THOMSON Solutions ™ At Work
INSTRUMENT COMPANY

htslabs.com

# OPTIMUM GROWTH

## TIPS & TRICKS FOR CHO & HEK


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MADE IN USA

# Thomson Cell Culture Solution

Thomson Instrument Company was founded in 1970 to service the needs of the growing life sciences industry. It remains a family run business with a long history of product innovation. In addition, it should be noted that all Thomson products are designed and manufactured in the USA. Thomson has worked with its customers to design products that outperform the competition by introducing unique design features that add functionality to an otherwise static product market. In particular, Thomson has reinvented shake flasks that are used for culturing *E.coli* and mammalian cells for recombinant DNA and protein production. These features are reviewed in Dr. Bruecher's article, "Evolution of Shake Flask Technology. Novel Product Introductions Offer Advantages by Increasing DNA and Protein Production."[1]

The advantages of Thomson Optimum Growth™ Flasks (patented) can be attributed to a fairly simple principal of good mixing and high oxygen transfer rate helping cells grow to higher densities. Increased aeration is achieved through a patented baffle design along with a large diameter neck and gas permeable cap.

The innovation in Thomson's Optimum Growth™ product line does not end with a single flask. Thomson has worked with its customers to reduce the footprint of its flasks in such a way to maximize space in the most commonly used cell culture incubators.

In the tradition of evolving to fit customer needs, Thomson has introduced a line of companion products that work along with the Optimum Growth™ Flasks. These include caps, lids & ports that allow the sterile transfer of fluid into and out of the flasks. Current cell culture processes often involve longer culture durations that require both sampling over time and batch feeds. Thomson products support these existing workflows and help to streamline the process wherever possible.

Optimum Growth™ Flasks

Optimum Growth™
Transfer Caps

Optimum Growth™
Special Flasks

[1]Bruecher. September 15, 2015. Novel Product Introductions Offer Advantages by Increasing DNA and Protein Production. Genetic Engineering & Biotechnology News. 35 (16). http://www.genengnews.com/issue/toc/255


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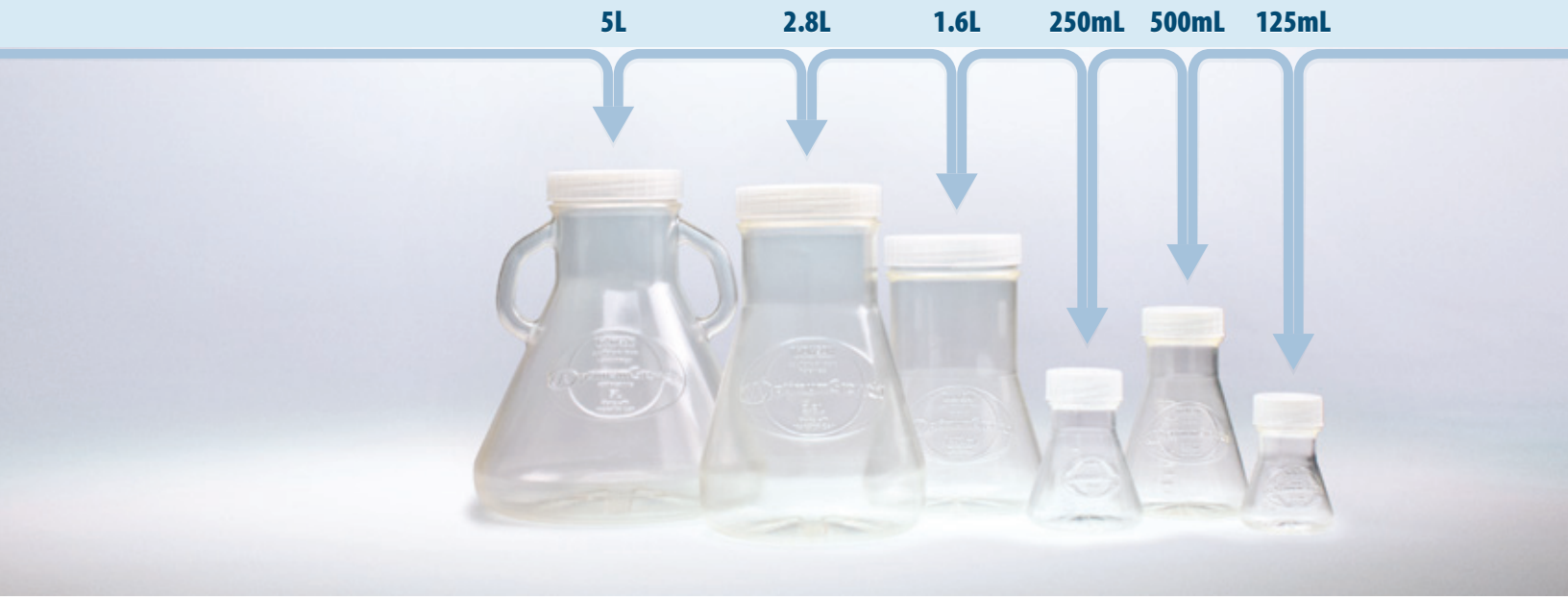
| Page Number | | Product | Cell Growth | Aseptic Gravity Transfer | Aseptic Pump Transfer | Sampling | Feeding | 0.2µm PTFE Vent Cap | Sterile |
|---|---|---|---|---|---|---|---|---|---|
| 4 |  | **Optimum Growth™ Flasks**<br>Available in 125mL - 5L for insect & mammalian cell growth. | ● | | | | | ● | ● |
| 14 |  | **Sampling Flasks**<br>Available in 125mL, 250mL, 500mL & 5L Optimum Growth™ Flask sizes. Provides simple aseptic way to sample cells in the shaker. | ● | | | ● | | ● | ● |
| 17 |  | **Multiported Optimum Growth™ Flasks**<br>Available in 1.6L & 5L with ports for aseptic transfer, feeding & sampling during cultivation. | ● | | ● | ● | ● | ● | ● |
| 19 |  | **Inversion Transfer Caps**<br>Gravity transfer from 1.6L, 2.8L & 5L Optimum Growth™ Flasks to flasks, bags or bioreactors. Removing the peristaltic pump from the process reduces stress on cells during transfer. | | ● | | | | ● | ● |
| 22 |  | **Bidirectional Transfer Caps**<br>Sterile bidirectional transfer utilizing a peristaltic pump from 1.6L, 2.8L & 5L Optimum Growth™ Flasks to flasks, bags or bioreactors or to feed/ seed flasks during cultivation. | | | ● | | ● | ● | ● |
| 24 |  | **Rapid Clear® 3000 Cap**<br>An innovative new technique that allows high speed clarification of cellular material | ● | | ● | | | | ● |




## Key Features

- Baffles designed for High Aeration & Low Shear
- Same Footprint as Comparable Fernbach Flask
- Less Foaming than Disposable Fernbach
- Transfer Cap connects directly to bags & bioreactors with quick connect or tube fusing
- .2µm Vented Cap
- Individually Packaged and Sterilized

# OptimumGrowth™

The advantages of Thomson patented Optimum Growth™ Flasks can be attributed to a fairly simple principal of good mixing and high oxygen transfer rate helping cells grow to higher densities. Increased aeration is achieved through a patented baffle design along with a large diameter neck and gas permeable cap. The innovation in Thomson's Optimum Growth™ product line does not end with a single flask. Thomson has worked with its customers to reduce the footprint of its flasks in such a way to maximize space in the most commonly used cell culture incubators. In the tradition of evolving to fit customer needs, Thomson has introduced a line of companion products that work along with the Optimum Growth™ Flasks. These include caps, lids & ports that allow the sterile transfer of fluid into and out of the flasks. Current cell culture processes often involve longer culture durations that require both sampling over time and batch feeds. Thomson products support these existing workflows and help to streamline the process wherever possible.

