032</th>
</tr>
</thead>
<tbody>
<tr>
<td>Viable cells</td>
<td>32</td>
<td>3768</td>
</tr>
<tr>
<td>Viability</td>
<td>94.1 %</td>
<td>93.5 %</td>
</tr>
<tr>
<td>Total cells / ml</td>
<td>2.71 x 10^8</td>
<td>2.23 x 10^8</td>
</tr>
<tr>
<td>Viable cells / ml</td>
<td>2.95 x 10^8</td>
<td>3.02 x 10^8</td>
</tr>
</tbody>
</table>
Software
with power, flexibility,
and simplicity

Power and Flexibility for R&D, QC and Manufacturing Applications – At Your Fingertips

The Vi-CELL software interface has been designed to be simple to use, yet offers numerous innovative features for those users demanding the maximum flexibility.

For many users the main screen may be the only one they need. Everything the user requires to log in samples and view results is right there. All of the available graphs, including Viability %, Viable size distribution, and Total cells/mL are easily selectable via the drop-down menu.

The bioprocess tracking, auto-sampler queue and control monitoring features are easily accessed via the novel navigation bar on the left side of the screen.

Real-time cellular imaging provides additional information not available using standard aperture cell counting methods. This image enhances the results, combining cellular detail with viability, size and concentration.

Real-time cellular imaging enhances results

Optimize your bioreactor data
Monitor your culture over time

Bioprocess Tracking

The Vi-CELL bioprocess-tracking feature allows convenient, automated tracking of your cell culture parameters, essential for optimum bioreactor productivity. Data points of total cell counts and viability percent are electronically recorded and stored, eliminating potential errors in manual recording. Thus, the bioprocess-tracking feature offers the complete solution for your bioreactor’s cellular growth cycle.
**Regulatory Compliance**

*Establishing a strong partnership*

**21 CFR Part 11**

The Electronic Records and Electronic Signatures Rule (21 CFR Part 11) was established by the FDA to define the requirements for submitting documentation in electronic form and the criteria for approved electronic signatures. Since analytical instrument systems such as the Vi-CELL generate electronic records, these systems must facilitate compliance with the Electronic Records Rule. By selecting the 21 CFR Part 11 option in the software, it automatically allows the user to configure the system for compliance.

The Vi-CELL features the following key system components to facilitate 21 CFR 11 compliance:

- Audit trail
- Electronic signature capability
- Secure user sign-on
- User level permissions
- Administrative configuration tools

**V-Check Program**

Beckman Coulter Inc. complies with current Good Manufacturing Practices (cGMP's). This gives Beckman Coulter a unique understanding of the strict requirements that users in regulated industries are subjected to. As a result, Beckman Coulter has established a comprehensive program to address all aspects of the instrument validation.

The V-Check program is a comprehensive package that addresses all appropriate aspects of a product's life cycle, from instrument development to ongoing performance verification (SQ, DQ, IQ, OQ, PQ). The V-Check program contains all the necessary documentation for instrument validation. This documentation is required to show auditors and investigators proof of proper instrument validation. It consists of a number of functional inter-linked components, which have been designed to give the user assurance that the product is fit for the purpose that it has been designed for and will perform on a consistent basis for these tasks. Where other instrument manufacturers leave off, Beckman Coulter and the V-Check program assists with ongoing quality checks of the instrument (PQ). This demonstrates that it is important to consider products from a manufacturer that not only understands your needs, but is also willing to develop a Partnership for quality.
Vi-CELL Series
Solutions for low and high-throughput environments

The Vi-CELL S (Single Position)
Allows individual sample runs for most all cell types in the size range of 5 to 70 micron diameter.

The Vi-CELL AS (Auto-Sampler)
Offers identical capabilities with the added feature of a 12-position sample carrousel for increased sample throughput and enhanced automation.

The Vi-CELL XR (Extended Range)
Offers additional benefits over the S and AS Models:
- Extended size range to 2 microns, allowing additional analyses of yeast, and smaller cells.
- Increased sample throughput with greater efficiency.
- Reduced sample volume results in less reagent use.
- Auto focus capability increases instrument ease of use.
- Variable aspiration and mixing cycles optimize results.
- Enhanced image magnification (6.75x), provides unparalleled cellular detail.
- Circularity measurement helps isolate debris from cells.

Integrated, Validated Reagent Solutions
- Color coded packs
- Quick & easy installation
- Validated reproducibility
<table>
<thead>
<tr>
<th>Feature</th>
<th>Vi-CELL XR</th>
<th>Vi-CELL AS</th>
<th>Vi-CELL S</th>
<th>Benefits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Part Number</td>
<td>383565</td>
<td>6605769</td>
<td>383080</td>
<td></td>
</tr>
<tr>
<td>Auto Sampler</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>Eliminates need to remove carrousel</td>
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<tr>
<td>Size Range (μm)</td>
<td>2.70</td>
<td>5.70</td>
<td></td>
<td>Improved measuring range for small cells and yeast</td>
</tr>
<tr>
<td>Sample Volume (mL)</td>
<td>0.5</td>
<td>1</td>
<td></td>
<td>Reduced reagent consumption, nearly double the sample runs</td>
</tr>
<tr>
<td>Analysis Time (min.)</td>
<td>2.5</td>
<td>3.5</td>
<td></td>
<td>Time savings, increased throughput</td>
</tr>
<tr>
<td>Imaging Technology</td>
<td>Camera Focus, Camera, Image Collection</td>
<td>Auto Firewire (394x394) CCD, Manual Image Frame Grabber (460x460) CCD</td>
<td>Resolution increased 3x, providing for better analysis of small cells and yeast. Higher resolution improves identification of clustered cells for optimum analysis</td>
<td></td>
</tr>
<tr>
<td>Image Zoom</td>
<td>Yes</td>
<td>No</td>
<td></td>
<td>Helps identify and optimize cell types and cell clustering</td>
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<tr>
<td>Aspiration and Trypan Blue Mixing</td>
<td>Variable</td>
<td>Fixed</td>
<td></td>
<td>Helps optimize cell types, such as fragile cell lines. Added mixing helps separate sticky cells before analysis, improving results.</td>
</tr>
<tr>
<td>Out of Range Concentration Flag</td>
<td>Yes</td>
<td>No</td>
<td></td>
<td>Automatically keeps operator informed</td>
</tr>
<tr>
<td>Filled Dispense Tray Flag</td>
<td>Yes</td>
<td>No</td>
<td></td>
<td>Automatically keeps operator informed</td>
</tr>
<tr>
<td>Bioprocess 3D, Rotateable Plotting</td>
<td>Yes</td>
<td>No</td>
<td></td>
<td>Visually see trend changes</td>
</tr>
<tr>
<td>Export Multi-run Files to MS Excel</td>
<td>Yes</td>
<td>No</td>
<td></td>
<td>Facilitates Data Handling</td>
</tr>
<tr>
<td>Upgraded Audit Trail</td>
<td>Yes</td>
<td>No</td>
<td></td>
<td>Assists in system validation requirements</td>
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<tr>
<td>Non-viable Cell Declustering</td>
<td>Yes</td>
<td>No</td>
<td></td>
<td>Helps in optimizing cell types, such as &quot;sticky cell lines&quot; and helps number cells in clusters</td>
</tr>
<tr>
<td>User-defineable Declustering Options</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Added Preferences for Secured Users</td>
<td>Yes</td>
<td>None</td>
<td></td>
<td>Assists in system validation requirements</td>
</tr>
<tr>
<td>Enhanced Circularity Measurement</td>
<td>Yes</td>
<td>No</td>
<td></td>
<td>Helps in isolating debris from sample</td>
</tr>
</tbody>
</table>
Technical Specifications

Instrument Function:
- Concentration Range: 5x10^9 to 1x10^10 cells/mL
- Counting Accuracy: ± 6%*

Operating System:
- Windows® 98, Windows® 2000, Windows® XP

Instrument Type:
- Video imaging through a quartz flow cell

Power Requirements:
- Power 50 watts (65 Watts Max.)
- Voltages: 100V, 120V, 220V or 240V 50/60 Hz

Temperature:
- 10°C to 40°C (50°F to 104°F)

Weight:
- 11.3 kg (25 lb)

Unit Dimensions (HxWxD):
- 44.5 cm (17.5") x 38 cm (15") x 41 cm (16")

Ordering Information

<table>
<thead>
<tr>
<th>PART NUMBER</th>
<th>AUTO SAMPLE</th>
<th>SIZE RANGE (µL)</th>
<th>SAMPLE VOLUME (µL)</th>
<th>CYCLE TIME (min)</th>
<th>VARIABILITY</th>
<th>IMAGING TECHNOLOGY</th>
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<tbody>
<tr>
<td>383556</td>
<td>VI-CELL XR</td>
<td>Yes</td>
<td>2-70</td>
<td>&lt;2.5</td>
<td>0-100</td>
<td>Auto-focus routine, Image frame grabber 640 x 480 CCD array</td>
</tr>
<tr>
<td>605769</td>
<td>VI-CELL AS</td>
<td>Yes</td>
<td>5-70</td>
<td>&lt;3.5</td>
<td>0-100</td>
<td>See VI-CELL S</td>
</tr>
<tr>
<td>383080</td>
<td>VI-CELL S</td>
<td>No</td>
<td>5-70</td>
<td>&lt;3.5</td>
<td>0-100</td>
<td>Manual focus routine Image frame grabber 640 x 480 CCD array</td>
</tr>
</tbody>
</table>

383722       | VI-CELL XR Quad Pack |
383198       | VI-CELL AS, S Quad Pack |
175478       | VI-CELL Concentration Control |
175474       | VI-CELL Focus Control |

The VI-CELL Series – and all our Cell Lab offerings – are an important part of a broad continuum of Beckman Coulter products, including automated liquid handling, capillary electrophoresis, centrifugation, ultracentrifugation, DNA sequencing, electrophoresis, flow cytometry, fragment analysis, HPLC, integrated core systems, microarrays, particle characterisation, immunolabelling, and spectrophotometry.

For information on our comprehensive line of systems, please contact your local Beckman Coulter representative or visit our web site at www.beckmancoulter.com/cell.lab

* Against the Coulter® reference method

Developing innovative solutions in Systems Biology.

Innovate. 
Simplify.
Automate.
The DeltaV digital automation system helps you improve your operations by harnessing today’s predictive technologies in an easy, intuitive, and interoperable way to connect your people, processes, and production.

I/O on Demand

What you want, when you want it, where you want it.

With the introduction of I/O on Demand, an unprecedented amount of field I/O adaptability, ease-of-integration and plant availability becomes possible. Costs and concerns around single points of failure, marshalled cross-wiring, power and grounding of FOUNDATION fieldbus segments, and late project I/O and process design change orders can completely disappear.

Regardless of I/O type—traditionally wired I/O, FOUNDATION fieldbus, Profibus DP, DeviceNet, AS-i bus, or even redundant wireless—you can add and begin using the information all natively and with far less engineering, design, and field work. You choose the I/O you need, we make it easy. I/O on Demand—your I/O, any type, anytime, anywhere.

Ultimate Scalability

Inherent functionality regardless of size.

Process control facilities and applications certainly come in all sizes and levels of complexity. To maximize the return on your investment, the automation system should easily scale without adding complexity.

Part of Emerson’s PlantWeb™ architecture, the DeltaV™ system is built from the ground up for ultimate scalability. Regardless of your application’s size, the DeltaV system keeps the same look and feel. This reduces administration and training costs, and optimizes both initial investment and future expansions.

From bench top, to pilot plant, to full production; from 25 I/O points to over 1 million, your system adapts to meet your needs. Same operations experience. Same maintenance experience. Same system, scaled to fit. Easy.
Embedded Intelligent Control

**Advanced technologies that are easy to use and maintain.**

Plant availability at peak performance, that’s really the ultimate goal of any automation system. Keeping the facility running in a safe and secure manner, while optimizing the production is what the DeltaV system with AMS™ Suite: Intelligent Device Manager is all about.

All the predictive power of smart devices is combined with the latest advanced control technologies to provide the ultimate in embedded intelligent control. Whether it’s the latest in predictive device alerts, adaptive tuning, or model predictive control—you have the power of embedded intelligent control within an integrated system that’s easy to use and maintain.

Inherently Integrated

**Delivering the power of PlantWeb to every installation.**

The DeltaV system has the commissioning and monitoring power of AMS Device Manager included. This combination connects your operations with the predictive intelligence in smart devices and creates PlantWeb—for greater availability.

The inherent integration of the DeltaV system extends to batch, advanced control, change management, engineering tools, diagnostics, simulation, and event and continuous historian.

Emerson provides solutions that integrate with your plant systems above, below, and in parallel with the DeltaV system. And, it is tightly integrated with:

- Syncade™ suite which provides operations management
- AMS™ Suite which provides predictive maintenance
- DeltaV SIS™ system which provides integrated yet separate safety
- Integrated machinery monitoring.

Built for Purpose

**Designed specifically for your process control applications.**

Over the last ten years, commercial off-the-shelf technologies (COTS) have provided tremendous increases in functionality and cost advantages to end-users of today’s automation systems. The DeltaV system was the first such system on the market, and continues to provide open, proven products to its process manufacturers.

However, while COTS has given many advantages, it has also come with expensive administration and life-cycle costs requirements. A better approach is to take advantage of the cost benefits and open standards of COTS, but to add functionality that allows the equipment to function much more like other parts of the system—plug-and-play, full lifecycle support without upgrades, built-in security, etc. We call this balance “Built for Purpose”, and the DeltaV system is the first automation system to address this critical need in many of the most important facets of the system.
The proven PlantWeb digital plant architecture helps you detect operations, process, and equipment problems before they even occur, so you can move from reactive to proactive and profitable plant operations.
The DeltaV architecture provides reliability through redundancy:
- Ethernet network connections
- Controllers
- Controller & field interface power supplies
- Digital HART I/O and classic field interface cards
- H1 FOUNDATION fieldbus with integrated power and diagnostics
- Profibus DP Master interface
- Modbus RTU/ASCII interface
- SIS logic solvers
- SISNet communications
- Batch Executive
- Zone servers
- OPC servers

Digital Communications
- FOUNDATION fieldbus
- HART
- WirelessHART
- Profibus DP
- DeviceNet
- AS-i bus
- Modbus RTU/ASCII/TCP
- Ethernet/IP
- OPC
- OPC Express Interface (Xi)
Electronic Marshalling

The I/O you want, when you want it, where you want it.