**Optimum Growth™ Flasks have 0.2µm PTFE Vent Caps**

**Optimum Growth™ Flask Specifications**

| Flask Size | 125mL | 250mL | 500mL | 1.6L | 2.8L | 5L |
|---|---|---|---|---|---|---|
| Part # | 931110 | 931111 | 931112 | 931113 | 931114 | 931116 |
| Image |  |  |  |  |  |  |
| Description | Optimum Growth™ 125mL Flask w/ Vent Cap \| Sterile | Optimum Growth™ 250mL Flask w/ Vent Cap \| Sterile | Optimum Growth™ 500mL Flask w/ Vent Cap \| Sterile | Optimum Growth™ 1.6L Flask w/ Vent Cap \| Sterile | Optimum Growth™ 2.8L Flask w/ Vent Cap \| Sterile | Optimum Growth™ 5L Flask w/ Vent Cap \| Sterile |
| Qty/Case | 50 | 50 | 25 | 12 | 6 | 4 |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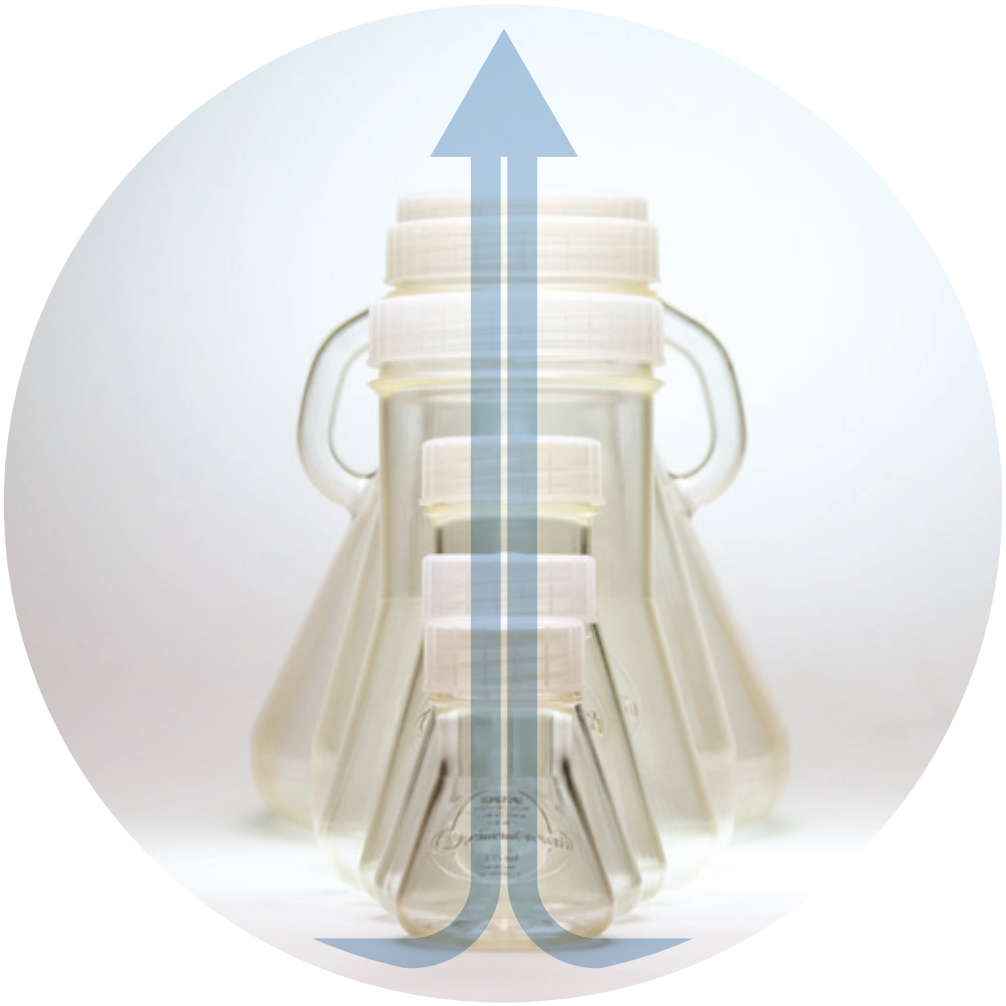
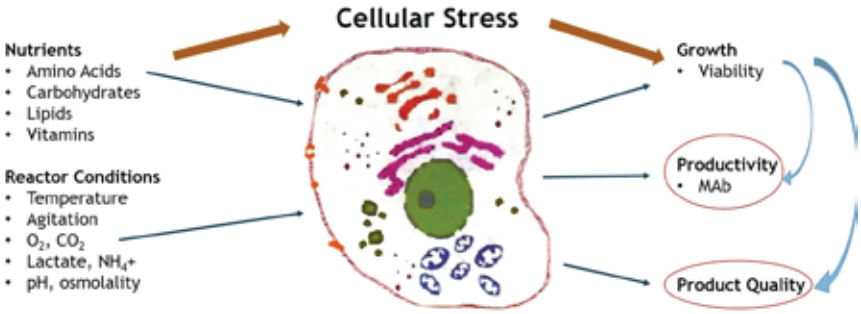


Thomson Optimum Growth™ Flasks are designed in a way that protein production scales consistently across all sizes, unlike any other shake flasks on the market. The Optimum Growth™ Flask Family has a unique patented design that allows one shake speed for all sizes. Multiple flask sizes on one shaker platform eliminates the need for additional shakers at different speeds.

# Consider the Health of Your Cells:

## Complex Cellular Systems

Are your cultures healthy? Cellular stress can be triggered by environmental changes including oxygen/CO2, pH, and acetate levels. These stresses will lower the viability and protein yield of cultures. The Optimum Growth™ Flasks patented design improve aeration improving both quality and quantity of the cell culture.




# Comparison of 293 & CHO Cell Line Traits for Transient Expression

Transient expression of HEK-293 and CHO-K1 cell lines are frequently used for antibody production. Both cell lines are easily adaptable to suspension culture, and grow to high cell densities in the Optimum Growth™ Flasks.

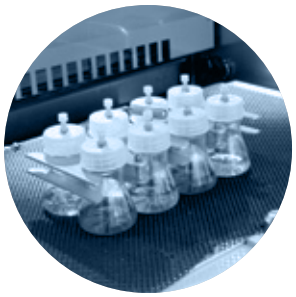
| Characteristic | 293 | CHO |
|---|---|---|
| Tolerance to culture stress | Best | |
| Ability to shift from growth to expression | | Best |
| Speed of expression | Best | |
| Duration of expression | | Best |
| Stability of transfection complexes | Best | |
| Lower amount of DNA needed | | Best |
| Flexibility of protocol | | Best |
| Benefit of batch feeds | | Best |

# Excellent Growth with Space Saving Capability

Compared to competing flask systems, Thomson's Optimum Growth™ line of flasks have higher working volumes while keeping the same footprint. Using smaller flask sizes with similar working volumes to larger competing flasks allows a higher total volume per shaker.

**18 x 1.6L Optimum Growth™ Flasks**
Total Volume 16.2L/shaker

**12 x Optimum Growth™ 2.8L Flasks**
Total Volume 16.8L/Shaker



**8 Position Carrier available**
for 125mL & 250mL Flasks

# Fill Volumes & Shake Speeds

**For all tables** | 1" = 25mm | 2" = 50mm

**CHO Stable Cells, CHO Transient, HEK 293 Transient , Hybridoma**

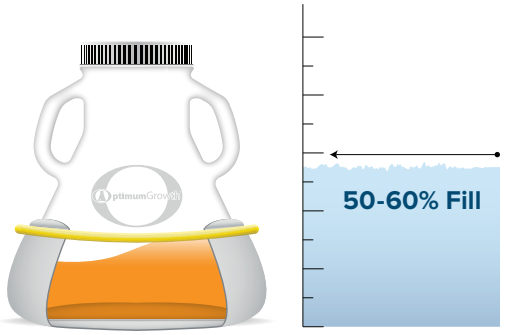
| Best Fill Volume | Working Volume | Flask Size | Best Speed *RPM in 1"/2" | Speed Range 1" | Speed Range 2" |
|---|---|---|---|---|---|
| **63mL** | 24-75mL | 125mL | 150 / 110 | 120-150 | 90-110 |
| **150mL** | 100-150mL | 250mL | 150 / 110 | 120-150 | 90-110 |
| **250mL** | 175-250mL | 500mL | 150 / 110 | 120-150 | 90-110 |
| **900mL** | 0.4-1.1L | 1.6L | 150 / 110 | 120-150 | 90-110 |
| **1.4L** | 0.9-1.6L | 2.8L | 150 / 110 | 120-150 | 90-110 |
| **2.5L** | 1.7-3.2L | 5L | 120 / 90 | 120-140 | 90-110 |