The DeltaV system’s unique flexible field architecture delivers I/O on demand—providing the I/O you want, when you want it, where you want it. It is flexible because you can now decouple the process design from the I/O infrastructure design, to easily incorporate late process changes into the automation system.

Electronic Marshalling

Tight project schedules with changing requirements during design and implementation are a way of life. DeltaV Electronic Marshalling lets you land field cabling wherever you want, regardless of signal type or control strategy.

With Electronic Marshalling, each terminal block has a channel characterization module, or CHARM, which includes an A/D converter and associated signal characterization for different types analog and digital I/O. Field wiring of any signal type can be terminated anywhere and characterized by the various CHARMS. A digital communication bus runs along the terminal strip to send device signal information to the top of the redundant CHARM I/O card where I/O conditioning is completed.

Integrated CHARMS

- CHARM base plate snaps on rail
- CHARM terminal block snaps into base
- Auto keying sets terminal block when first CHARM is inserted
- CHARM secured with locking mechanism in both operating and “knife-edge” disconnect positions
- Insertable/removable under power in a Zone 2 environment
- Signal fault protection and circuit protection built in
- Fault isolation built in to CHARM.
Process design changes often occur throughout the life of a project. For example, after the process hazard analysis is completed, new temperature measurements might need to be added to a process vessel. This can create significant hardware design challenges if the correct I/O channel type isn’t available, or if there is no room for new I/O to be added. In most control systems this would require substantial re-work to move some or all of the control strategy to another controller.

With the unique DeltaV Electronic Marshalling solution, implementing this change can be as simple as adding a few new CHARMS to any existing terminal strip, regardless of which controller will use the input data.

**Marshalling made easy**

Electronic Marshalling makes design easier and more forgiving, because any input value can be read by any DeltaV controller regardless of where the wiring is landed.

DeltaV Electronic Marshalling eliminates the complexity associated with marshalling field wiring in a control system.

Electricians can terminate the field wires on terminal strips in the same way they have in the past, but the cross-wiring from the marshalling panel to I/O cards has been eliminated. This greatly simplifies control cabinet design, installation, and maintenance.

**Increased robustness**

Troubleshooting of installation issues can be done on a channel-by-channel basis, because problems are isolated to a single channel—providing increased robustness.

Because each CHARM comes fully equipped with the ability to read HART v7 data, intelligent field devices can be monitored and quickly diagnosed around the clock.

**Installation of Electronic Marshalling** is intuitive and easy, because it is similar to existing methods for terminating field wiring. No special training or expertise is needed to terminate wiring on the terminal blocks. An integrated “knife-edge” disconnect eliminates the worry over accidentally induced faults during hot cutovers and maintenance.

**Redundancy ensures reliability:**

- Redundant CHARM I/O card
- Redundant communications between CHARMS and the CHARM I/O card
- Redundant power between CHARM I/O card to each CHARM
- Redundant network communications between CHARM I/O cards and controllers.

**Late changes? No problem**

Every project has late changes that can have significant impact on cost and schedule. Making these late changes is now easier, because new field wiring can be added to cabinets at any time with no impact on the system architecture.

Process design changes often occur throughout the life of a project. For example, after the process hazard analysis is completed, new temperature measurements might need to be added to a process vessel. This can create significant hardware design challenges if the correct I/O channel type isn’t available, or if there is no room for new I/O to be added. In most control systems this would require substantial re-work to move some or all of the control strategy to another controller.
Traditional I/O

Proven, plug and play—a smart choice for your control system.

Traditional I/O is a modular subsystem that offers flexibility during installation. It's designed to be installed in the field near your devices. Modularity, protection keys, and plug-and-play capabilities make DeltaV traditional I/O a smart choice for your process control system.

Traditional I/O is available in two designs—the established M-series and the new S-series. The S-series incorporates human-centered design concepts to improve usability and robustness with the same proven technology inside. The exterior hardware design delivers easier installation and improved robustness.

Easy snap-in installation

Installation is easy since I/O is automatically auto-sensed when added to the system. No-value engineering is eliminated.

S-series classic I/O is equipped with a snap-in retention system for quick installation and error-free maintenance.

A guide prevents bent pins and cards easily snap in place. Carriers snap onto the DIN Rail—no tools required. Snap-on technology makes cards easy to install with tight connections every time and easy to release with a push of a button.

I/O cards, terminal interfaces and terminal blocks have I/O function keys. This ensures the correct I/O card is always plugged into its corresponding terminal block.

All wiring is through the carriers and terminal blocks so that I/O cards can easily be removed without disconnecting any wires.

Reliable means available

Reliability and increased system availability are built in throughout the rugged DeltaV control hardware. Redundancy options are available for:

- Controllers
- Control and field interface power
- Controller Ethernet communications
- Many classic field interface cards
- H1 FOUNDATION fieldbus
- Profibus DP
- Serial interface.
Online addition of new I/O cards means your process does not get interrupted. The DeltaV system enables you to add system components including controllers, I/O cards, field devices and workstations while the system is powered and running. You can expand and upgrade your system on-the-fly with no downtime.

The rugged, S-series hardware includes a venting system that prevents screws, metal shavings, and other debris that could short-circuit electronic components from entering.

**Modular design for added flexibility**
Both the S-series and M-series traditional I/O hardware can co-exist in the same DeltaV system with no trade-offs or incompatibilities.

The modular design lets you buy the exact number of I/O cards, 8-wide carriers, power/controllers, and 2-wide carriers you need and add more DeltaV I/O as your system grows.

**Rugged design for use anywhere**
The DeltaV system supports a full range of analog, discrete, digital bus, thermocouple, and RTD field devices.

DeltaV control hardware is built rugged and flexible to mount almost anywhere. It is designed for extreme field installation conditions, including:
- Class 1 Division 2 areas
- CENELEC Zone 2 areas
- ISA-71.04-1985 Airborne Contaminants Class G3.

All DeltaV traditional I/O cards are rated for extreme operating temperature ranges of -40 to 70 °C (-40 to 158 °F). You can mount the I/O interface carrier in a junction box in the field, significantly reducing your equipment footprint.

Shared remote I/O is available for Zone 2 installations. Unlike other remote I/O, DeltaV remote I/O can be shared among several controllers for a greater range of applications and installation flexibility.

**Safety in hazardous areas**
The DeltaV Intrinsically Safe I/O M-series subsystem provides the perfect solution for locating I/O in hazardous areas. The I/O subsystem connects intrinsically safe field circuits and field devices into FM Class I, Division 1, Zone 1, and Zone 0 hazardous areas for most standard analog input, discrete input and discrete output applications.
Built for Busses

Digital communications deliver predictive diagnostics for improved operations.

The DeltaV system is the only system built from the ground up to unleash the advantages of FOUNDATION fieldbus. Not an add-on, not an afterthought, it’s built to deliver the project and operational savings of a digital plant—easy!

Digital busses

The DeltaV system includes other popular digital communication busses such as Profibus DP and DeviceNet for integration of motor starters and drives. It also includes AS-i bus for low-cost, simple installation of discrete devices such as push-buttons, on/off valves, and proximity sensors. The DeltaV system provides native support for configuring busses with no need for 3rd party configuration tools. Ethernet I/O devices are easily connected through a virtual I/O module.

With the DeltaV system you have a wide variety of digital busses from which to choose, as well as the world’s best implementation of HART to easily take advantage of the diagnostics that HART-based intelligent field devices provide.

FOUNDATION fieldbus (FF) devices deliver predictive alerts, millisecond data capture, validated data, field-based control, diagnostics, and asset information bi-directionally with the DeltaV system. DeltaV FF I/O communicates digitally with field devices, increases your input/output capacity, and provides access to more information about your process than conventional I/O subsystems. DeltaV FF I/O enhances device diagnostics that affect your control strategy and alert operators to device malfunctions.

Multi-dropping up to 16 devices on one port reduces your wiring expenses substantially. The DeltaV FF I/O’s integrated design can eliminate the need for marshalling panels—saving you even more.

Easy design, installation, and commissioning

Fieldbus power conditioners are integrated in the H1 card. This eliminates difficult segment power design, installation, and troubleshooting. The additional cabinet footprint associated with use of external FF segment power supplies is eliminated.

FOUNDATION fieldbus devices are auto-sensed when connected to the control network and automatically added to your configuration. As a result, your engineering and commissioning efforts are dramatically reduced.

Improved plant availability

Benefits include upfront engineering, installation, and commissioning savings. Of greater significance are the ongoing savings in reducing process variability, improving quality, increasing throughput and avoiding upset conditions that can limit your production capability.

Reliability and increased system availability are built in throughout the rugged DeltaV control hardware. Redundancy options are available for FOUNDATION fieldbus and Profibus DP.
Smart Wireless

Extending predictive intelligence more economically where you need it.

Wireless Field Network
Emerson’s Smart Wireless solutions provide an interoperable, adaptive, flexible approach to wireless. It has been proven in installations around the globe. At its heart, a self-organizing wireless network based on the globally accepted WirelessHART (IEEE 802.15.4) standard, providing secure, robust, and reliable performance.

DeltaV wireless is reliable
Redundant DeltaV wireless I/O cards each connected to a 781 Smart Wireless Remote Link provides a fully redundant solution for critical wireless communications that is reliable enough for control.

The mesh continuously monitors communication paths for degradation and automatically improves itself. If an obstruction occurs, devices will find the best alternate communication path. Greater than 99% reliability is ensured.

DeltaV wireless delivers flexibility
Many plants are missing important measurements. Typically, the measurements and associated wiring were not easy to add—given distances, hazardous areas, or path blockages. WirelessHART devices and easy DeltaV connectivity open the path to improved plant efficiency. AMS Device Manager with the AMS Wireless SNAP-ON™ application helps you effectively plan and monitor your wireless network for maximum process availability. The DeltaV PID control algorithm is specifically designed to handle communications variability from WirelessHART instrumentation. It is ideal for control applications like level and temperature control.

DeltaV wireless is robust
Redundant DeltaV wireless gateways provide reliable communications with the self-organizing, adaptive wireless mesh.

DeltaV wireless is secure
DeltaV wireless field networks protect valuable information with multi-tiered, always-on security. Based on the highly-secure WirelessHART standard, the network devices implement encryption, authentication, verification, anti-jamming and key management methods to ensure that data transmissions are secure.

Wireless Plant Solutions
Smart Wireless solutions for plant-wide operations provide standards-based network infrastructure for easy integration of all the wireless applications in your plant, including video, location tracking, mobile worker productivity solutions, as well as a field data backhaul to bring remote wireless field data to the system.

Wireless access points provide Wi-Fi coverage and can even be implemented in hazardous areas. Emerson services tie these Wi-Fi access points with the applications you need for a total solution—easy.

A North Sea offshore oil and gas producer needed a better way to measure well casing pressure. Sudden pressure drops can indicate problems with a well. Twice daily, operators manually recorded these pressure readings from this Zone 1 hazardous area. Adding WirelessHART, AMS Device Manager and pressure transmitters provided continuous monitoring to spot and initiate corrective actions sooner.

Integrated Smart SIS

Protect your assets with the proven, secure DeltaV SIS system.
Smart safety loops. Reliable process.

Optimized reliability
Safety instrumented systems perform a critical role in providing safer, more reliable process operations. Based on industry research, over 85% of all faults in SIS applications occur in field instruments and control elements. Therefore, it is critical to consider the entire safety instrumented function (SIF)—from sensor, to logic solver, to final control element—as a complete entity.

A smart SIS shuts down your plant when needed for safety, but keeps you running safely when components fail. As a key element of Emerson Process Management’s Smart SIS, the DeltaV SIS™ safety management system reliably protects your assets by providing an integrated approach to complete safety loops.

The DeltaV SIS system helps you to improve your process safety by continuously monitoring and diagnosing the ability of the sensors, logic solvers, and final control elements to perform on demand as required. To increase your process availability, the DeltaV SIS system detects component failures and keeps you running when other systems might shut you down.

The use of digital intelligence and predictive diagnostics increases system availability while reducing life cycle costs by providing:
- Health diagnostics to detect device failures
- Device alerts for quick action
- Automatic partial stroke testing
- Automated proof testing
- Integrated, comprehensive documentation tools.

Flexibility to meet your process needs
The DeltaV SIS system is flexible to provide the safety you want, when you want, where you want. It provides a unique modular, distributed architecture that is based on a safety instrumented function approach to logic solving. The modular architecture eliminates a single point of failure, while the distributed architecture enables implementation of complex logic across multiple logic solvers. This optimum architecture simplifies change management and enables the system to be custom fit for SIS applications.

The DeltaV SIS system is IEC 61508 certified for use in SIL 3 applications. Flexible redundancy enables modular hardware fault tolerance to meet your process availability requirements.

The modular logic solver hardware scales in sizes of 16 configurable I/O; therefore, memory and CPU are added with each logic solver. The deterministic scan rate ensures proper performance as you expand your system.

For further flexibility, the I/O mix is configurable and can be located remotely. And the system can be as large as your application requires—30,000 I/O.
Increased visibility into your process
The DeltaV SIS system provides an optimum integrated but separate architecture to meet the IEC 61511 requirements for separation of safety and control—with dedicated safety hardware, software and networks; and integrated configuration, operations, and maintenance with the DeltaV system. This approach provides unmatched visibility into your process, by enabling direct access to all SIS information across the entire safety loop.

Physical separation and independence
The DeltaV SIS system provides key safety functionality that is independent of the DeltaV basic process control system. Separate safety hardware features include a unique logic solver, independent operating system, and diverse advanced safety function blocks. Additionally, the power supply and communication networks are dedicated and independent for the DeltaV SIS hardware. For added protection, the DeltaV Controller acts as a firewall between the SIS logic solvers and the control network.

Integrated engineering, operations and maintenance
The DeltaV SIS platform seamlessly integrates with the DeltaV system to provide a comprehensive process safety solution that leverages your automation investment.

Reduced engineering and complexity
The DeltaV SIS advanced function blocks deliver powerful functionality out of the box, and simplify the implementation of complex SIS applications. A full pallet of IEC 61508 certified function blocks are built to the IEC 61131-3 function block standard, making safety logic development intuitive and easy. The powerful function blocks reduce what used to be pages and pages of logic to engineer, test, and commission. It’s now a simple drag-and-drop configuration process—with no custom programming. Simplified configuration with less complexity reduces your lifecycle costs and process risks.