**Insect Cells**

| Best Fill Volume | Working Volume | Flask Size | Best Speed *RPM in 1"/2" | Speed Range 1" | Speed Range 2" |
|---|---|---|---|---|---|
| **63mL** | 24-75mL | 125mL | 150 / 110 | 120-150 | 90-110 |
| **150 mL** | 100-150mL | 250mL | 150 / 110 | 120-150 | 90-110 |
| **250mL** | 175-250mL | 500mL | 150 / 110 | 120-150 | 90-110 |
| **900mL** | 0.4-1.1L | 1.6L | 150 / 110 | 120-150 | 90-110 |
| **1.4L** | 0.9-1.6L | 2.8L | 150 / 110 | 120-150 | 90-110 |
| **2.5L** | 1.7-3.2L | 5L | 135 / 95 | 120-140 | 90-110 |

**Microbes/*E.coli***

| Best Fill Volume | Working Volume | Flask Size | Best Speed *RPM in 1"/2" |
|---|---|---|---|
| **63mL** | 24-75mL | 125mL | 250 / 150 |
| **125mL** | 100-150mL | 250mL | 250 / 150 |
| **250mL** | 175-250mL | 500mL | 250 / 150 |
| **900mL** | 0.4-1.1L | 1.6L | 250 / 150 |
| **1.4L** | 0.9-1.6L | 2.8L | 250 / 150 |
| **2.5L** | 1.7-3.2L | 5L | 250 / 150 |



**What have people done successfully to change vessels from Spinner flasks & Roller bottles to Optimum Growth™ Flasks (patented)?**

Cells adapted to Spinner Flasks and Roller Bottles can be easily transitioned to Optimum Growth™ Flasks. Adjusting existing cultures from different formats to Optimum Growth™ Flasks requires reducing the volume and shake speeds of the first 1-2 passages*. The addition of up to 1% of surfactant** to the media may be needed due to spinner flasks and roller bottles having lower shear than shake flasks. Once the cells have adjusted to the shake flasks, recommended speeds will work well.

* See chart with fill volumes and shake speeds.
** ThermoFisher Pluronic, p/n 24040032 or MilliporeSigma Simethicone, p/n 59920C

**Why do Optimum Growth™ Flasks work better than other disposable flasks (non-baffled or baffled) for mammalian cell lines (CHO, HEK293, etc.) & insect cell lines (SF-9, SF-21, High Fives, Trichoplusia ni)?**

Optimum Growth™ Flasks are patented shake flasks designed for high aeration and low shear. Optimum Growth™ Flasks achieve high aeration due to a unique baffle design that has been optimized for mammalian and insect cell lines. They provide enhanced gas exchange with low shear mixing, which can increase yields significantly when combined with both nutrient enriched media and proper pH balance.

**What clamps and shakers work best with the Optimum Growth™ Flasks?**

Optimum Growth™ Flasks are designed to shake in 1" or 2" orbit shakers. Sticky tape or rug gripper pad is recommended for under 170rpm. Our 125mL, 250mL and 500mL flasks will work with standard shake flask clamps.

Thomson Flask Clamp Compatibility Chart

| Flask Size | Eppendorf® | INFORS HT® | Kuhner® | Fisher Scientific® | VWR® |
|---|---|---|---|---|---|
| 5L | ACE-5000S | 12207 ATM 3000 | SM313000F | 50-901-18155 | 57019-696 |
| 2.8L | ACE-2000S | ATK 2000 | SM312800T | 14-281-27 | 57019-686 |
| 1.6L | N/A | 31272 | SM311600 | N/A | N/A |
| 500mL | M1190-900 | 12204 ATM 500 | SM310500 | 50-901-18152 | N/A |
| 250mL | M1190-9002 | 12203 ATM 250 | SM310250 | 50-901-18151 | N/A |
| 125mL | M1190-9001 | 12202 ATM 100 | SM310125 | 50-901-18150 | N/A |

**Are the Optimum Growth™ Flasks single use?**

Yes, the Optimum Growth™ Flasks are designed for single use and are not autoclavable. They are competitively priced compared to disposable bioreactors or shake flasks from other manufacturers.

**What are the Transfer Caps that go along with the Optimum Growth™ Flasks?**

Inversion & Bidirectional Optimum Growth™ Transfer Caps (patented) allow for a quick stress free cell transfer between flask and downstream vessel (Optimum Growth™ Flasks, cell culture bags, bioreactors, etc.). Inversion Transfer Caps use the power of gravity to facilitate transfer, thus maintaining higher culture viability than pumping methods. Bidirectional Transfer Caps use a standard pump to transfer culture and/or media; come in a wide variety of tubing sizes. Transfer Caps come with multiple types of end fittings; quick connect, luer lock, and tube fusing. Please see our website htslabs.com for more details.

**High cell death and a large amount of foam and/or cell clumping issues?**

Cell death and foaming in the Optimum Growth™ Flasks is usually due to cell shearing. Adding up to 1% surfactant will reduce foaming and increase cell viability without stressing the cells.

**How can you best use media from ThermoFisher such as F17 and its derivatives?**

FreeStyle™ F17 Expression Medium contains lower amounts of pluronic than other comparable medium. Cells grown in this media may experience more shear stress due to the lower amount of surfactant. To avoid this, add in additional pluronic (ThermoFisher p/n 24040032). The recommended range of pluronic is 0.05 gm/L to 0.2 gm/L. Up to 1% simethicone from MilliporeSigma (p/n 59920C) can also be used. Either of these methods usually will work to reduce foaming and restore high culture viability.

**What can I do if the doubling time for my cell culture is longer than expected when using the Optimum Growth™ Flasks?**

This varies between cell types and strains, as well as with environmental conditions. If the doubling time for your culture is taking longer than expected or desired in the Thomson Optimum Growth™ Flasks, we recommend increasing the shake speed beyond our recommended speeds by 10 to 20 rpm. The reason for the increased doubling time is that the oxygen transfer rate maybe lower with higher fill volumes, and the increase in speed will compensate for this.

**Disposable shake flasks are hard to remove from the sticky pad. What do we do?**

Some suggestions from people who find it too sticky:

1. Spray ethanol on the sticky pad until you reach the desired stickiness. Ethanol will lower the bonding strength, as will any alcohol.
2. Some people use rug gripper pads on top of the sticky tape.

**Which transfection reagent works best with CHO & HEK293 cells?**

We see that there are three classes of transfection reagents that have varying efficiencies:

| Class | Example | Efficiency of Transfection |
|---|---|---|
| Polymers | PEI | < 65% |
| Cationic Liposomes | Lipofectamine™ | 70-95% |
| Electroporation | Maxcyte® | > 96% |

**Polymers/PEI:** The most common transfection reagent used in the market. It is inexpensive, but may not lead to as high of a transfection rate, and requires higher DNA quantities. Commonly used for all small and large scale transfections.

**Cationic Liposomes/Lipofectamine™:** This class of transfection reagents is highly efficient and is commonly used in CHO-S, 293F and other high titer systems. Cationic Liposomes work well with our flasks. We have seen consistent transfection with great viability from TransIT-Pro®. This used with CHOgro(r) from Mirus in 24 well plates (2.5mL), small scale flasks, and production in Optimum Growth Flasks ( 50mL-2.5L) have given scalable usable results.