Simplified regulatory compliance
The DeltaV SIS system is built from the ground up to simplify regulatory compliance, eliminating your concerns related to proper implementation. The engineering tools enforce good practices, so special restrictions do not need to be considered when configuring the system. Simplified IEC 61511 compliance is provided by:

- Change management of safety logic and field device configuration and calibration
- Security management, including authorization of online trip point or bypass changes
- Secure write mechanism for repeat confirmation of online changes
- Automatic logging of system events and diagnostics faults
- Automated workflow for proof testing field devices.

You are asked to automate a Burner Management System, but you have limited time and resources. Looking for a scalable safety solution, you decide to install the DeltaV SIS system and use the powerful, certified safety function blocks. The built-in state machine and step sequencer functionality eliminates the need for complex ladder logic—reducing your engineering, testing and documentation efforts. The modular architecture allows you to install only the hardware needed for this application. You are able to complete the project on time and under budget.
Ultimate Scalability

Easily fits applications of any size.

Process control applications come in many different sizes and levels of complexity. It’s critical to have an architecture built to support this required scalability, or you end up with multiple, isolated, difficult-to-integrate solutions.

Scalability starts at the field device level. Technologies like WirelessHART and its self-organizing wireless communications help you scale your instrumentation device by device, and area by area within your plant. AMS Device Manager captures and delivers predictive diagnostics from all of these devices, as well as your HART, FOUNDATION fieldbus and Profibus DP devices—even across multiple DeltaV systems.

**Scales to fit**
The DeltaV architecture scales in size from 25 I/O to over one million I/O. And, by integrating I/O through open interfaces more than one million I/O is possible. No matter how small or how large your application is, the DeltaV system scales to fit.

DeltaV Zones segment the systems to ensure flexible operation and expansions with enhanced system performance. Maintenance or commissioning activities can be performed in each zone without impacting other zones. Also, to more easily manage software upgrades based on process criticality, each system can operate using different DeltaV software revisions, and still share data across zones.

To meet the challenges of your process operations, you need the scalable DeltaV system, which expands online, without redesign, and with the existing software—no upgrade required.

**Application scalability**
The DeltaV system scales in functionality to provide you with the tools you need for your process control application. With a common set of engineering tools and a common database, it provides a single platform and eliminates the typical headaches associated with integration. You have the flexibility to add advanced control, or batch, or safety instrumented functions as needed.

No matter your application’s size, all hardware components are the same—the engineering tools are the same, operations and maintenance applications are the same. The result? Less training, fewer spares, and easier operations.
Your company develops a new product on lab scale equipment before scaling it up to produce trial quantities in a pilot plant. After successful pilot-scale production trials, the process is commercialized in a large scale production unit. All of this is done in the same facility and you are responsible for supporting the control equipment. Obviously, the most desired situation is that all of these systems look and feel identical to the users: scientists, process engineers, automation engineers, and operators. The DeltaV system has ultimate scalability and was built from the ground up with the idea of a single platform to fit any size application. Whether or not the system is 25 or 25,000 I/O, the operator, engineer, production manager, and maintenance technician all have the same experience. There is no re-configuration, re-architecting, special "gateway" or other equipment to learn, use, and maintain.
Embedded Intelligent Control

Continuously adapting to changing conditions helps optimize your plant.

Emerson revolutionized the process control industry with the introduction of the PlantWeb architecture, which provides predictive intelligence through the use of intelligent field devices. Now, with embedded intelligent control, Emerson takes predictive intelligence a step further. By embedding learning algorithms directly into the DeltaV system, it can systematically apply the process knowledge it acquires to:

- Locate hidden variability and under-performing control loops
- Monitor control performance against model-based performance benchmarks
- Identify problems and diagnose causes such as faulty valves or process interactions
- Prevent downtime and increase availability
- Reduce variability, increase quality and throughput
- Sustain gains from performance improvements.

DeltaV embedded intelligent control provides you a full array of applications including enhanced PID control, automatic variability inspection, tuning, fuzzy logic control, model predictive control, and neural networks. Never before has a control system provided a full suite of embedded advanced control applications that enable you to get the most from your plant, with the least amount of effort.

Advanced control—easy

DeltaV embedded intelligent control enables you to quickly deploy state-of-the-art control technologies without the implementation and maintenance problems associated with traditional advanced control systems. Designed for the average control system engineer, advanced control has never been easier. With embedded intelligent control, advanced applications can be implemented with minimal configuration and maintenance because all the technology and tools are inherently integrated with the DeltaV system. No data mapping is required. It is not an add-on, it is part of the DeltaV system.

DeltaV advanced control applications are built as part of the same, easy-to-learn and use environment as standard regulatory control. PID, Fuzzy, Predict, and Neural function blocks are all available for you to drag and drop from the Control Studio pallet—it’s that easy!

Studies have shown that nearly 40% of all process loops are under performing. You are responsible for hundreds of control loops and instruments and you don’t have the time or the tools to monitor and maintain them. Your company is losing millions of dollars each year due to process variability and poor control performance. With embedded intelligent control, the DeltaV system provides you with a systematic way to automatically monitor, diagnose, and improve process control performance.
Intelligent control also makes life easier for your operators. More robust control means that your operators are less likely to operate in manual mode. Automatic control with reduced variability gives your operators less to worry about, so that they can focus on other important operating concerns.

**Reliable information increases availability**

You cannot have sustainable advanced control unless you have a strong foundation—built on healthy devices and reliable field information. The DeltaV system uses validated data and equipment health information from intelligent field assets to ensure the right control action is taken, preventing unwanted shutdowns when an asset fails.

All DeltaV intelligent control functions run in the DeltaV controller, including advanced control algorithms. This ensures that critical strategies run in a rugged, high-speed, optionally redundant environment.

**Online adaptability**

Changing process conditions require a control system to quickly adapt and take corrective action to prevent unsafe or sub-optimal operations. Reliable measurements and intelligent control strategies provide accurate and flexible control during changing process conditions and market demand.

Intelligent field devices that provide diagnostic information ensure the regulatory and advanced control algorithms are working with good data and enable corrective action to be taken in the case of questionable or bad data.

The DeltaV system’s embedded intelligent control provides the ability to quickly adapt to changing process conditions and the flexibility to confidently respond to changing market demand. Embedded learning algorithms identify control problems and provide continuous adaptive control to automatically adapt to changing process conditions. Model predictive control and optimization go one step further to continuously monitor process and economic conditions to ensure optimal plant performance within operating constraints.

The embedded DeltaV intelligent control applications are designed for you to use on a broad array of control challenges, enabling you to develop the right control strategies for your plant, at a fraction of the traditional cost—what you want, when you want it, where you want it.

**Preventing hazardous consequences**

By reducing process variability and adapting to changing conditions, embedded intelligent control keeps your process running smooth and within safe limits. This helps prevent unwanted shutdowns or hazardous consequences that may otherwise result from abnormal situations such as process disturbances, upsets, and unplanned events.
Embedded Intelligent Control

Optimized loops—all the time.

**DeltaV InSight**
DeltaV software provides the tools to monitor, analyze and tune control loops for peak performance. DeltaV InSight, inherently integrated into the system, instantly identifies under-performing control loops, enabling you to reduce process variability and increase the efficiency of your operation. It can be used to commission and automatically tune both PID and Fuzzy blocks.

There is no setup or configuration required, because InSight automatically recognizes function blocks as they are configured.

**DeltaV Adapt**
DeltaV Adapt continuously adjusts PID tuning for optimal control as process conditions change. In addition to calculating new tuning, DeltaV Adapt also remembers the best tuning from the last time it was controlling in the same operating region. And best of all, DeltaV Adapt can be applied to any PID loop in the control system—without control configuration changes.

**DeltaV Fuzzy**
DeltaV Fuzzy offers a practical, field-proven substitute for PID control for processes that may benefit from non-linear control action. Using an embedded fuzzy logic control algorithm with automated loop tuning, requires no special expertise in fuzzy logic.

DeltaV Fuzzy is robust and provides superior performance over PID control in many cases, providing faster response to set point changes or load disturbances without overshoot. Benchmark tests have shown loop performance improvement of 30-40% over traditional PID.

**DeltaV PID Control**
Intelligent control begins with robust regulatory control. DeltaV PID control delivers improved performance using intelligent device information and enhanced PID algorithms. Even for basic PID control, the DeltaV system has more capability than other DCSs and PLCs.
**DeltaV Predict**

Obtain greater throughput, reduced variability, and increased profitability by using DeltaV Predict and DeltaV PredictPro to implement multivariable model predictive control strategies. DeltaV Predict and PredictPro use the power of model predictive control to easily address process interaction and difficult dynamics. Since DeltaV Predict and PredictPro are fully embedded in the DeltaV system, you can use pre-engineered components and function blocks to quickly develop, validate, test and deploy your multivariable control strategies.

**DeltaV Neural**

DeltaV Neural provides a practical way to create virtual sensors for measurements previously available only through the use of lab analysis or online analyzers. Easy to understand and use, DeltaV Neural gives process engineers a way to produce extremely accurate results, even without prior knowledge of neural network theory. DeltaV Neural automatically uses the historical data provided from embedded historian, making it easy for you to quickly train the neural network and verify the accuracy of the resulting model.
The DeltaV suite of engineering tools handles configuration management, both locally and remotely, for all aspects of the DeltaV system and intelligent field devices. A single, global configuration database enables you to coordinate all configuration activities. Forget about data mapping between separate databases or referencing your process and engineering information by arcane registers or numbers. With DeltaV software, it’s all in one dynamic tag-driven configuration database:

- Control strategies
- Batch control strategies
- Safety strategies
- Process graphics
- History
- Events
- Change management.

In the DeltaV system, context-sensitive help takes you right to the documentation that’s relevant for the task you are doing. There is no need to search through books and online manuals. DeltaV Books Online shows you what you need to know, when you need it.

**DeltaV Explorer**

DeltaV Explorer is the primary tool for system configuration. It presents the complete system in a single view and allows direct access to any item. Similar in appearance to the Windows Explorer, it lets you define system components and view the overall structure and layout of your system. The DeltaV Explorer includes configuration and fast commissioning of WiressHART, HART, FOUNDATION fieldbus and Profibus DP devices. The DeltaV system is predominantly configured in place through interactive dialogs within DeltaV Explorer.

**Easy I/O configuration**

DeltaV controllers, I/O, and FOUNDATION fieldbus devices are auto-sensed when connected to the control network and automatically added to your configuration. The result is dramatically reduced engineering and commissioning time.

Native support for configuring busses with no need for 3rd party configuration tools makes it easy to configure Profibus DP, DeviceNet, and AS-i bus I/O.

Bulk Edit can be used to speed up the configuration process and eliminate tedious tasks.

**DeltaV Control Studio**

Control Studio lets you graphically create and modify individual modules and templates that make up your control strategies. The DeltaV system helps you create and maintain control strategies as small, modular components (modules). These modules become reusable configurations for control of your process equipment.

Control Studio treats each module as a separate entity—allowing you to focus on a specific module without affecting other modules that may be running in the same controller. Built on IEC 61131-3 control languages, including function block diagrams, sequential function charts and structured text, Control Studio provides a drag-and-drop palette to easily design and document your control strategies.
Use DeltaV Control Studio to develop:
- Regulatory control
- Advanced process control
- Basic logic
- Sequential logic.

Display configuration is easy with pre-defined, modular graphics such as faceplates, module detail displays, trends, alarm summaries and display directories.

**Configuration made easy**

With an intuitive user interface based on Microsoft’s Fluent Interface, you can quickly learn to develop control strategies using drag-and-drop configuration. Self-documenting graphical modules make it easy to design and document your control strategies.

Standard product design and pre-engineered, out-of-the-box solutions make configuration inherently easy to learn, use, and customize.

Unlike hybrid and component based automation systems, operating faceplates and history collection are built automatically as you assemble your control strategies.

DeltaV embedded history automatically collects historical continuous and event data for all modules in an assigned area.

As you are pressured to commission your new process so that production can start ahead of schedule, it is more and more important to have a common set of engineering tools to configure, calibrate, and commission different types of equipment. This ensures that you can quickly complete your tasks in a single interface, without having to make the same change in multiple locations.

With the DeltaV Explorer, you can easily design the control system architecture including all busses, without the need to map data between databases or to use third party configuration tools. The DeltaV Explorer enables you to configure your I/O and your field devices in a common interface. When configuring control logic with DeltaV Control Studio, it makes no difference whether the associated I/O comes from FOUNDATION fieldbus, serial interface, DeviceNet, or traditional I/O. It simply connects to any I/O, without any special tools required for different types of I/O.

The DeltaV engineering tools are developed with ease of use as a primary design criteria. The DeltaV system is designed to eliminate low-value engineering to ensure quick configuration, testing, and commissioning of any process manufacturing plant.
Adaptable
The DeltaV system gives you the flexibility to implement your system how you want, when you want, where you want.

Multiple users can concurrently configure the system and access the global configuration database from DeltaV workstations. For very large or tight deadline projects, the DeltaV system’s multi-client architecture provides:
- Off-line configuration
- Bulk editing in spreadsheet mode
- Bulk import from third-party software
- Bi-directional communication with Intergraph’s SmartPlant Instrumentation (INtools).

The DeltaV modules help you design your system from the top down and implement as you go. With minimal effort, you can specify loops and field devices, then quickly complete the configuration.

Implement portions of the system on the fly in a modular fashion as process design and control requirements become available. You can finish what you know and leave other sections to complete later. Work-in-progress flags ensure that no items are left incomplete.

Your configuration can be built from the bottom up, starting with I/O and finishing with control strategies and displays.

With Control Studio On-line, it’s easy to modify existing strategies independent of the running process and simulate them offline. When you are ready, just install the changes to the running system without affecting other control modules executing in the controller.

**SmartPlant® Instrumentation integration**
The SmartPlant Instrumentation (SPI) software from Intergraph Corporation is used by many engineers for instrumentation design. Projects that use SPI can benefit from the DeltaV data exchange interface.

The DeltaV system has a bi-directional interface with SPI that provides the seamless exchange of I/O and instrumentation information between the two databases. The information that can be transferred spans both conventional I/O, including HART, and Fieldbus I/O systems.

The SPI product has been enhanced to allow DeltaV definitions for I/O hardware objects, DeltaV terminology, and Foundation Fieldbus device definitions to appear directly in SPI.