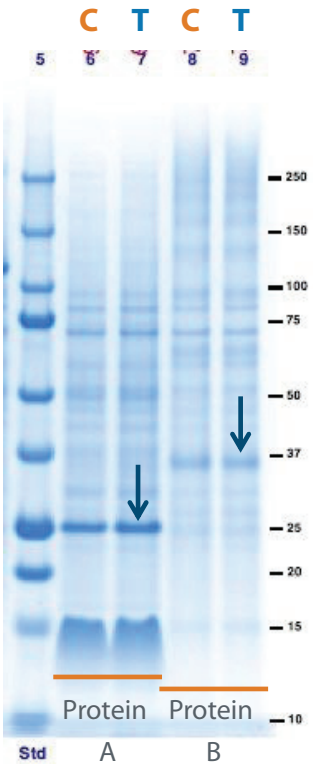
**Electroporation:** Most often used method for large scale, >1L transfection. Unfortunately, electroporation is not as useful for multiple transfections at one time. Customer feedback shows that stabilizing the cells with a 1%-1.2% addition of surfactant (pluronic/PF68) 30 minutes after transfection leads to higher titers and viability.

One shaker many flask sizes: consistent shake speeds across all sizes of Optimum Growth™ Flasks


Optimum Growth™ 250mL Flasks with CHO & HEK293 Cells in shaker

# Corning® vs Optimum Growth™ Flasks 2 Membrane Proteins Expressed

Data provided by Genentech part of the Roche Group




Corning® – 500mL flask, 200mL culture

Thomson – 250mL flask, 150mL culture

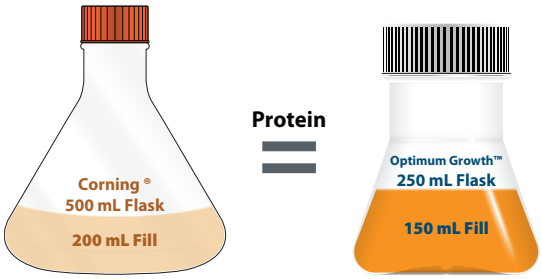
4mL samples purified over Ni NTA

**Protein A** – Membrane protein of moderate expression, 34kDa

**Protein B** – Membrane protein of low expression, 45kDa

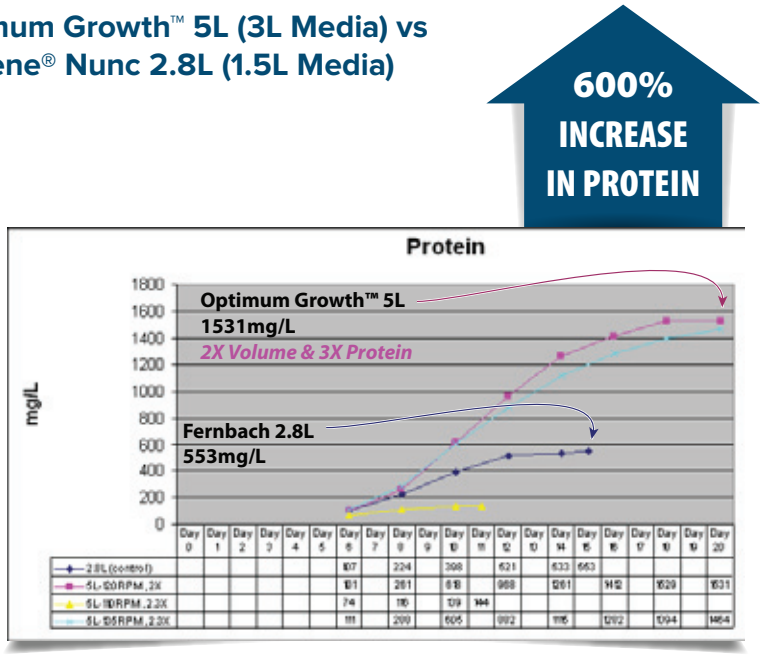
12µL of elution resolved on a coomassie gel

**Conclusion:** Thomson flasks work at least as good as Corning® standard. Improved working volume / flask volume ratio when using Thomson.




# Same Footprint-Double Volume

## Optimum Growth™ 5L (3L Media) vs Nalgene® Nunc 2.8L (1.5L Media)




Thomson Instrument Company is not affiliated with Corning Life Sciences®, Nalgene Nunc®, Genentech, NYSGRC or their products.

# Regular Shake Flask vs Thomson Shake Flask

Lake Pharma

## Background Information

The purpose of this study was to compare the Regular shape shake flask with Thomson shake flask for cell growth and impact on protein yield.

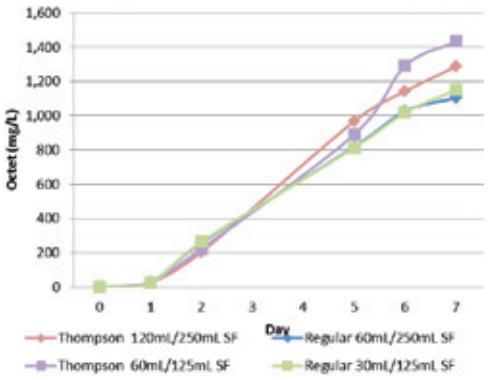
## Conditions

HEK-293 Transient production– seeded at $2.5x10^6$ cells/mL and incubated at 37°C, 5% $CO_2$. Supplemented with feed on day 1. Cells were harvested on day 7.

CHO Stable pool production– seeded at $0.8x10^6$ cells/mL and incubated at 37°C, 5% $CO_2$. Supplemented with feed and glucose as needed. Temperature shift to 32°C on day 5. Cells were harvested on day 14.

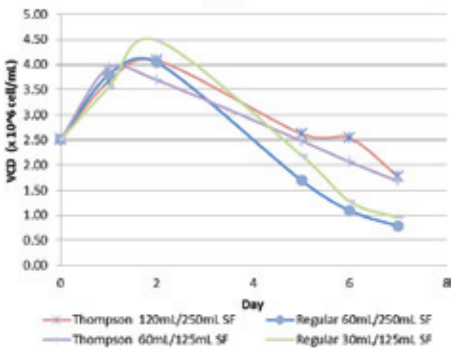
## Double the Volume with Thomson Optimum Growth™ Flasks

### Protein Titer

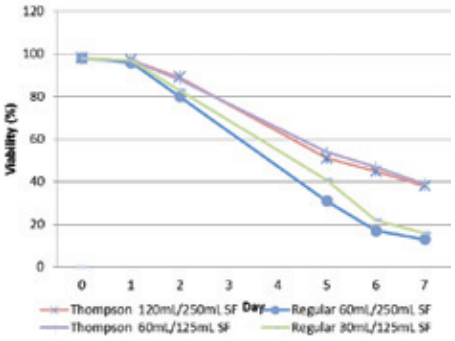


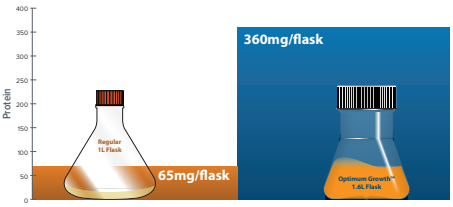

# 293 transient production results: Case 1

### VCD




### Viability

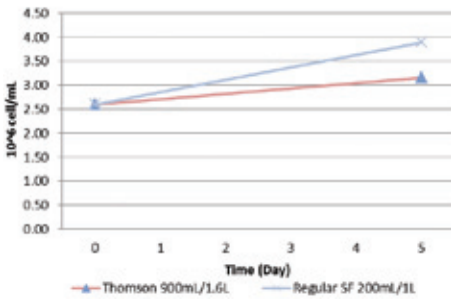


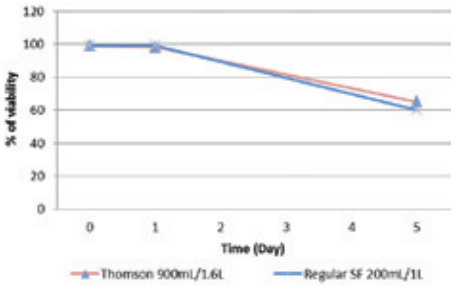

# 293 transient production results: Case 2

**900mL(WV)/1.6L Thomson vs 200mL(WV)/Regular SF1L**

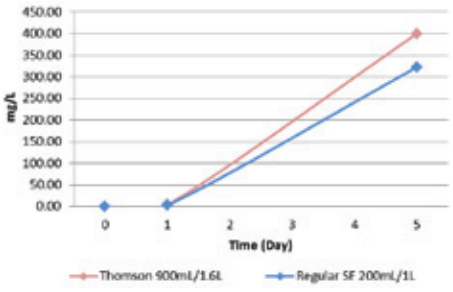
### VCD




### Culture Cell Viability

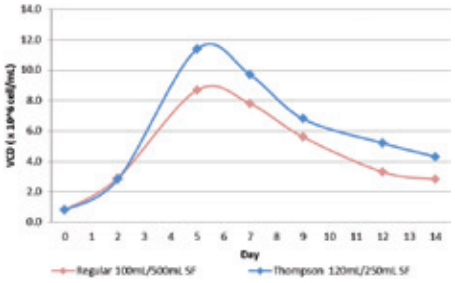



### Protein Yield

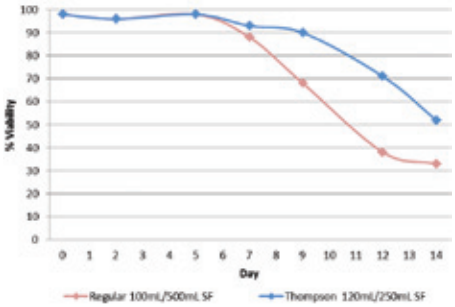


## CHO stable pool production results

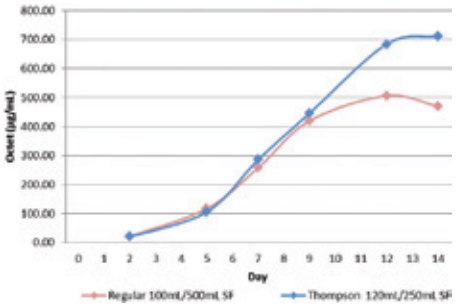
### VCD




### Culture Viability




### Protein Titer




## Conclusion

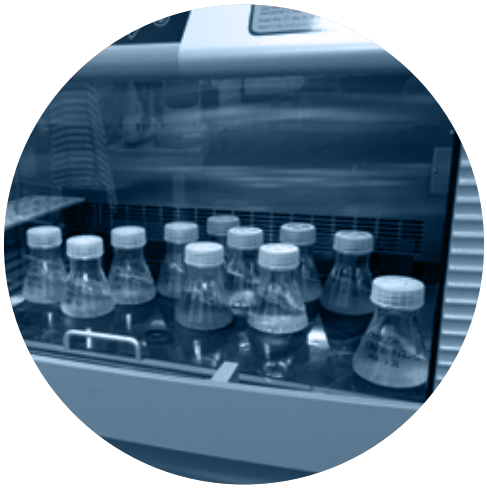
### Transient protein expression (293)

- Both type of flasks support comparable peak VCD
- Thomson Shake Flask maintained higher VCD and viability
- Thomson Shake Flask boost protein yield more than 20%

### Stable pool protein expression (CHO)

- Thomson Shake Flask supported higher peak VCD (11.4 vs 8.7 x 10^6 cell /mL)
- Thomson Shake Flask maintained higher culture VCD and viability
- Extended culture life for 2 days if based on the harvesting criteria
- Thomson Shake Flask results 50% titer increase


Optimum Growth™ 125mL Flasks in a shaker for cell line development



Optimum Growth™ 250mL Flasks with CHO & HEK293 Cells in shaker

# High & Low Expressing Proteins in HEK293 Cells

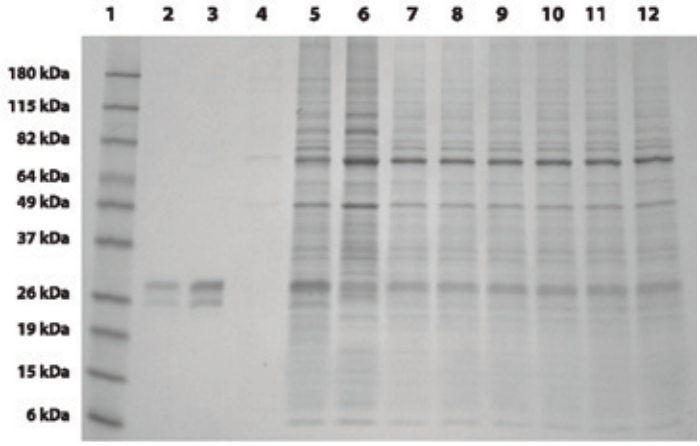

Corning® 3L Flask
*(1L Working Volume)*

Optimum Growth™ 5L Flask
*(3L Working Volume)*

## Low Expressing Gel

This gel shows equal bands from 5 replicates of a low expressing protein, producing roughly 10 to 20 mg/L.

1. Benchmark Pre-Stained Protein Ladder
2. Purified protein, 100 ng control
3. Purified protein, 200ng control
4. Untransfected cells, -ve control
5. +ve control
6. +ve control
7. Protein of interest, 5L Combined Flasks #1-5
8. Protein of interest, 5L Flask #1
9. Protein of interest, 5L Flask #2
10. Protein of interest, 5L Flask #3
11. Protein of interest, 5L Flask #4
12. Protein of interest, 5L Flask #5




4-20% SDS-PAGE Quick Blue Stain Commassie Gel
Expected MW of dimer 24.5 kDa  Estimated expression level ~10-20 mg/L


Fernbach 2.8L Flask
*(1.5L Working Volume)*

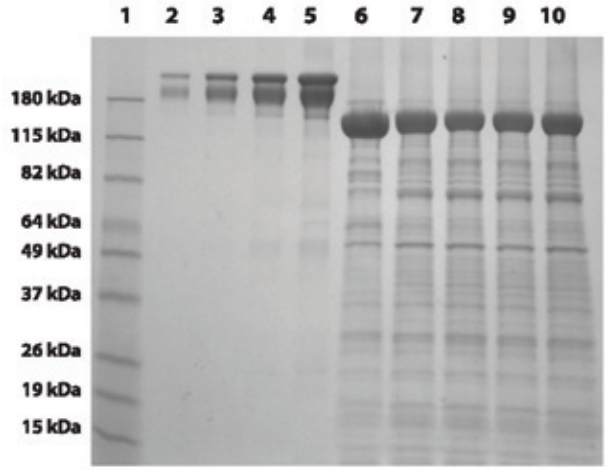
Fernbach 2.8L Flask
*(1.5L Working Volume)*

Optimum Growth™ 5L Flask
*(3L Working Volume)*

## High Expressing Gel

Thomson 5L flasks are consistently able to maximize production of your best expressers. This gel shows equal bands from 3 replicates of a high expressing protein, producing approximately 300 mg/L.

1. Benchmark Pre-Stained Protein Ladder
2. Purified mAb 100 ng control
3. Purified mAb 250 ng control
4. Purified mAb 500 ng control
5. Purified mAb 1000 ng control
6. +ve control
7. Protein of interest, 5L Flask #1
8. Protein of interest, 5L Flask #2
9. Protein of interest, 5L Flask #3
10. Protein of interest, 5L Combined Flasks #1-3




4-20% SDS-PAGE Quick Blue Stain Commassie Gel
Expected MW of dimer 159.4 kDa  Estimated expression level ~300 mg/L

## Conclusion

Thomson Optimum Growth™ Flasks not only ensure consistent expression from Hek293 strains, they can also increase shaker capacity. With the same footprint as a typical Corning® 3L flask and a culture volume of up to 3L, the Optimum Growth™ 5L Flask may increase production 200%, if not more, in the same space (this is construct dependent).

Most constructs express at higher levels in the Optimum Growth™ 5L flasks. This makes one Optimum Growth™ 5L equivalent to, if not greater than, two 3L flasks.