Using the DeltaV SPI integration capabilities significantly reduces DeltaV and SPI engineering hours and delivers higher quality project deliverables because shared data is entered once. Data conversion or transfer errors caused by manual processes are eliminated.
Demands on operators continue to increase as their span of control increases and as technology advances create more information to digest than ever before. It’s more critical than ever to start from the operators’ perspective and streamline and focus their view into the process, especially in abnormal plant situations.

**Human-centered design**

Emerson founded the Human Centered Design Institute and is a key participant in the Center for Operator Performance, an operator-focused, human factors research consortium whose members include academics, engineering and automation suppliers, and process manufacturers. Improved DeltaV Operate and AMS Suite software usability emerged out of this extensive research and human centered design approach. The results are easily seen alarms at a glance, faster abnormal situation recognition, and intuitive views of loop deviations.

The operator experience begins with color-scale graphics, which provide subdued colors to make the bright colors associated with alarms and abnormal conditions stand out. Based on the ISA S18 alarm standard, operator-centric alarm help is available to provide immediate in-context access to allow response time, probable cause and operator instruction. These can include equipment protection and prediction through integrated machinery monitoring, environmental protection, product quality and process efficiency.

**Fast access**

DeltaV Operate gives operators easy, one-click access to alarm summaries, faceplates, trends, display navigation, and on-line help. Unlike pieced-together automation solutions, the built-in, one-click access capability makes the DeltaV system easy to learn and use. As a result, operator training costs are typically reduced by 50% compared to other automation solutions.

DeltaV Flexlock provides the application accessibility that is appropriate for personnel’s job function and skill level.

AMS Device Manager provides detailed alert information from DeltaV operator faceplates. Detailed troubleshooting information is available in the Audit Trail records and through applications such as AMS ValveLinkTM SNAP-ON™ application.

**Easy alarm analysis**

DeltaV Analyze, which is based on the ISA S18 and EEMUA 191 alarm metric standards, simplifies alarm analysis. It allows you to quickly spot which areas and modules have the most alarms in a given time period by connecting embedded historical alarms and events from the DeltaV Event Chronicle or Plant Event Historian.

**DeltaV diagnostics**

As a key component of the PlantWeb digital plant architecture, DeltaV diagnostics extend not only to the system components, but beyond—to cyber-security and intelligent device and machinery monitoring diagnostics with AMS Suite software. Diagnostics from FOUNDATION fieldbus, Profibus DP, DeviceNet, HART, and WirelessHART are easily incorporated into control strategies and operator graphics to reduce abnormal situations and provide rapid decision support to normalize the process.
Increasingly stringent regulations require manufacturers to provide comprehensive documentation of their process. DeltaV Configuration Audit Trail is a powerful tool that tracks changes and manages revision information for any item in the DeltaV configuration database, including Safety Instrumented System (SIS) items. This application creates and maintains a configuration change history for configuration items, such as modules, SIS modules, phases, operations, unit procedures, user accounts, and operator graphics—simplifying configuration management and regulatory compliance.

**Easy to track changes**

Comprehensive version control of a configuration item is automatically tracked and updated. The new version is time-stamped and a history comment can be recorded when the item is checked back in. Embedded reporting tools give users the ability to print configuration change histories for any item in the configuration database.

By keeping detailed historical information on configuration items, the system automatically maintains quality data for regulatory compliance requirements and troubleshooting. Configuration Audit Trail is tightly integrated with the DeltaV configuration tools, such as Explorer, Control Studio, Recipe Studio and Graphics Configuration. DeltaV administrative tools allow the Configuration Audit Trail database and the DeltaV database to be backed up together in one operation. It is also possible to archive and restore versions of items in the audit trail database.

**Ensure authorized configuration changes**

The DeltaV security system provides the ability to grant privileges to individual users. Items may be checked out for editing only by approved users.

**Ensure compliance during operation with Electronic Signatures**

To support regulatory compliance requirements, including FDA 21 CFR Part 11, the DeltaV system provides comprehensive electronic signature capability during process operations. Any actions taken can be configured to require a confirmation in which the user name and password is needed to execute, as well as an additional verifying user name and password if required.

**Change management provides these key benefits:**

- Tracks configuration changes
- Displays differences between different versions of a configuration item
- Rolls back an individual item or the entire database to a prior version
- Creates change management reports
- Displays version identifiers online for downloaded configuration items
- Logs recipe authorization before release to production
- Tracks SIS Module download authorization based on SIL level
- Tracks SIS Module testing approval based on SIL level.
Security

Prevents unauthorized system changes that can compromise your plant’s performance.

The DeltaV system provides easy, flexible, system-wide security management for all users including operators, engineers, technicians, and other automation users.

Easy security management
Based on user login, the easy-to-use DeltaV role-based security keys control both system functionality and span of operator control. A separate set of locks and keys is provided for control and safety.

DeltaV security ensures that you have the correct privilege for each task. When you make changes to system users and their privileges in DeltaV User Manager, the changes are immediately applied across all DeltaV applications and Windows security is automatically updated.

Adaptable user manager
All facilities do not operate the same. With the role-based user access, you have complete flexibility to modify the security structure to match your operating philosophy. Through a single sign-on, you can define groups of users, such as operators or supervisors, and assign them DeltaV and AMS Device Manager privileges.

For example, one group may be able to change only operating parameters, while another also may be able to change selected tuning parameters. And you can limit a user to particular areas of the plant—providing you with peace of mind that only the appropriate people are making decisions affecting your plant.

Built for security
The DeltaV system was developed with system security as a key design criterion. To safeguard your assets and ensure proper access, the DeltaV system delivers many important security capabilities.

- The DeltaV control network architecture delivers a system that is more secure from unauthorized external access.
- DeltaV controllers have been hardened to mitigate specific, well-documented security threats.
- Workstation hardening disables unused operating system services and disables CD-ROM and USB ports to prevent the introduction of viruses and malware.
- The DeltaV Flexlock security application creates a secure workstation desktop to prevent unauthorized access outside of the DeltaV operations environment.
- DeltaV Smart Switches provide auto lockdown to prevent unauthorized network connections on switch ports.
- Unauthorized network devices cannot participate in DeltaV communications, because DeltaV devices are authenticated as part of system configuration.
- Physical access to local equipment is not required for routine maintenance procedures and troubleshooting because system diagnostics are done over the network using DeltaV workstations.

Starting up a large manufacturing facility can be stressful. An inherent change management system can help eliminate pressure and improve productivity—when there is too much to do and too little time. DeltaV system changes are made by authorized personnel and are automatically tracked and approved as needed. The result is up-to-date documentation that supports regulatory compliance requirements. Made a mistake? No problem. The database can be rolled back to a prior version. Enabling smoother startups has never been easier.
The seamless integration of AMS Suite: Intelligent Device Manager with the DeltaV system enables your operations and maintenance teams to easily monitor field device health status. Plant personnel can then work together to resolve potential issues before they become costly problems.

Only Emerson’s technologies and the PlantWeb architecture are built to turn the wealth of intelligent field device diagnostic data into focused, actionable information. AMS Device Manager and DeltaV software help you move to a predictive maintenance environment by giving plant staff a window into the health of intelligent field devices.

Based on real-time diagnostics from intelligent field devices, your staff can respond quickly and make informed decisions to prevent unexpected downtime.

With AMS Device Manager, you can monitor status and alerts on drives, instruments, and valves, troubleshoot from the control room, perform advanced diagnostics, manage calibration, and automatically document activities with a single application.

**An easy-to-use interface**

A graphical interface makes diagnostic information easy to understand. The interface, powered by EDDL, provides compelling visualization to aid in troubleshooting and support decision-making. These diagnostics are based on human-centered design principles for fast, easy access. In addition, AMS Device Manager provides complete asset management capabilities for HART, FOUNDATION fieldbus, WirelessHART, and Profibus DP devices—a single user interface in an integrated operating environment.

**Increase plant availability**

Predictive maintenance using AMS Device Manager helps you avoid unplanned shutdowns and inefficient practices. Online access to device diagnostics allows you to continually monitor devices and to know immediately if there is a problem. SNAP-ON applications like AlertTrack can be used for email and cell phone notification of process upsets, often helping you to intercept problems before they cause major plant upsets.

**Predictive maintenance pre-empts unplanned downtime**

AMS Device Manager provides adaptability in many ways:

- Remotely access status and diagnostic information from connected devices to identify issues. Use AMS Device Manager to easily make configuration changes or replace a device.
- Automatically document device information including alerts, configuration changes, and calibration events using AMS Device Manager Audit Trail.
- Associate electronic drawings and notes with a particular device quickly and easily.

**Asset management improves safety**

Online access to critical asset information eliminates unnecessary trips to the field and reduces visits to hazardous locations. The DeltaV system passes status and diagnostics to AMS Device Manager, giving clear and specific descriptions of faults. When maintenance functions are performed, records are automatically produced and logged in the Audit Trail. The documentation step is done simultaneously and accurately to give a complete history of your device maintenance records, reducing maintenance costs over typical paper-based systems.

Asset Management allows you to operate with confidence.

**EDDL-based device screens apply a graphical indication of condition, as in this example showing device status and process variables as good.**
Integrated Machinery Monitoring

Fast, trouble-free integration delivers critical feedback on Machinery Health.

As turbomachinery and mechanical equipment deteriorate, performance decreases, throughput is reduced, and unplanned shutdowns are possible. When operators have visibility to the performance of these high stakes assets, they can make process adjustments and reduce process disruptions. Real-time integration of machinery information in the DeltaV system delivers actionable information to operations staff.

Eliminate complex and expensive integration

With most control systems, integration of machinery health information using MODBUS may require as many as 2400 steps for 24 vibration channels to complete the integration process—not to mention the discovery process to determine vibration and process automation systems are implemented.

Save hundreds of man-hours and gain a more complete, error-free integration of machinery information when you use the CSI 6500 Machinery Health Monitor with your DeltaV system. You will gain integrated prediction, protection, and performance monitoring that is pre-engineered with automatic sensor health and automatic synchronization of alarm limits in the DeltaV system.

Emerson’s technologies streamline integration in three easy steps: scan, configure, and import. From AMS Suite and the CSI 6500, asset parameters are scanned and then imported to the DeltaV system. The entire process is completed in 10 minutes.

Build operator graphics fast

Datasets and control modules are automatically configured in the DeltaV system. Function blocks are automatically created in control studio allowing custom rules for plant-specific abnormal situation scenarios. Machinery Health faceplate templates and dynamos are pre-built and ready for operator graphics. What once required custom programming is now a drag-and-drop process to quickly build a machinery health operator interface.

Out-of-the-box machinery health diagnostics for operators

After the integration process, simply launch DeltaV Operate and if any machinery health alarms occur, they are automatically displayed in the alarm banner. Built-in instrumentation alarms automatically sync alarm limits with Machinery Health systems so immediate action can be taken to prevent plant shutdowns.

The DeltaV system provides critical missing machinery health feedback to operators. Comprehensive protection, plant-wide prediction, and performance monitoring integrated with process control gives confidence that your mechanical equipment is truly operating reliably.
Ready access to continuous and event historical information from your process is critical to operating, analyzing, and optimizing your process. This collected information needs to extend beyond the control system boundaries down to the intelligent field devices, which are much closer to the process and have a higher resolution view of the process.

**Continuous Historian**

The Continuous Historian is a database designed for historical storage, retrieval, and integration into the DeltaV system, as well as open access from the system. It captures analog, discrete, and text data and stores it for future analysis.

As an Emerson Process Management product, the DeltaV Continuous Historian was designed to support the PlantWeb architecture and provide a data repository for the information available in intelligent field devices. The DeltaV Continuous Historian captures the value, timestamp, and status or validity of the information from these intelligent field devices. You can make better decisions with this high fidelity data.

Instead of being a layered application afterthought, the DeltaV Continuous Historian is embedded in the system and can easily scale from 250 to 30,000 historical items. Since it’s fully integrated with the DeltaV system, it’s easy to start collecting information and maintain it. No data mapping or non-value engineering is required.

DeltaV regulatory and advanced control applications including model predictive control and neural networks use the historical information and its associated status. For higher availability and robustness, these applications can automatically detect when the item status is not good, alerting the operator or application that data is suspect.

**Event Chronicle**

The Event Chronicle captures all system events, such as operator changes, control module installations, alarms, sequence of events and changes in device status. For each event, information such as who made a change and when the change occurred is recorded.

The DeltaV system is designed to capture data values and their associated time stamps at the lowest possible level in the system, providing you with a more accurate picture of the alarms and events as they occur. The Event Chronicle receives these time stamps and events and makes them available to the operator for easy viewing and troubleshooting.

Multiple Event Chronicles can be used in the DeltaV system to collect events from different plant areas or from the same plant areas for added data availability and robustness. Since the events are time stamped in the DeltaV controller, multiple Event Chronicles will always have consistent time stamps.

**Plantwide Event Historian**

Beyond the boundaries of your DeltaV system, the Plantwide Event Historian captures and displays event data such as alarms, operator actions, system events, and sequences of events from DeltaV and third-party automation systems throughout the entire plant.
History View Software Suite
The DeltaV History View Software Suite is the window into your operation’s continuous, event, and batch data. It provides easy access to real-time and historical trend monitoring—with seamless movement between the two. A single view integrates real-time and historical data, including continuous and event data.

Process engineers can more easily see how user changes have impacted the process through these views of real-time and historical data. Embedded historical trends are available in DeltaV Operate that enable operators to quickly scan the direction and magnitude of process changes before taking action.

Building a virtual sensor based on DeltaV Neural (neural network technology) or DeltaV Predict (model predictive control technology) requires a wealth of historical data to accurately build the models to address the expected operating regions of the process. With the history collection function embedded in the DeltaV system, this process is greatly simplified.

History Analysis
History Analysis is a web-based historian client application that allows you to view DeltaV historical data from any computer running Microsoft Internet Explorer—from anywhere in the world. History Analysis has access to DeltaV historical batch, continuous, and event data, and it integrates the DeltaV historical data in a single, easy-to-use client application. History Analysis also provides an intuitive data search engine to make it easy for users to find just the right data. Once the data is found and evaluated, you can save the data view or export the data for further analysis.

DeltaV Reporter
The DeltaV system comes with DeltaV Reporter—an Excel-based historical data reporting and analysis tool available on any workstation. Use DeltaV Reporter to populate a spreadsheet with historical process and event data. Once in the spreadsheet, use the power of Excel to view, analyze, and create reports on the data. DeltaV Reporter also enables you to easily add historical data collected from outside the DeltaV system, such as laboratory data. This historical data includes status information, is saved in the historical database, and is available for viewing and reporting with the rest of the continuous data.

Historical data anywhere
With the DeltaV OPC History Server, OPC Event Server, OPC Express Interface (OPC Xi) and History Web Service you can extend the wealth of historical data to other data historians such as OSIsoft’s PI and web service-based client applications. Using these industry standard interfaces, the DeltaV system can deliver information to other systems, applications or users on the plant local area network or across the Internet. Through an intuitive web browser-based client, powerful local history clients and easy-to-use and secure historical data interfaces, the DeltaV system enables your experts to quickly identify optimization opportunities or issues to resolve.
The DeltaV system architecture is based on the ISA88 Batch Standard. Whether it is the physical model, procedural model, or easy-to-use class-based configuration—the DeltaV system is “built-for-batch.”

Like the rest of the DeltaV system, DeltaV Batch fully supports compliance with the FDA’s 21 CFR Part 11 requirements with recipe and campaign management, batch history, automatic version control and change management, and electronic signature support.

**DeltaV Batch** is a complete suite of products supporting all components of the ISA88 Control Activity Model. All batch control logic for a unit, including phases, is executed in the DeltaV controllers.

**The Batch Executive** is the batch engine which coordinates all batch processing activity, creates detailed batch history records and schedules recipes and resources.

**Recipe Studio** is a powerful yet simple-to-use application for graphically configuring recipes and formulas for successful batch production.

**The Campaign Manager** creates and manages campaigns by specifying the recipe, formula, equipment, and number of batches that are to be run within the campaign. A web service enables external applications to programatically interact with the Campaign Manager.

The **Batch Historian** automatically collects and displays recipe execution data from the DeltaV Batch Executive and process management event data from the DeltaV Event Chronicle. The new History Analysis application enables web-based access to recipe event and continuous historian information for anyone, anywhere.

**Recipe Exchange** provides an open, programmatic interface to the DeltaV recipe management system. Recipe Exchange is based on an XML schema that provides the ability to use web services to import and export DeltaV recipes.

**Easier batch operations** DeltaV Batch includes process cells, unit modules, phases, equipment modules and control modules. From recipe scheduling to device control to advanced control; from simple sequencing to multi-stream formulations, the DeltaV system makes your batch operations easy.

DeltaV Batch is inherently integrated with the DeltaV system. The same intuitive, drag-and-drop user interface makes it easy to configure your recipes. Data is entered once into a common global database—no data mapping is needed. In DeltaV Operate, your operators have easy access to all batch information in a single, integrated environment. And batch records are automatically collected for easy regulatory compliance.

DeltaV Batch provides batch standard compliance out of the box because the ISA88 batch hierarchy is built into the DeltaV system.
When used with Emerson’s Syncade Smart Operations Management suite, DeltaV Batch offers a comprehensive operations management solution to optimize work processes plant-wide.

**Reliability is built in**
Every batch is run as a separate process in the Batch Executive. A batch failure is isolated from impacting other batches.

DeltaV Batch provides redundancy at all levels of execution—reducing process shutdowns and eliminating risk of lost batches. Online upgrades are supported for systems with redundancy, thus minimizing the impact on production, and making it easy to stay current with the latest technology available.

Redundancy is available for the DeltaV controller, Batch Executive, and Campaign Manager, providing robustness for unit, process, and recipe execution.

**Flexibility for agile manufacturing**
During recipe execution, DeltaV Batch provides flexibility for agile manufacturing to meet real-time demands and captures comprehensive records for regulatory compliance. Class-based configuration and recipe management deliver repeatability.

DeltaV Batch enables recipe changes and equipment selections on-the-fly. Support for dynamic unit selection, automatic unit selection, unit aliasing, and equipment trains delivers:
- better support for flexible manufacturing
- improved process equipment failure handling
- reduced risk of equipment selection errors.

**Know when, where and why changes are made**
To meet your regulatory compliance requirements, the DeltaV system integrates change management into your process automation. This Configuration Audit Trail provides a complete version-to-version comparison, including not only what changed, but who made the change, when, where and why.

DeltaV function-based security provides you control over who can perform Batch tasks in the system. Examples include restricting operator access to batch abort commands and starting/stopping batches and recipes.

DeltaV Batch incorporates electronic signatures into your batch processing to support regulatory compliance requirements, including FDA 21 CFR Part 11. Any and all actions taken can be configured to require a confirm mechanism. A user’s name and password, along with a verifying user’s name and password, if required, are needed to execute the action.

A large life science manufacturer needs to expand an existing facility to meet the urgent demand for a vaccine. By adding onto the existing DeltaV system the reusable, standards-based software modules of DeltaV Batch, the engineers can easily configure the added equipment—saving precious time. Additionally, complete redundancy of the system, from control to recipe level, gives the manufacturer a robust system that will not cause process shutdowns. End result: Faster product to market; more lives saved.

An integrated engineering and operations environment makes it easy to control your batch processes.
The seamless integration of Syncade suite with the DeltaV system provides a comprehensive operations management solution that optimizes across plant-wide work processes and increases productivity.

By using the latest technology and adhering to industry standards, Syncade Smart Operations Management suite provides a modular, manufacturing IT solution to increase manufacturing performance by managing resources, optimizing operations, integrating information and simplifying regulatory compliance.

**Resource Management reduces variability**
Syncade suite helps you effectively manage resources and allows you to do more with less. By scheduling and tracking equipment usage, Syncade suite can increase manufacturing capacity. It can reduce waste and rework by optimizing material usage and eliminating the use of outdated material. Syncade suite replaces paper equipment records with electronic logbooks by guiding operators through manual processes and enabling easy access to support documents—resulting in improved productivity. Additionally, personnel training and qualifications can be verified real-time to ensure proper authorization.

**Optimized Operations improves efficiency**
Syncade suite manages workflow across plant functions to assure “right-first-time” production. Coordinating manual and automated processes enables your plant personnel to make the most of their time. Syncade suite provides a single recipe / workflow that adheres to ISA88 / ISA95 standards—reducing engineering efforts by enabling modular, reusable software libraries. Forced sequencing or work instructions that guide the operator and provide access to reference documentation (such as SOPs and MSDS) can eliminate errors and ensure that accurate data is collected and omissions flagged during production.

Recipe Authoring provides a quick way to create integrated orders and recipes—using standardized libraries, modular building block construction and drag-and-drop design tools.
Integrated information supports better decisions

Many manufacturing facilities use numerous systems that don’t often communicate with each other, resulting in an inefficient use of time and resources.

Syncade suite enables easy communication between business and manufacturing systems. It helps improve productivity by enabling interdependent activities to be effectively synchronized while eliminating duplicate efforts or manual data entry. By validating data and putting it in relative context for consumption by users and other applications, Syncade suite creates the information for collaboration and improved decision-making. Syncade suite can automatically create manufacturing orders with automated downloads from the enterprise resource planning (ERP) system. Using Syncade suite as a single engine tool to gather all your data needs from the manufacturing process, you can streamline your process and improve productivity.

Syncade suite is easy to use, integrate and maintain because it’s built on industry standard OPC and .NET-based web services. Syncade suite synchronizes your key business and plant floor systems for total knowledge management.

Quality and Compliance simplifies document management and reduces errors

Efficiently managing documents saves time and money. Documentation is a necessity of effective operations and includes many types of documents. These documents support a wide array of audiences, such as operations, maintenance, and quality, and convey various types of information, such as production records, SOPs, order forms, and lab reports. The development, change management, and approval of documentation can be inefficient and time consuming.

Syncade suite provides comprehensive document management including online storage, change control, review and approval routing, version management, and archiving. In addition, user groups and privileges provide security to ensure proper access and authorization.

Larry is pulling his hair out. After the batch is complete and records are collected, it becomes obvious that data is missing from the batch record. If only operations became aware of this omission before the batch progressed to the next step!

Syncade suite enables comprehensive production records to be generated in real-time—flagging omissions or inaccurate data during processing, as well as enabling review by exception. This functionality speeds batch release time and improves manufacturing performance.
At the heart of your production process is your process automation system. Its ability to easily connect up, down, and sideways with other systems and applications is critical for providing an information-sharing, collaborative environment. The DeltaV system provides many data integration options with its open, interoperable standards-based technologies such as serial, OPC, OPC Xi, high-speed Ethernet, SQL, XML and web services.

### Ethernet and serial device connectivity

Simplifying integration with your plant subsystems, the DeltaV Ethernet I/O card (E/OC) connects through Ethernet using Modbus TCP and Ethernet/IP protocols. With redundancy, this external data can be robustly integrated into your control strategies. Making integration easy, Ethernet device configuration may be bulk loaded into DeltaV control strategies to reduce engineering efforts.

Serial communications using MODBUS RTU/ASCII protocols also makes integration with other systems easy, by connecting your legacy DCSs and PLCs to the DeltaV system.

#### OPC and OPC Xi

Open and interoperable OPC communications have served the process industries well for over a decade as a way to connect servers of data with a multitude of valuable clients. This standard supports real-time and historical data access as well as alarm/event data access. Cyber-security concerns and increased use of firewalls around the automation system’s perimeter have created problems with network distributed OPC communications—until now.

OPC Express Interface (OPC Xi) is a new data communications interface developed by many diverse, process automation suppliers to meet customer needs for a secure, reliable and standard way to exchange data between the automation system and the enterprise. OPC Xi connectivity provides secure, robust, firewall-friendly data access to real-time and historical process data as well as real-time alarm and event data. To ease migration to OPC Xi from current OPC systems, OPC Xi can directly interface to existing OPC Data Access, OPC Historical Data Access and OPC Alarms & Events clients and servers to deliver a secure data communication path even on legacy systems. In addition, OPC Xi provides process manufacturers a migration path to the OPC Unified Architecture (UA) as needed. OPC Xi is based on Windows Communication Foundation (WCF), the latest communications technology from Microsoft, enabling both fast and efficient data communications between Windows-based clients and servers and secure and reliable streamlining collaboration for greater production efficiency.

Your EPC is using Intergraph’s SmartPlant Instrumentation (SPI) software to design your large projects. This software enables the instrumentation and wiring database to drive the physical layout of control system I/O and cabinetry. In the past you have been able to import the I/O configuration from the SPI tool, automatically configuring your DCS with the same I/O layout. This eliminates a lot of duplicate engineering effort. However, without bi-directional communication, any changes made to the I/O design on the DCS side cannot be re-incorporated into the SPI database without manual effort.

Synchronizing the configuration after changes are made to the DCS configuration means that two tasks must be performed, one in each system, likely by two different people. This creates significant coordination costs and often results is quality problems when errors are made or changes are lost.

Now with DeltaV XML-based bi-directional SPI-integration, data exchange and synchronization in both directions is accomplished with only a few clicks of the mouse. You can enter it once and be done. It’s that easy!
data communications through firewalls and to non-Windows systems.

OPC Xi also facilitates the development of visually stunning client applications using Windows Presentation Foundation (WPF), Microsoft’s next generation user-interface development platform.

**SQL**

Connecting upwards with transactional, planning-based systems often requires SQL database connectivity. DeltaV alarms, events, and batch history data are stored in an SQL-server database and available to applications like operations management systems, enterprise planning systems and other decision support systems requiring access to information from the process.

This well-known, well-proven, easily-adaptable standard supports the data requirements for your workflow processes.

**Web Services**

Many process manufacturers want to integrate their control and business systems to more efficiently run their organization, but existing solutions may not be flexible or secure enough to meet the demands of these systems. Service Oriented Architecture (SOA) provides a way to address these requirements. It’s a standards-based design approach to create an integrated IT infrastructure and agile, loosely coupled dynamic applications capable of rapidly responding to changing business needs.

Web services use specific standards and language protocols to execute an SOA approach. The DeltaV system provides an SOA approach to Level 3 and Level 4 data integration with DeltaV Web Services for batch recipe creation and batch execution scheduling data. The DeltaV SOA Gateway with DeltaV Web Services provides a highly-secure, authenticated means of communications between the DeltaV system and plant planning and execution applications.

---

The DeltaV OPC Xi interface provides a secure, firewall-friendly data communications path between the DeltaV system and the enterprise.
Built for Purpose

*Designed for ease-of-use in your most demanding applications.*

Over the last ten years, commercial off-the-shelf (COTS) technologies have provided tremendous increases in functionality and cost advantages to end-users of today’s automation systems. The DeltaV system was the first of this kind and continues to provide open proven products to its user base.

However, while COTS has provided many advantages, it has also come with a price—increased administration and life-cycle costs requirements. A better approach is to take advantage of the cost benefits and open standards of COTS, but to add on top of this functionality that allows the equipment to function much more like other parts of the system (plug-and-play capability, full life-cycle support without upgrades, security built in, etc.) We call this balance “Built for Purpose”, and the DeltaV system is the first automation system to address this critical need in many of the most important facets of the system.

**Built for security**

To help you address challenges created by using COTS, security is integrated throughout the DeltaV system architecture. Ethernet network switches and security devices are treated as DeltaV devices and are fully preconfigured for purpose. Alerts and diagnostics from these devices are integrated with other maintenance alerts so your maintenance staff, not your IT staff, can quickly address any issues. AMS Device Manager integrates with the DeltaV software to provide common security and confidence in the operation of your field assets.

DeltaV Smart Switches come completely preconfigured to plug and play in the DeltaV network with no additional configuration or troubleshooting required. To prevent physical intrusion on the control network, you can automatically lock down unused switch ports with a single mouse click.

A perimeter firewall protects your control system from security risks from outside the control network. On your control network, DeltaV controller firewalls further protect your control hardware.

Security extends up to the enterprise applications through Xi and web services providing two-way, authenticated communications for historical process data control, and advanced control data, alarms and events, and batch-based information. Unlike other automation systems, the data includes status information from the intelligent field devices. Instead of wondering if critical business decision-making information coming from the automation system is accurate—the quality of the data comes along with the data.

**Built for humans**

DeltaV engineering applications organize the functions in ribbon bars, which consolidate functions by logical task and are fully customizable. Productivity enhancing tooltips and fast keys streamline your configuration efforts. Because time is precious, this technology helps focus process engineers on high-value activities like control strategy improvements instead of keyboard data entry.

The DeltaV system has led the way in easy-to-use engineering applications to simplify project execution and ongoing maintenance. Whether your application is continuous, batch, or process safety-related, this common set of engineering applications provides the simplicity and flexibility for your most demanding applications.
The DeltaV system built for process control
The DeltaV system enables you to quickly deploy state-of-the-art intelligent control to improve your process plant performance, without the aid of costly outside experts. DeltaV hardware components are plug-and-play. You plug them in and they are auto-sensed and recognized by the system. Software configuration is drag-and-drop, with automatic process control functionality delivered out of the box. With the DeltaV system, you install your system hardware, connect everything together, configure the logic and everything works—easy!