## Key Features

- **Aseptic sampling in the hood or on a shaker**
- **1-way valve for simple sterile sampling**
- **Prevent potential contamination – no need to open the flasks**

## Sampling Flask

The Optimum Growth™ Flasks provide several options for aseptic sampling in all flask sizes. The 125mL, 250mL, and 500mL Optimum Growth™ Flasks have an optional 1-way valve in the vented sample cap. The 5L Optimum Growth™ Flasks has an optional 1-way valve in the side of the flask.

**The aseptic sampling option is available for the 125mL, 250mL, 500mL & 5L Optimum Growth™ Flasks.**

## Vented Sampling Cap

The Optimum Growth™ Sampling Cap is ventilated for optimal cultivation and has a 1-way valve built into it. This reduces contamination and allows for aseptic sampling of cells while the flasks remain in the shaker, eliminating the need for transfer to the hood from the shaker.

The Optimum Growth™ Sampling Flasks come with a 0.2µm PTFE vented cap for optimum aeration during cultivation. The Thomson vented caps create a safe aseptic barrier from harmful contaminants, while the large surface area creates an optimum air exchange for cell growth.

**Sample Flasks have ventilated caps for optimum aeration during cultivation.**



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# Comparison of Old vs Thomson Sampling Method

## OLD Sampling Method:

1. Remove flask from shaker
2. Spray down flask before putting in the hood
3. Placing flask in the hood
4. Removing cap
5. Take sample
6. Replace cap
7. Put back in shaker

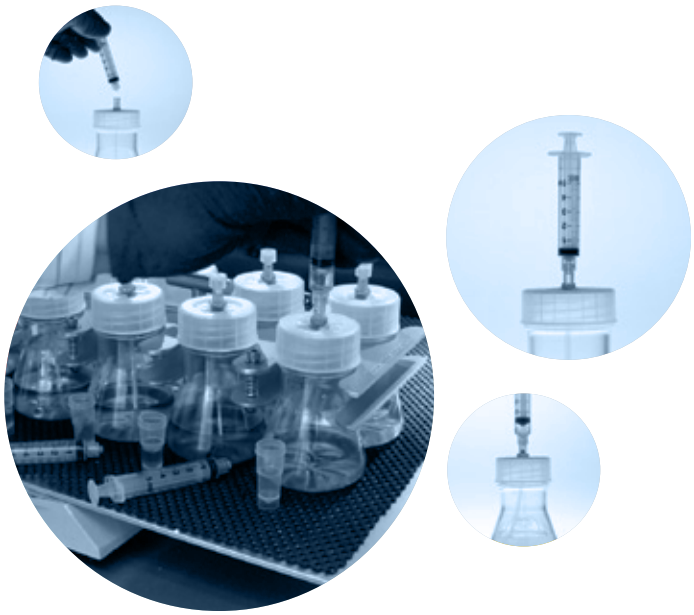
## Thomson Improved Sampling Method:

1. Connect syringe to luer lock on cap
2. Sample flask while in the shaker
3. Remove syringe

# Simpler Sampling in the Shaker

Thomson's improved sampling method allows you to sample directly in the shaker without the need to remove caps or use a deteriorating needle septum.

1. Open shaker
2. Attach syringe to sampling port and withdraw the sample
3. Remove syringe & close shaker



| Sampling Flask w/ Vented Cap Specifications | | | | |
|---|---|---|---|---|
| **Flask Size** | **125mL** | **250mL** | **500mL** | **5L** |
| **Part #** | 931110-SP | 931111-SP | 931112-SP | 931116-PORT-E |
| **Image** |  |  |  |  |
| **Description** | Optimum Growth™ 125mL Flask w/ Sampling Port I Sterile | Optimum Growth™ 250mL Flask w/ Sampling Port I Sterile | Optimum Growth™ 500mL Flask w/ Sampling Port I Sterile | Optimum Growth™ 5L Flask w/ Sampling Port I Sterile |
| **Flask Connection** | Male Luer Lock | Male Luer Lock | Male Luer Lock | Male Luer Lock |
| **Tubing Connection** | n/a | n/a | n/a | n/a |
| **Sample Tubing Volume** | 163µL | 218µL | 313µL | 381µL |
| **Top Style** | Threaded | Threaded | Threaded | Threaded |
| **Cap Material** | PP (polypropylene) | PP (polypropylene) | PP (polypropylene) | PP (polypropylene) |
| **Sterility** | $10^{-6}$ | $10^{-6}$ | $10^{-6}$ | $10^{-6}$ |
| **Air Filter/Ventilation** | 0.2µm PTFE for cultivation & pressure relief | 0.2µm PTFE for cultivation & pressure relief | 0.2µm PTFE for cultivation & pressure relief | 0.2µm PTFE for cultivation & pressure relief |
| **Qty/Case** | 50 | 50 | 25 | 4 |

## Key Features

- **Sterile tube fuse inoculation**
- **1-way valve sampling allowing for a simple use in a shaker**
- **Eliminate the need for under 20L cell bags**
- **Replaces current process requiring tube fusing for inoculation**
- **Consistently allows for multiple day additions**
- **Allows for simple use within a shaker**
- **Great for aseptic manufacturing; never any opening needed preventing potential contamination**

# Multiported Optimum Growth™ Transfer & Feed Flask

The multiported flask  is completely aseptic, making it the perfect start for initial seed cultures that inoculate bioreactors in multiple stages of clinical drug production. Other uses for the Multiported Optimum Growth™ Flasks include maintaining processes requiring long term duration cell culture and other manufacturing functions.

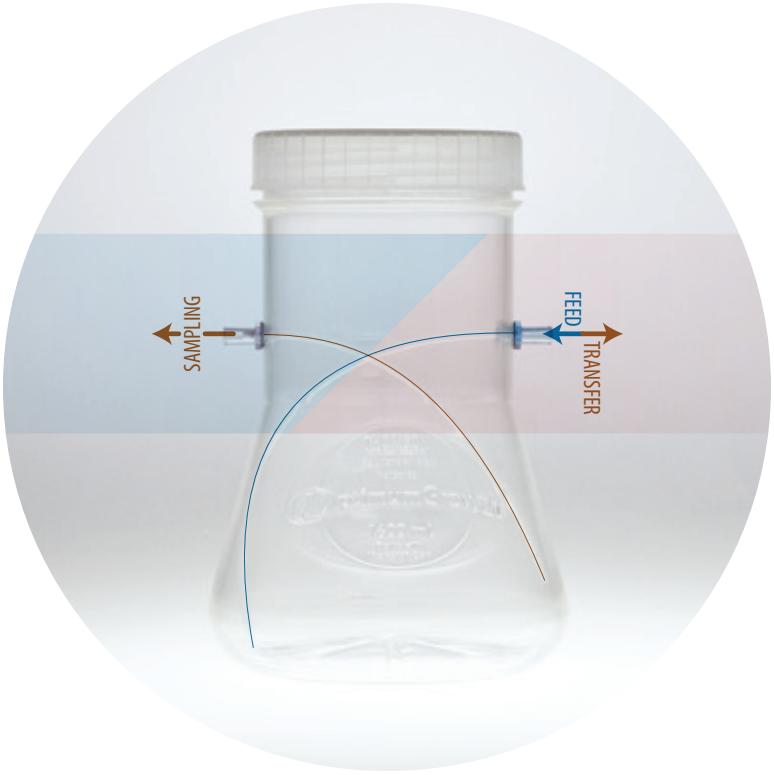
Born out of necessity, the Multiported Optimum Growth™ Flask has replaced the need for bags to start seed cultures for the inoculation of bioreactors in biopharmaceutical companies

5L TRT Flask, Transfer/Feed side

5L TRT Flask, Sample port side

# Multiported Optimum Growth™ Transfer & Feed Explained

One way sample port allows safe sampling of cells while the flasks remain in the shaker.