Built for busses
The DeltaV digital automation system is the only system built from the ground up to unleash the advantages of digital fieldbus communications. Not an add-on, not an afterthought, it’s built to deliver the project and operational savings of a digital plant—easy!

Built for batch
The DeltaV system provides an architecture that is based on the ISA 88 batch standard. Whether it is the physical model, procedural model, or easy-to-use class-based configuration, the DeltaV system is “Built for batch”—easy!

Once a control system is up and running, you want to avoid making changes as much as possible—especially in cases where a change might have unknown consequences. Your company’s IT department has mandated that all “SwitchCo” network devices must be managed by them even though some reside on your control network. However, they don’t understand the difference between a business network and a control network. The IT department updates the network firmware on a Friday evening, at the same time that they do it for the business network so that office workers are not affected. Unfortunately, this causes loss of communications and your plant shuts down. Who gets the call in the middle of the night? How do you troubleshoot the problem? Who can you reach in IT for support?
Day after day, year after year, Emerson’s industry experts have been helping businesses like yours with an array of solutions and services that range from improving project and implementation costs to helping plants increase process availability and productivity while reducing overall cost of ownership.

Consultants use the Independent Project Analysis (IPA) model and provide services value throughout each phase.

**Consulting Services**
Emerson provides a wide range of consulting services to help you perform operational analysis, quantify benefits, evaluate potential investments, develop business cases, and define specific project requirements from which a project budget and execution plan can be developed.

Consulting services are provided by a team of senior consultants with a track record of solving high-stakes problems across all process industries including chemical, life sciences, oil & gas, and refining.

**Project Services**
Emerson project services span a wide range of commercial and contracting strategies including:
- Front End Engineering and Design (FEED)
- Hot Cutover
- Process Skid and Modular Structures
- Project Management
- Safety Instrumented Services Engineering and Design
- Main Automation Contractor (MAC)
- Detailed Engineering and Design.

Services vary in scope and size from basic consulting to complete turnkey responsibility for projects of any size. The leadership from Emerson’s project management office drives best practices, improvement, service excellence and consistency around the world. Emerson can help reduce project risk, lower project cost, shorten your overall project schedule and allow your plant to start up faster.

**Data Management Services**
Accessing real-time plant floor information and the connectivity between your manufacturing and operations management systems can have significant impact on your profitability. Emerson’s IT experts provide integrated enterprise architecture, engineering, production and asset data management solutions that will optimize your business operation, including:
- Data integration and system connectivity
- Data management consulting services
- Network infrastructure and security solutions
- Software system implementation.
Modernization and Migration Services
Emerson provides application, platform and technology savvy experts to address specific needs at the appropriate stages of modernization projects. These experts help ensure success in achieving your process and business objectives through applied automation—taking the risk out of modernizing.

SureService
The SureService™ program from Emerson Process Management offers an array of support services designed to help you achieve your business objectives, reduce or contain your operating and service costs, and keep your systems running at peak performance. It’s a partnership with a company that knows your business and can help you operate your plant safely, reliably, and more efficiently.

Guardian Support is the core element of the SureService support program. The Guardian service module is designed to help you proactively achieve peak availability, sustainability and performance on your system investment through critical service and support information. Guardian consolidates and securely delivers personalized, real-time service intelligence tailored specifically to your system architecture, assets and use. Guardian provides a single-point source of critical services and system information to help you effectively manage your DeltaV digital automation system throughout its life cycle. To view the entire SureService portfolio, visit: www.SureService.com

Educational Services
With over 65 years of training experience and an extensive network of 50 certified training centers, Emerson Educational Services is committed to providing quality customer training, when and where you need it. Each year nearly 24,000 individuals attend courses at one of several regional training centers, or participate in classes tailored to their particular needs conducted locally or at their plant. Visit www.EmersonProcess.com/education to view the catalog of available courses.
SteamScrubber Dishwasher -- 6921-09A

Product Details

Product Overview

Labconco laboratory glassware washers have specialized features to meet the laboratory's demand for superior cleaning and convenience. SteamScrubber Glassware Washers have top and bottom racks that accommodate accessory inserts for a wide variety of glassware shapes and sizes, primarily beakers and other wide-mouth glassware. FlaskScrubber Glassware Washers have a spindle rack that holds up to 36 pieces of primarily narrow-neck glassware such as volumetric flasks. All racks are interchangeable among washers.

- LED displays program selected or details of the program.
- Flexible cycle options allow you to change wash and dry cycle duration and number of rinses.
- Upper and lower rotating wash arms with adjustable height center tower distribute up to 60 gallons (227 liters) of water per minute.
- Tower adjusts to accommodate various glassware heights.
- Built-in forced air drying system.
- Dual heaters boost water and glassware temperatures: With minimum inlet temperature of 120° F (49° C), the sump heater elevates water temperature approximately 20° F (11° C).
- Dry or liquid detergent dispenser.

Specifications

<table>
<thead>
<tr>
<th>Specification</th>
<th>Value</th>
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<tbody>
<tr>
<td>Product Category</td>
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<td>Configuration</td>
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<td>Heating</td>
<td>Steam</td>
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<tr>
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<td>Height</td>
<td>34.1 inch (866 mm)</td>
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<td>Features</td>
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<td>User Interface</td>
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<td>Display</td>
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For more information:

More Info on Supplier Site | Email Supplier | Request a Quote
### Your Order Management Team

<table>
<thead>
<tr>
<th>Order Manager</th>
<th>Partner</th>
<th>Sales Manager</th>
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<tbody>
<tr>
<td>Mars Yalkut, BS EE, MBA</td>
<td>Miriam Valdez, Prod Specialist</td>
<td>Rod Behnia, BS, MS EE</td>
</tr>
<tr>
<td>714-578-6107</td>
<td>714-578-6109</td>
<td>714-578-6108</td>
</tr>
<tr>
<td><a href="mailto:Mars@TerraUniversal.com">Mars@TerraUniversal.com</a></td>
<td><a href="mailto:Miriam@TerraUniversal.com">Miriam@TerraUniversal.com</a></td>
<td><a href="mailto:Rod@TerraUniversal.com">Rod@TerraUniversal.com</a></td>
</tr>
<tr>
<td>Fax: 714-578-3107</td>
<td>Fax: 714-578-3109</td>
<td>Fax: 714-578-3108</td>
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### Local Sales & Support Representative

TUI Direct Support

- **Trans ID**: 142346
- **TUI Ref #**: 142346

### Requested By:

- **Email**: muncan.adam@gmail.com
- **Phone**: 215-898-1150

### End User:

- **Accounting Department**
  - **University Of Pennsylvania - Accts Payable**
  - **Room 440 Franklin Building**
  - **3451 Walnut Street**
  - **Philadelphia, PA 19104-6281**
  - **Tel**: 215-898-1150
  - **Fax**: 215-898-1150

### Quote Summary

- **Invoice To**: Accounting Department
- **Client #**: 89021

- **Products & Services Total**: $7,039.00

### Tracking

- **Trans ID**: 142346
- **TUI Ref #**: 142346
- **Quote #**: 142346

### Critical Notes

- **Voltage**: 240

- **Products built or bought for you, especially "custom" items marked with *, are not returnable. ALL shipping and lead time estimates are only estimates and are NOT guaranteed (see Term 3).**

### Terms of Sale:

- **1. Payment terms are as given above. A Late Charge is invoiced on product and service invoices unpaid 15 days after their due dates. The late charge must be paid to retain open account status. The Late Charge is 10% of the products and services invoiced or the discount granted, if any, on these items, whichever is greater. Invoice due date is based on date shipped. 2. This order has been accepted with the understanding that the "Ship To" address and location provided are the final destination of these products for purposes of Department of Commerce regulations and that you will notify Terra if these change.**

- **3. All Estimated Ship Dates, including confirmed ES&Ds, are estimates, depend on workloads when the order is ready for manufacturing release and are NOT guaranteed. 4. Except when specified "F.O.B Destination" in Shipping Terms, above, orders accepted by Terra are FOB Ex-Works. FOB Ex-Works means that risk of loss passes to you when the goods are loaded on the truck and you must file claims for freight damage directly with the freight carrier. If you order freight charges "prepaid and add," freight cost plus a handling charge computed under Terra's standard policy is added to each shipment. These costs may be avoided by ordering "freight collect" and FOB Ex-Works. To reduce costs and speed delivery, it may be necessary to ship from different factories and in different shipments. These are not "partial shipments." 5. Orders accepted, released and processed by Terra cannot be cancelled or returned except on terms that compensate Terra for work performed and expenses incurred. Custom items, items not purchased from Terra, and items modified or damaged by improper use, repairs, application of labels or nameplates are not returnable. 6. All returns must be approved by Terra in writing in advance and may be assessed restock and handling charges. No returns will be accepted without an RMA. **

- **7. Terra's warranty is as shown on TerraUniversal.com. This order may not be assigned without Terra's written approval. 8. If Terra files any proceeding to enforces the terms of this order or to collect any amount due, you agree to pay all reasonable attorney's fees and costs.**

### Detailed List Of Products And Services, Specifications And Cost Follows

<table>
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<tr>
<th>Tracking</th>
<th>Products &amp; Services List</th>
<th>Products &amp; Services Total*</th>
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</thead>
<tbody>
<tr>
<td>(Out of State)</td>
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<td>$7,039.00</td>
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**Pay to Terra Universal, Inc.**

- **800 S. Raymond Ave., Fullerton, CA 92831**
- **Tel**: 714-578-6000
- **Fax**: 714-578-6020
### Order Manager
Mars Yalkut, BS EE, MBA

### Partner
Miriam Valdez, Prod Specialist

### Sales Manager
Rod Behnia, BS, MS EE

**Estimated Lead Time**
4 - 5 weeks

### Local Rep:
TUI Direct Support

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<th>Of Count</th>
<th>Unit</th>
<th>Unit Price</th>
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<td>6921-09A</td>
<td>SteamScrubber; Undercounter, 24.1&quot;W x 27.4&quot;D x 34.1&quot;H, 230V</td>
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<td>Voltage requirements: 208/240V, 50/60 HZ, 12 amps</td>
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<td>Maximum Internal Water Temperature: 93°C/199°F</td>
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<td>Includes: 3/8” (10 mm) female NPT inlet valve for hot tap water.</td>
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<td>Ten factory-set cycle programs.</td>
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<td>Built-in forced air drying up to 99 minutes and programmable from 38-70°C (100-158°F)</td>
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<td>Includes detergent dispenser to hold powder or liquid and separate rinse aid solution dispenser.</td>
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<td>Includes steam generator and purified water pump.</td>
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| 2 | 9998-FasTrak   | Fast Trak Expediting | 0   | EA    | | | $0.00 | No | $0.00 T |

**Fast Trak Expediting**
- On a tight schedule? You may choose Terra's Fast Trak Expediting to help meet your critical schedule for Terra-manufactured products.
- FAST TRAK 24/7 provides a higher level of service: a 24/7 commitment to meet the shipping date YOU specify, regardless of quoted lead times. Fast Trak 24/7 assigns a dedicated production team plus a dedicated senior expeditor working three shifts to meet your delivery specification. Fast Trak 24/7 guarantees to meet the agreed-to specified ship date.
- Call for pricing for Fast Trak 24/7 expediting to meet your production schedule. (Fast Trak service fees cover costs of additional services only, without additional profit.)
- This line item only explains the service -- to order Fast Trak service, ask your Sales Associate to include the Fast Trak 24/7 line item and fee.

*Terra's Fast Trak expediting limited guarantee is to ship on or before the ESD or date specified or to refund up to 200% of Fast Trak charges on the client's approved request. This guarantee does NOT cover direct, special, consequential or other damages and is strictly limited to up to 200% of the amount paid for Fast Trak service.*
Terra's REAL-TIME ORDER TRACKER displays progress on each manufactured item in Terra's shops, even before they ship. After your order is released to manufacturing, click "Order Status" any time, day or night. As items ship, the display includes full freight tracking information.

Terra's PRODUCT CATALOGUES present more information quickly. View thousands of products in minutes on line or download for off-line reference at:

http://www.terrauniversal.com/catalogs.php

Terra provides full, live engineering and technical specialist support 12 hours each working day.
Thermo Scientific™ CryoPlus™ Storage Systems

Low-profile storage tanks combine liquid nitrogen storage reliability with microprocessor technology

Sixteen preset audible and visual alarm combinations provide maximum product protection. Automatic defogger is incorporated into the manual fill index to improve visibility during retrieval.

**Microprocessor Control**
- Precise liquid level control with over 16 parameters; with autofill system
- Control panel is mounted on top for convenient access and easy touchpad programming
- Digital temperature display sensor is located under the lid; this indicates the highest temperature reading inside the tank
- 24 tricolor LEDs continuously display actual liquid nitrogen level and high-level/low-level setpoints
- Alarm contacts for remote monitoring of storage tank conditions

**Durable Construction**
- Low-profile tank with vacuum-insulated, stainless-steel chamber Counterbalanced lid with foamed-in-place, high density polyurethane insulation; dedicated vent; 100% clearance
- Two independent, flexible lid gaskets reduce moisture migration into the chamber
- Liquid level sensor and fill port within vacuum space, for maximum storage and sensor protection
- Front-mounted key lock and rear-mounted recessed power switch; control panel can also be locked
- Temperature sleeve (included) provides colder temperatures and efficient vapor phase operation
- Heavy-duty casters

**Specifications & Ordering Information:**
Optional racks, canisters, frames and risers allow you to create an organized inventory system that provides optimum storage in liquid or vapor phase. Contact your Customer Service Representative for details.

**Compliance:** UL listed to U.S. and Canadian requirements; CE marked

**Specifications**

<table>
<thead>
<tr>
<th>Specifications</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Color</td>
<td>White</td>
</tr>
<tr>
<td>Body</td>
<td>18-gauge cold-rolled steel with powder-coated paint</td>
</tr>
<tr>
<td>Reservoir</td>
<td>Stainless steel</td>
</tr>
<tr>
<td>With Level Monitor</td>
<td>Yes</td>
</tr>
<tr>
<td>With Autofill</td>
<td>Yes</td>
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</tbody>
</table>

† Add 5 in. (12.7cm) to length for utilities and lid opening.