Two way port allows feeding of media during growth and transfer to bioreactor for seeding a larger production growth.

| Multiported Optimum Growth™ Transfer & Feed Flask Specifications | | |
|---|---|---|
| **Flask Size** | **1.6L** | **5L** |
| **Part #** | 931113-PORT-TRT | 931116-PORT-TRT-F |
| **Image** |  |  |
| **Description** | Multiported Optimum Growth™ 1.6L Flask w/ Bidirectional Transfer/ Feed & Sampling Ability \| Sterile | Multiported Optimum Growth™ 5L Flask w/ Bidirectional Transfer/Feed & Sampling Ability \| Sterile |
| **Flask Connection** | Male Luer Lock | Male Luer Lock |
| **Tubing Connection** | Tube Fuse | Tube Fuse |
| **Tubing Diameter** | C-Flex® 16 ID: 1/8" (3.1mm), OD: 1/4" (6.35mm) | C-Flex® 16 ID: 1/8" (3.1mm), OD: 1/4" (6.35mm) |
| **Tubing** | Chemically resistant, heat sealable, flexible | Chemically resistant, heat sealable, flexible |
| **Tubing Length** | 24" (609.6mm) | 24" (609.6mm) |
| **Sample Tubing Volume** | 326µL | 381µL |
| **Top Style** | Threaded | Threaded |
| **Cap Material** | PP (polypropylene) | PP (polypropylene) |
| **Sterility** | $10^{-6}$ | $10^{-6}$ |
| **Air Filter Ventilation** | 0.2µm PTFE vent filter | 0.2µm PTFE vent filter |
| **Qty/Case** | 12 | 4 |

## Key Features

- **Transfer from an Optimum Growth™ Flask to another Flask, cell bag or bioreactor**
- **Gravity feed keeps cells stress free**
- **Allows for simple aseptic transfer outside of hood**

# Inversion Transfer Cap For 1.6L – 5L

The Sterile Inversion Transfer Caps (patented), allow for the efficient aseptic transfer of media or cells to cell bags, bioreactors, or flasks (from all manufacturers).

The Inversion Transfer Cap works with the 1.6L, 2.8L and 5L Thomson Optimum Growth™ Flasks (patented). Simply, replace the culture cap with the Transfer Cap and connect to your vessel of choice.

# How to Transfer?

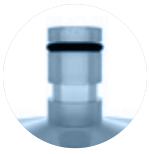
To transfer, invert the Optimum Growth™ Flask and let gravity do the rest. The Optimum Growth™ Flask and Transfer Cap System eliminates the need to transfer cells to an intermediate flask for scale up. Inversion or gravity feed has the lowest shear force of any transfer method available.

The Inversion Transfer Cap in conjunction with the 1.6L, 2.8L and 5L Thomson Optimum Growth™ Flasks (patented) product line can be used for reagent addition/seeding of larger bioreactors cell bags, or other liquid media transfers.

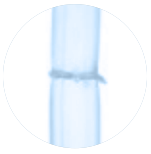
## Connection Options

**Quick Connect**

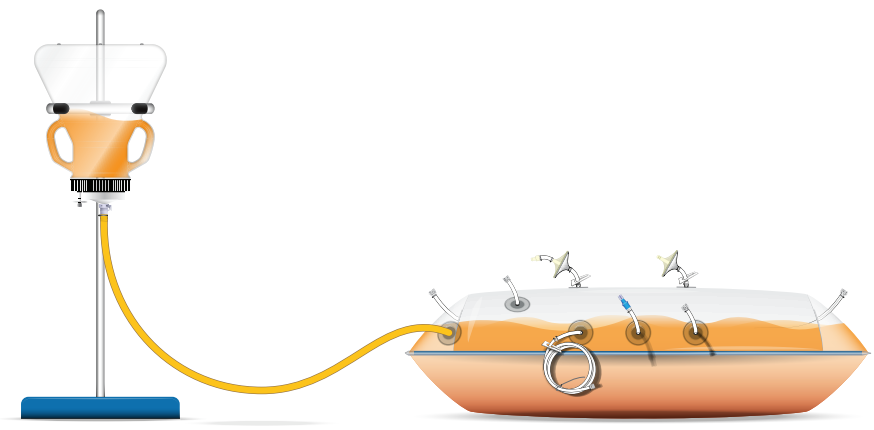
**Luer Lock**



**Quick Connect**



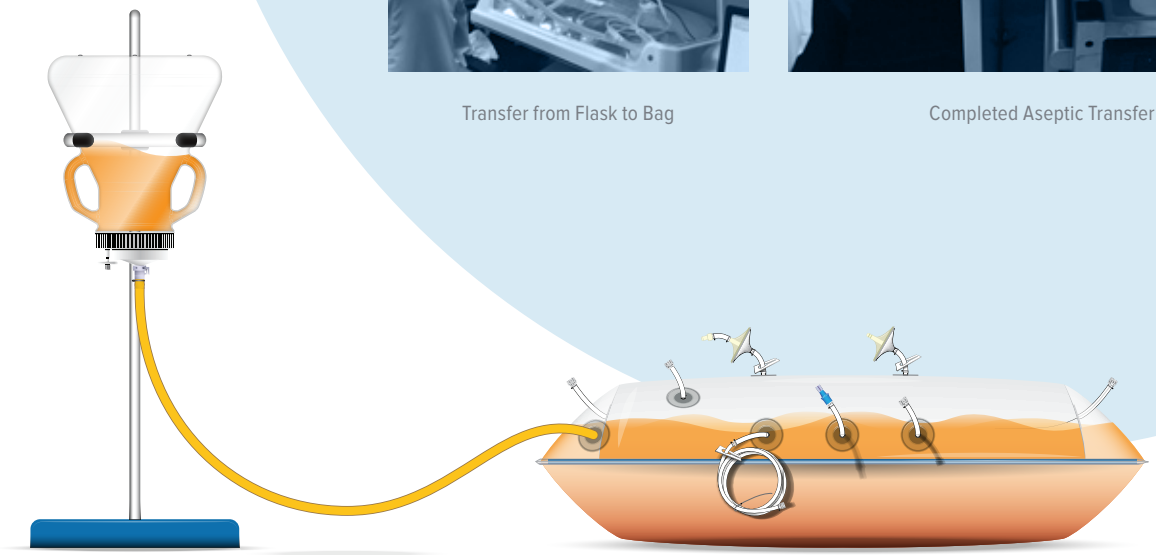
**Tube Fuse**



# Transfection/Scale-Up from Optimum Growth™ 5L Flask to Bag

Transfer from Flask to Bag

Completed Aseptic Transfer outside of hood

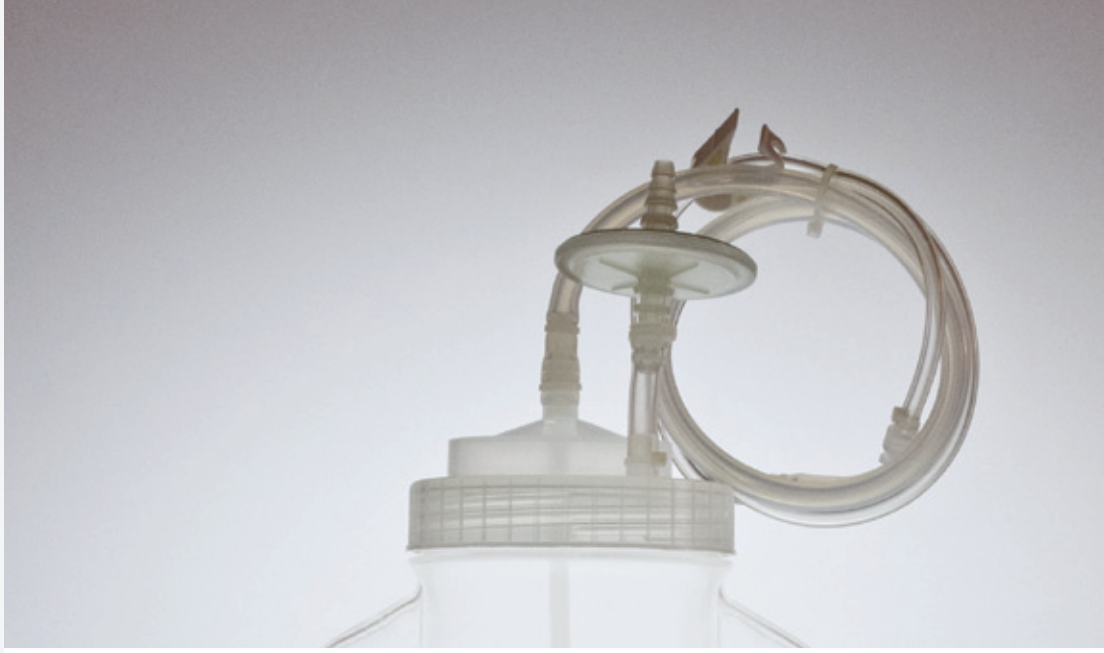


Stand with Ring are available for hands free transfer.