**LN₂ Capacity**

<table>
<thead>
<tr>
<th>LN₂ Capacity</th>
<th>Rack/Vial Capacity</th>
<th>Reservoir D x Dia.</th>
<th>Static Evaporation Rate</th>
<th>Static Holding Time</th>
<th>Exterior L x W x H</th>
<th>Electrical Requirements</th>
<th>Mfr. No.</th>
<th>Cat. No.</th>
<th>Availability</th>
<th>Quantity</th>
<th>Price</th>
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</thead>
<tbody>
<tr>
<td>23.8 gal. (90L)</td>
<td>5500 to 6318</td>
<td>27.5 x 16 in.</td>
<td>3L/day</td>
<td>30 days</td>
<td>26 x 21.5 x 41 in. (66 x 96 x 104 cm)</td>
<td>200/230V 50/60Hz</td>
<td>TF7401</td>
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<td>N/A</td>
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<td>LN2 Capacity</td>
<td>Rack/Vial Capacity</td>
<td>Reservoir D x Dia.</td>
<td>Static Evaporation Rate</td>
<td>Static Holding Time</td>
<td>Exterior L x W x H</td>
<td>Electrical Requirements</td>
<td>Mfr. No.</td>
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</tr>
<tr>
<td>--------------</td>
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<tr>
<td>23.8 gal. (90L)</td>
<td>5500 to 6318</td>
<td>27.5 x 16 in. (69.9 x 40.6cm)</td>
<td>3L/day</td>
<td>30 days</td>
<td>26 x 21.5 x 41 in. (66 x 54.6 x 104.1cm)</td>
<td>200/230V 50/60Hz</td>
<td>7401</td>
<td>TF7401</td>
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<td>$9,781.00</td>
</tr>
<tr>
<td>52.8 gal. (200L)</td>
<td>13,000</td>
<td>27.5 x 24 in. (69.9 x 61cm)</td>
<td>5L/day</td>
<td>40 days</td>
<td>34 x 28.5 x 41 in. (86.4 x 72.4 x 104.1cm)</td>
<td>200/230V 50/60Hz</td>
<td>7403</td>
<td>TF7402</td>
<td>N/A</td>
<td>N/A</td>
<td>Each for $9,781.00</td>
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<tr>
<td>89.8 gal. (340L)</td>
<td>22,100 to 24,000</td>
<td>27.5 x 31 in. (69.9 x 78.7cm)</td>
<td>8L/day</td>
<td>42.5 days</td>
<td>41.5 x 34.5 x 41 in. (105.4 x 87.6 x 104.1cm)</td>
<td>200/230V 50/60Hz</td>
<td>7405</td>
<td>TF7405</td>
<td>N/A</td>
<td>N/A</td>
<td>Each for $13,022.91</td>
</tr>
<tr>
<td>145.8 gal. (552L)</td>
<td>36,400 to 38,500</td>
<td>27.5 x 39.5 in. (69.9 x 100.3cm)</td>
<td>10L/day</td>
<td>55 days</td>
<td>50 x 43.5 x 47 in. (127 x 110.5 x 119.4cm)</td>
<td>200/230V 50/60Hz</td>
<td>7407</td>
<td>TF7407</td>
<td>N/A</td>
<td>N/A</td>
<td>Each for $24,887.48</td>
</tr>
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<td>Each for $24,887.48</td>
</tr>
</tbody>
</table>
Hamilton Scientific™ SafeAire™ II Fume Hood Assemblies

**Includes:**
- Vent kit
- Fillers
- Work surface with vent and cupsink cutout
- Cupsink
- Water service fixture
- Air service fixture
- Gas service fixture
- Vacuum service fixture
- Molding
- Corners
- Asymmetrical exhaust duct
- Blower sized for system
- Constant volume/bypass fume hood superstructure on one or two fume hood base cabinets
- Exhaust volumes from 760 to 1710 cfm, depending on hood size

- [View Specifications](#)

---

(2 item(s) in product Group)

**Items** | **Specifications**
--- | ---

**Catalog No.** | **Description** | **Price per Unit** | **Quantity & Availability**
--- | --- | --- | ---
HMLAB025 | One acid storage base cabinet | Each for $12,937.45 | [Check Availability](#)
Hamilton Scientific No.: HMLAB025

HMLAB027 | One Fume hood base cabinet; 1 Acid storage cabinet | Each for $27,565.94 | [Check Availability](#)
Hamilton Scientific No.: HMLAB027
Purified Water Generation

IPEC Purified Water Generation Systems are designed to meet and exceed industry standards for USP-grade water. Our automated systems are available with a range of output capacities and can be fabricated standard or with custom additions to help meet aggressive project schedules.

The use of reverse osmosis, continuous electrodeionization and other practices provide our customers with dependable, low maintenance solutions for water purification. System design and pretreatment components are configured based upon the specific quality and properties of the feedwater.

Modular designs, with optional add-on features are pre-engineered to minimize the package footprint, utility requirements, and installation efforts. Pre-validation via Factory Acceptance Testing (FAT) further minimizes the time required for commissioning at the customer's facility.

Generation of high purity water requires experienced engineering because of variability in feedwater characteristics. IPEC's robust design, precision fabrication and ability to incorporate additional treatment options allow our customers to confidently produce purified water meeting stringent quality requirements.
Benefits Through Investment In IPEC Purified Water Generation

When you purchase an IPEC Purified Water Generation System, be assured that the highest quality engineering, components, and fabrication methods are employed to deliver a product that exceeds your requirements. Start to finish, we will guide you through every step of the process.

Feedwater Analysis

Every system built is custom configured for the specific feedwater quality and temperature at your facility. Upon request, IPEC will send prospective customers a test kit with instructions for sample collection and pre-paid return postage to our lab for a full analysis.

Standard Features

IPEC Purified Water Generation Systems include the following standard features:

- Feedwater Pre-Filtration
- Water Softening
- Carbon Filtration
- 5 μm Filtration
- Stainless Steel Feedwater Break Tank
- Reverse Osmosis (RO)
- Continuous Electrodeionization (CEDI)
- Industrial PLC w/ Touch-Screen Interface
- FRP Softener, Filter, & RO Housings
- Sanitary Stainless Steel Tubing (Post RO)
- Stainless Steel Framing & Control Enclosures
- Single-Point Utility Connections
- Chemical Sanitization/CIP ports
- Complete Documentation Package

Optional Features

The following optional features are available as required to meet water quality specifications:

- Multi Media Pre-Filtration
- Feedwater Heater
- Ultraviolet (UV) Disinfection
- Hardness/Chlorine Monitoring
- pH Adjustment
- Degassing Membrane(s)
- Final Filtration or Ultrafiltration
- TOC Monitoring
- Hot Water Sanitization
- All Stainless Construction
- All Plastic Construction (PVC, PP, PVDF)
- 21 CFR Part 11 Compliant Data Collection
- Seismic Design/Certification

Experienced Integration

IPEC has extensive experience providing systems for filtration, chromatography, sterilization, and other critical process and utility functions. Our expertise has positioned IPEC as an industry leader in modular system design, fabrication and documentation. The same procedures and quality standards are leveraged for each Purified Water System we build.

Thoughtful Design

IPEC takes pride in every aspect of process system design. Each layout is carefully reviewed against your floor plan to ensure accessibility during operation and maintenance. Sample valves with drain funnels are located after every treatment device to allow comprehensive quality monitoring. Our automation platform provides flexible scheduling of maintenance routines like hot water sanitization or carbon filter back washing with warnings and alarms for components approaching the need for routine maintenance. We rely on early and frequent communication with the customer to incorporate any special design considerations into the final product.

www.ipec-inc.com/water  sales@ipec-inc.com  920.568.0475
Efficiency in Technology

IPEC system components are selected from suppliers that offer innovative technologies to improve system efficiency and reduce maintenance. IPEC works with our vendors to identify and provide the best in value and cutting edge technology for the benefit of our customers. This includes features like softener brine reclamation which can save up to 30% in yearly salt costs and adjustable RO concentrate recycling/blending which can prevent thousands of gallons per year from being sent to drain.

Adaptive Design

IPEC Purified Water Systems include accommodations for the addition of many standard options, even if requested after the skid has been in service for some time. Our designs allow for retrofit additions via spool pieces or capped ports, should it be determined that certain features like degassing, UV lamps, or TOC monitoring are needed post-installation.

A Complete Solution

IPEC also provides Purified Water and WFI Storage and Distribution Systems that become the backbone of your facility’s water utility. Our dependable systems are configured with storage volumes and distribution rates designed to match the demands of your facility. You can rely on our industry experience to help guide and assist you with selection of the most appropriate instrumentation, sanitization and automation options.

Available Features include:
- Duplex Supply Pumps
- Loop Flow/Back Pressure Control
- UV Disinfection
- Heating/Cooling Exchangers
- Conductivity Monitoring
- TOC Monitoring
- Ozone Systems
- Hot Water Sanitization
- Sampling Equipment
- Point-Of-Use Equipment
Our commitment to the customer does not end after delivery of your system. IPEC offers the following additional services:

- Installation Support & Start-Up Assistance
- Training & Technical Support
- Qualification Protocol Development
- Sampling Protocol Development
- Corrective Action Program Development
- Spare/Replacement Parts
- Scheduled/Emergency Inspection & Maintenance

IPEC is recognized as an industry leader in custom modular process equipment. Please let us also assist with the design and fabrication of your next:

- Custom Water Purification Systems
- Purified/WFI Storage & Distribution Systems
- Purified/WFI Heating or Cooling Systems
- Filtration Systems
- Point-Of-Use Equipment
- Clean-In-Place Systems

### Standard Specifications

<table>
<thead>
<tr>
<th>Model</th>
<th>400</th>
<th>800</th>
<th>1400</th>
<th>2000</th>
<th>3000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Typ. Generation Rate @ 55 °F - gpm (lpm)</td>
<td>4 (15)</td>
<td>8 (30)</td>
<td>14 (52)</td>
<td>20 (75)</td>
<td>30 (113)</td>
</tr>
<tr>
<td>Typ. Generation Rate @ 77 °F - gpm (lpm)</td>
<td>6 (22)</td>
<td>12 (45)</td>
<td>20 (76)</td>
<td>30 (113)</td>
<td>45 (151)</td>
</tr>
<tr>
<td>Typ. Feedwater Rate - gpm (lpm)</td>
<td>8.3 (33)</td>
<td>16.5 (63)</td>
<td>30.3 (117)</td>
<td>41.6 (158)</td>
<td>52.2 (198)</td>
</tr>
<tr>
<td>Max. Feedwater Rate - gpm (lpm)</td>
<td>20 (75)</td>
<td>35 (133)</td>
<td>70 (265)</td>
<td>85 (322)</td>
<td>110 (417)</td>
</tr>
<tr>
<td>Req’d Feedwater Pressure - psi (bar)</td>
<td>60 to 90 (4 to 6)</td>
<td>60/100</td>
<td>100/150</td>
<td>100/150</td>
<td></td>
</tr>
<tr>
<td>Electrical Service (3ph 480VAC) A^4/A^5</td>
<td>30/60</td>
<td>30/60</td>
<td>60/100</td>
<td>100/150</td>
<td>100/150</td>
</tr>
<tr>
<td>Overall Length - in (mm)</td>
<td>150 (3810)</td>
<td>172 (4355)</td>
<td>180 (4595)</td>
<td>200 (5100)</td>
<td></td>
</tr>
<tr>
<td>Overall Width - in (mm)</td>
<td>64 (1625)</td>
<td>72 (1830)</td>
<td>72 (1830)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Overall Height - in (mm)</td>
<td>84 (2130)</td>
<td>96 (2440)</td>
<td>108 (2745)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Approximate Shipping Weight - lbs (kg)</td>
<td>2,900 (1320)</td>
<td>3,200 (1460)</td>
<td>3,600 (1640)</td>
<td>4,400 (2000)</td>
<td>4,900 (2230)</td>
</tr>
<tr>
<td>Approximate Operating Weight - lbs (kg)</td>
<td>3,800 (1710)</td>
<td>4,100 (1860)</td>
<td>5,200 (2330)</td>
<td>6,800 (3070)</td>
<td>7,100 (3220)</td>
</tr>
</tbody>
</table>

1. Fee for test kit invoiced at time of order, waived with purchase of system. 2. Typical and maximum required rates will vary with available feedwater pressure and selected/required optional components. To be reviewed and verified at time of order. 3. Including maximum raw water feed and softener regeneration flows. 4. Amperage required for base model. 5. Amperage required for hot water sanitization option. 6. Final dimensions & weights depend on selected options and materials of construction, to be confirmed during final engineering.

Information/general descriptions included in this brochure may not always apply in actual case of use and are subject to change as a result of further product development. Any obligation to provide the respective characteristics described herein shall only exist if expressly agreed in the terms of a contract.
Feed water (PW) is preheated by means of two DTS heat exchangers, which use respectively the heat of the pure steam and distillate water outlet and the plant steam outlet. The first column of the CS water still is equal to our CPS steam generators, heated also with plant steam. The pure steam produced in the first column is used as the heating medium for the next one, so it condenses and turns into WFI. Simultaneously, the partial amount of non-evaporated water goes to the next column, so it is also partially evaporated as pure steam and used as heating energy for the next column. Here, the pure steam also condensates (resulting in WFI distillate) and it is transformed by pressure in the successive columns.

### Technical data

<table>
<thead>
<tr>
<th>Model</th>
<th>No. of Effects</th>
<th>Overall Dimensions</th>
<th>Main Utilities</th>
<th>Approx. Weight Kg</th>
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</thead>
<tbody>
<tr>
<td>WFIS 3-250</td>
<td>3</td>
<td>2.140 x 2.000 x 2.900</td>
<td>1.300</td>
<td>270</td>
</tr>
<tr>
<td>WFIS 3-500</td>
<td>3</td>
<td>2.105 x 1.900 x 2.875</td>
<td>960</td>
<td>500</td>
</tr>
<tr>
<td>WFIS 4-500</td>
<td>4</td>
<td>2.500 x 1.900 x 2.875</td>
<td>960</td>
<td>190</td>
</tr>
<tr>
<td>WFIS 4-750</td>
<td>4</td>
<td>2.910 x 2.100 x 3.100</td>
<td>1.100</td>
<td>775</td>
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<tr>
<td>WFIS 4-1250</td>
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<td>3.040 x 2.230 x 3.090</td>
<td>1.180</td>
<td>1.200</td>
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<tr>
<td>WFIS 5-500</td>
<td>5</td>
<td>2.915 x 1.900 x 2.875</td>
<td>960</td>
<td>165</td>
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<td>WFIS 5-750</td>
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<td>3.420 x 2.100 x 3.070</td>
<td>1.100</td>
<td>295</td>
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<tr>
<td>WFIS 5-1250</td>
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<td>3.590 x 2.230 x 3.090</td>
<td>1.180</td>
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<tr>
<td>WFIS 5-2000</td>
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<td>3.700 x 2.400 x 3.550</td>
<td>1.500</td>
<td>2.075</td>
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<tr>
<td>WFIS 5-3000</td>
<td>5</td>
<td>4.200 x 2.685 x 3.830</td>
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<td>3.065</td>
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<tr>
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<td>5</td>
<td>4.400 x 2.950 x 3.975</td>
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<tr>
<td>WFIS 6-2000</td>
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<td>2.075</td>
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<td>WFIS 6-3000</td>
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<td>4.880 x 2.980 x 3.830</td>
<td>1.500</td>
<td>3.065</td>
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<td>WFIS 6-4500</td>
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<td>1.548</td>
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<td>5.900 x 3.080 x 4.420</td>
<td>1.630</td>
<td>6.535</td>
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<td>WFIS 6-9000</td>
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<td>6.900 x 3.080 x 4.420</td>
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<td>6.675 x 3.170 x 4.500</td>
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<td>12.640</td>
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<tr>
<td>WFIS 7-3000</td>
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<td>5.560 x 2.980 x 3.830</td>
<td>1.500</td>
<td>3.065</td>
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<td>WFIS 7-4500</td>
<td>7</td>
<td>6.050 x 2.950 x 3.975</td>
<td>1.550</td>
<td>4.585</td>
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<tr>
<td>WFIS 7-6500</td>
<td>7</td>
<td>6.710 x 3.080 x 4.420</td>
<td>1.630</td>
<td>6.535</td>
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<td>WFIS 7-9000</td>
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<td>7.510 x 3.080 x 4.420</td>
<td>1.800</td>
<td>9.060</td>
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<tr>
<td>WFIS 7-12000</td>
<td>7</td>
<td>7.700 x 3.170 x 4.500</td>
<td>2.400</td>
<td>12.645</td>
</tr>
</tbody>
</table>

### Options and accessories

- Feed water conductivity monitoring
- Pure steam take from the first column
- Elevated WFI condenser
- Hot standby mode
- Sanitization sterilization of the separator columns and WFI condensers
- Protective mesh guarding
- Online TOC monitoring device
- WFI storage and distributor skid

### Control system

The control system is based on a PLC wire operation supervisor via a user-friendly touch-screen HMI with the following menu:
- Mimics of the equipment, showing the operational state in real time
- Process parameters (temperature, pressure and conductivity)
- Setting up of parameters
- Alarm information
- Startup and alarm recognition

Options in paper or electronic chart recorder for pure steam conductivity, temperature, extra feed water conductivity meter, online TOC monitoring, etc.
A choice of quality

Telstar Puretech Multiple Effect Water for Injection Stills are designed and constructed to produce pyrogen-free sterile water (WFI) in full compliance with cGMP guidelines as per FDA and EMEA requirements.

Engineering and manufacturing practices follow ISO 13850, ASME BPE, GAMP guidelines, etc. Design and construction meets the most stringent Regulations and Codes from Europe, USA and others concerning safety and pressure vessels.

To ensure the equipment meets your requirements, we work in partnership with you and a dedicated team follows your order as a unique project. We develop specific Quality Plans (DQ, IQ and OQ) and undertake factory acceptance testing (FAT) to give assurance, performance and quality.

WFI applications

WFI water for injection, as defined in the Ph.Eur and the USP, is used for the preparation of medicines for injectable administration, where water is used as a vehicle (water for injections in bulk), to dissolve or diffuse substances or preparations for injectable administration before use (sterile water for injection). According to the Ph. Eur water for injections can only be produced by distillation, or distilling water or purified water.

Design & construction features

Compact and Modular

The unit and all its components such as feed water pump, preheater and condensers are mounted on a stainless steel AISI 304 skid.

All parts in contact with the media are made of stainless steel AISI 316L, insulated with mineral wool (asbestos-free material) with external cladding made of stainless steel AISI 304. Inner surfaces are polished to Ra < 0.64 μm and electro polishing is an available option.

Hygienic design: including clamp connections, orbital welding techniques for tubing and components, minimisation of dead legs and proper piping slopes for self-drainability, double tube sheet construction in first columns, condenser and preheaters, diaphragm valves for distillate/reject, etc.

Ease of Maintenance and Installation

The heat exchangers are totally accessible and no internal elements are located within the columns. This makes inspection much easier than other designs, with long pipes or internal heat exchangers.

The replacement of column gaskets can be done easily and quick, without needing to dismantle the column, which removes the need for very high technical areas in order to take off any internal part.

Simple and Efficient Design

The lower part of the column consists of a double tube sheet shell heat exchanger with a large central pipe surrounded by a bundle of peripheral seamless pipes. This arrangement produces a natural fluid circulation: ascendant inside the peripheral pipes and descendant inside the central one. Steam flows up very slowly, but droplets cannot reach the top of the column as they fall down simply by gravity. Thus, impurities such as particulates and pyrogens contained in the droplets are dragged down towards the bottom of the columns where they are automatically broken down. Pure steam from the first columns serves as heating energy in the next columns where it condenses, as WFI. This can be reprocessed several times, so called multiple effects, up to 7 columns. The more effects we install, the less heating energy and cooling water required.

Design & construction features

Water For Injection Stills
Feed water (PW) is preheated by means of two DTS heat exchangers, which use respectively the heat of the pure steam and distillate water outlet and the plant steam outlet. The first column of the CS water still is equal to our CPS steam generators, heated also with plant steam. The pure steam produced in the first column is used as the heating medium for the next ones, so it condenses and turns into WFI. Simultaneously, the partial amount of non-evaporated water goes to the next column, so it is also partially evaporated as pure steam and used as heating energy for the next column. Here, the pure steam also condenses (resulting in WFI distillate) and it is transferred by pressure to the successive columns.

Options include paper or electronic chart recorder for pure steam conductivity, temperature, extra feed water conductivity meter, on-line TOC monitoring, etc.
A choice of quality

Telstar Puretech Multiple Effect Water for Injection Stills are designed and constructed to produce pyrogen-free sterile water (WFI) in full compliance with cGMP guidelines as per FDA and EMEA requirements. Engineering and manufacturing practices follow ISO 9001 procedures, ASME BPE criteria, cGMP guidelines, etc. Design and construction meets the most stringent Regulators and Codes from Europe, USA and others concerning safety and pressure vessels.

To ensure the equipment meets your requirements, we work in partnership with you and a dedicated team follows your order as a unique project. We develop specific Quality Plans (DQ, IQ and OQ) and undertake factory acceptance testing (FAT) to give assurance, performance and quality.

WFI applications

WFI water for injection, as defined in the Ph Eur and the USP, is used for the production of medicines for injectable administration, where water is used as a vehicle (water for injections in bal.), to dissolve or disperse substances or preparations for injectable administration (sterile water for injections). According to the Ph. Eur, water for injections can only be produced by distillation, or distilling water or purified water.

Design & construction features

Compact and Modular

The unit and all its components such as feed water pump, preheater and condensers are mounted on a stainless steel AISI 304 skid.

All parts in contact with the media are made of stainless steel AISI 316L, insulated with a suitable insulating material and with external cladding made of stainless steel AISI 304. Inner surfaces are polished to Ra ≤ 0.64 μm and electro-polishing is an available option.

Hygienic design: Including clamp connections, orbital welding techniques for tubing and components, minimization of dead legs and proper piping slopes for self-drainability, double tube sheet construction in first column, condenser and preheaters, diaphragm valves for distillate/reject, etc.

WFI applications

WFI water for injection, as defined in the Ph Eur and the USP, is used for the preparation of medicines for injectable administration, where water is used as a vehicle (water for injections in bal.), to dissolve or disperse substances or preparations for injectable administration (sterile water for injections). According to the Ph. Eur, water for injections can only be produced by distillation, or distilling water or purified water.

Design & construction features

Compact and Modular

The unit and all its components such as feed water pump, preheater and condensers are mounted on a stainless steel AISI 304 skid.

All parts in contact with the media are made of stainless steel AISI 316L, insulated with a suitable insulating material and with external cladding made of stainless steel AISI 304. Inner surfaces are polished to Ra ≤ 0.64 μm and electro-polishing is an available option.

Hygienic design: Including clamp connections, orbital welding techniques for tubing and components, minimization of dead legs and proper piping slopes for self-drainability, double tube sheet construction in first column, condenser and preheaters, diaphragm valves for distillate/reject, etc.

Simple and Efficient Design

The lower part of the column consists of a double tube sheet shell heat exchanger with a large central pipe surrounded by a bundle of peripheral seamless pipes. This arrangement produces a natural fluid circulation: a small part travels the peripheral pipes and descends inside the central one. Steam lines up very slowly, but droplets cannot reach the top of the column as they fall down simply by gravity. Thus, impurities such as particles and pyrogens contained in the droplets are dragged down towards the bottom of the column where they are automatically blown down. Pure steam from the first column serves as heating energy in the next column where it condenses, as WFI. This can be repeated several times, so called multiple effects, up to 7 columns. The more effects we install, the less heating energy and cooling water required.

Ease of Maintenance and Installation

The heat exchangers are totally accessible and no internal elements are located within the column. This makes inspection much easier than other designs, with long pipes or internal heat exchangers.

The replacement of column gaskets can be done easily and quickly, without needing to dismantle the column, which removes the need for very high technical areas in order to take off any internal part.

Heat exchanger pipes are always totally immersed in water, so there is a very low tendency to build scale inside the tubes. Moreover, as they are shorter than other designs, they are less stressed by oscillations and risk of corrosion is significantly reduced.
A choice of quality

Telstar Puretech Multiple Effect Water for Injection Stills are designed and constructed to produce pyrogen-free sterile water (WFI) in full compliance with cGMP guidelines as per FDA and EMEA requirements. Engineering and manufacturing practices follow ISO 9001 procedures, ASME BPE criteria, cGMP guidelines, etc. Design and construction meets the most stringent Regulations and Codes from Europe, USA and others concerning safety and pressure vessels.

To ensure the equipment meets your requirements, we work in partnership with you and a dedicated team follows your order as a unique project. We develop specific Quality Plans (DQ, IQ and OQ) and undertake factory acceptance testing (FAT) to give assurance, performance and quality.

Design & construction features

Compact and Modular

The unit and all its components such as feed water pump, preheater and condensers are mounted on a stainless steel AISI 304 skid.

All parts in contact with the media are made of stainless steel AISI 316L, insulated with mineral wool (asbestos-free material) with external cladding made of stainless steel AISI 304. Inner surfaces are polished to Ra ≤0.64 μm and electro polishing is an available option.

Hygienic design: Including clamp connections, orbital welding techniques for tubing and components, minimisation of dead legs and proper piping slopes for self-drainability, double tube sheet construction in first column, condenser and preheaters, diaphragm valves for distillate/reject, etc.

WFI applications

WFI water for injection, as defined in the Ph.Eur and the USP, is used for the preparation of medicines for injectable administration, where water is used as a vehicle (water for injections in bulk), to dissolve or dilute substances or preparations for injectable administration before use (sterile water for injections). According to the Ph. Eur water for injections can only be produced by distillation, or drinking water or purified water.

Simple and Efficient Design

The lower part of the column consists of a double tube sheet shell heat exchanger with a large central pipe surrounded by a bundle of peripheral stainless pipes. This arrangement produces a natural fluid circulation; condensate inside the peripheral pipes and descend into the central one. Steam flows up very slowly, but droplets cannot reach the top of the column as they fall down simply by gravity. Thus, impurities such as particles and pyrogens contained in the droplets are dragged down towards the bottom of the column where they are automatically blown down. Pure steam from the first column serves as heating energy in the next column where it condenses as WFI. This can be repeated several times, so called multiple effects, up to 7 columns. The more effects we install, the less heating energy and cooling water required.

Ease of Maintenance and Installation

The heat exchangers are totally accessible and no internal elements are located within the column. This makes inspection much easier than other designs, with long pipes or internal heat exchangers. The replacement of column gaskets can be done easily and quick, without needing to dismantle the column, which removes the need for very high technical areas in order to take off any internal part.

Heat exchanger pipes are always totally immersed in water, so there is a very low tendency to build up scale inside the tubes. Moreover, they are shorter than other designs, they are less stressed by oscillations and risk of corrosion is significantly reduced.
Feed water (PW) is preheated by means of two DTS heat exchangers, which use respectively the heat of the pure steam and distillate water outlet and the plant steam outlet. The first column of the CS water still is equal to our CPS steam generators, heated also with plant steam.

The pure steam produced in the first column is used as the heating medium for the next one, so it condenses and turns into WFI. Simultaneously, the partial amount of non-evaporated water goes to the next column, so it is also partially evaporated as pure steam and used as heating energy for the next column.

Here, the pure steam also condenses (resulting in WFI distillate) and it is transferred by pressure in the successive columns.

### Control system

The control system is based on a PLC wire operator supervision via a user-friendly touch-screen HMI with the following menu:

- Simulations of the equipment, showing the operational state in real time
- Process parameters (temperature, pressure and conductivity)
- Setting up of parameters
- Alarm information
- Startup and alarm recognition

Options in paper or electronic chart recorder for pure steam conductivity, temperature, extra feed water conductivity meter, on-line TOC monitoring, etc.

### Technical data

<table>
<thead>
<tr>
<th>Model</th>
<th>Feed Water Conductivity Monitoring</th>
<th>Pure Steam take from the first column</th>
<th>Elevated WFIS condenser</th>
<th>Hot standby mode</th>
<th>Sanitisation/Sterilization of the separator columns and WFIS condensers</th>
<th>Protective mesh guarding</th>
<th>Online TOC monitoring device</th>
<th>WFI storage and distribution skid</th>
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### Operating principle

- Feed water conductivity monitoring
- Pure steam take from the first column
- Elevated WFIS condenser
- Hot standby mode
- Sanitisation/Sterilization of the separator columns and WFIS condensers
- Protective mesh guarding
- Online TOC monitoring device
- WFI storage and distribution skid