| Inversion Transfer Cap Accessories | | | | |
|---|---|---|---|---|
| **Flask Size** | **1.6L** | **1.6L** | **5L** | **5L** |
| **Part #** | 931609 | 931700 | 931606 | 931607 |
| **Image** |  |  |  |  |
| **Description** | Stand with Ring for Inverting Optimum Growth™ 1.6 & 2.8L Flasks with Inversion Transfer Cap | Ring Only for Inverting Optimum Growth™ 1.6 & 2.8L Flasks requires a 22" stand | Stand with Ring for Inverting Optimum Growth™ 5L Flasks with Inversion Transfer Cap | Ring Only for Inverting Optimum Growth™ 5L Flask requires a 22" stand |
| **Stand Height** | 22" | n/a | 22" | n/a |
| **Ring Diameter** | 5" | 5" | 7" | 7" |
| **Qty/Case** | 1 | 1 | 1 | 1 |

| Inversion Transfer Cap Specifications | | | | |
|---|---|---|---|---|
| **Flask Size** | **1.6L & 2.8L** | **1.6L & 2.8L** | **1.6L & 2.8L** | **1.6L & 2.8L** |
| **Part #** | 931706 | 931710 | 931705 | 931708 |
| **Image** |  |  |  |  |
| **Description** | Inversion Transfer Cap for Optimum Growth™ 1.6 & 2.8L Flask | Inversion Transfer Cap for Optimum Growth™ 1.6 & 2.8L Flask | Inversion Transfer Cap for Optimum Growth™ 1.6 & 2.8L Flask | Inversion Transfer Cap for Optimum Growth™ 1.6 & 2.8L Flask |
| **Tubing Connection** | 7/16” (11.1mm) Male Connection | Tube Fuse/Female Luer Lock | Tube Fuse | Tube Fuse |
| **Tubing Diameter** | n/a | C-Flex® 16 ID: 1/8” (3.1mm), OD: 1/4” (6.35mm) | C-Flex® 16 ID: 1/8” (3.1mm), OD: 1/4” (6.35mm) | C-Flex® 24 ID: 3/16” (4.76mm), OD: 7/16” (11.1mm) |
| **Tubing** | n/a | Chemically resistant, heat sealable, flexible | Chemically resistant, heat sealable, flexible | Chemically resistant, heat sealable, flexible |
| **Tubing Length** | n/a | 24” (609.6mm) | 24” (609.6mm) | 24” (609.6mm) |
| **Top Style** | Threaded | Threaded | Threaded | Threaded |
| **Cap Material** | PP (polypropylene) | PP (polypropylene) | PP (polypropylene) | PP (polypropylene) |
| **Sterility** | $10^{-6}$ | $10^{-6}$ | $10^{-6}$ | $10^{-6}$ |
| **Air Filter Ventilation** | 0.2µm PTFE vent filter | 0.2µm PTFE vent filter | 0.2µm PTFE vent filter | 0.2µm PTFE vent filter |
| **Qty/Case** | 4 | 4 | 4 | 4 |

| Inversion Transfer Cap Specifications | | | | | |
|---|---|---|---|---|---|
| **Flask Size** | **5L** | **5L** | **5L** | **5L** | **5L** |
| **Part #** | 931594 | 931596 | 931616 | 931595 | 931598 |
| **Image** |  |  |  |  |  |
| **Description** | Inversion Transfer Cap for Optimum Growth™ 5L Flask | Inversion Transfer Cap for Optimum Growth™ 5L Flask | Inversion Transfer Cap for Optimum Growth™ 5L Flask | I Inversion Transfer Cap for Optimum Growth™ 5L Flask | Inversion Transfer Cap for Optimum Growth™ 5L Flask |
| **Tubing Connection** | 1/4” (6.35mm) Barb | 7/16” (11.1mm) Barb | Tube Fuse/Female Luer Lock | Tube Fuse | Tube Fuse |
| **Tubing Diameter** | n/a | n/a | C-Flex® 16 ID: 1/8” (3.1mm), OD: 1/4” (6.35mm) | C-Flex® 16 ID: 1/8” (3.1mm), OD: 1/4” (6.35mm) | C-Flex® 24 ID: 3/16” (4.76mm), OD: 7/16” (11.1mm) |
| **Tubing** | n/a | n/a | Chemically resistant, heat sealable, flexible | Chemically resistant, heat sealable, flexible | Chemically resistant, heat sealable, flexible |
| **Tubing Length** | n/a | 24” (609.6mm) | 24” (609.6mm) | 24” (609.6mm) | 24” (609.6mm) |
| **Top Style** | Threaded | Threaded | Threaded | Threaded | Threaded |
| **Cap Material** | PP (polypropylene) | PP (polypropylene) | PP (polypropylene) | PP (polypropylene) | PP (polypropylene) |
| **Sterility** | $10^{-6}$ | $10^{-6}$ | $10^{-6}$ | $10^{-6}$ | $10^{-6}$ |
| **Air Filter Ventilation** | 0.2µm PTFE vent filter | 0.2µm PTFE vent filter | 0.2µm PTFE vent filter | 0.2µm PTFE vent filter | 0.2µm PTFE vent filter |
| **Qty/Case** | 4 | 4 | 4 | 4 | 4 |



## Key Features

- **Tube fuse for aseptic transfer of media or cells into or out of flasks, cell bags, & bioreactors**
- **Bidirectional Transfer Cap with a downstem allows for pumping of liquid into or out of an Optimum Growth™ Flask**
- **Available for 1.6L & 5L Optimum Growth™ Flasks**

# Bidirectional Transfer Cap For 1.6-L – 5L

The Sterile Optimum Growth™ Bidirectional Transfer Caps (patented) with downstem, allow for easy aseptic transfer of media or cells into and/or out of cell bags, bioreactors, and flasks (from all manufacturers).

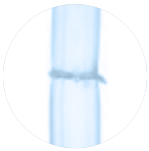
The Bidirectional Transfer Cap with downstem works with the 1.6L, 2.8L and 5L Thomson Optimum Growth™ Flasks (patented) and a peristaltic pump. Simply, replace the culture cap with the Transfer Cap and connect to your vessel of choice.

## How to Transfer or Feed

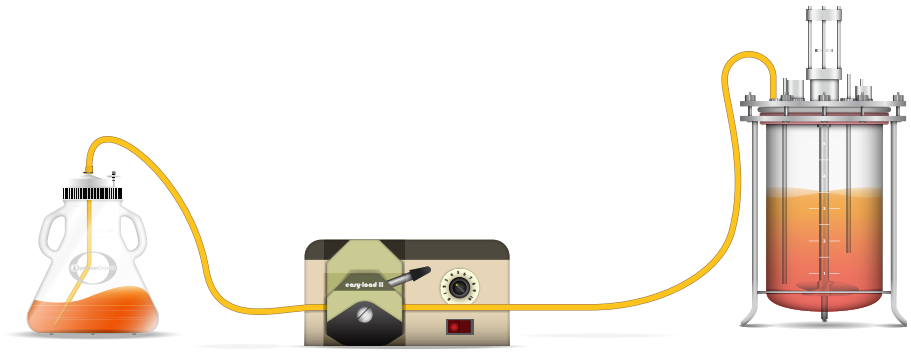
1. Replace with Bidirectional Transfer Cap
2. Connect to your receiving vessel by Tube Fusing or using our Luer Lock option
3. Place the silicone tubing in the peristaltic pump head
4. Liquid can then be pumped either into or out of the flask

## Connection Options

**Luer Lock**



**Tube Fuse**





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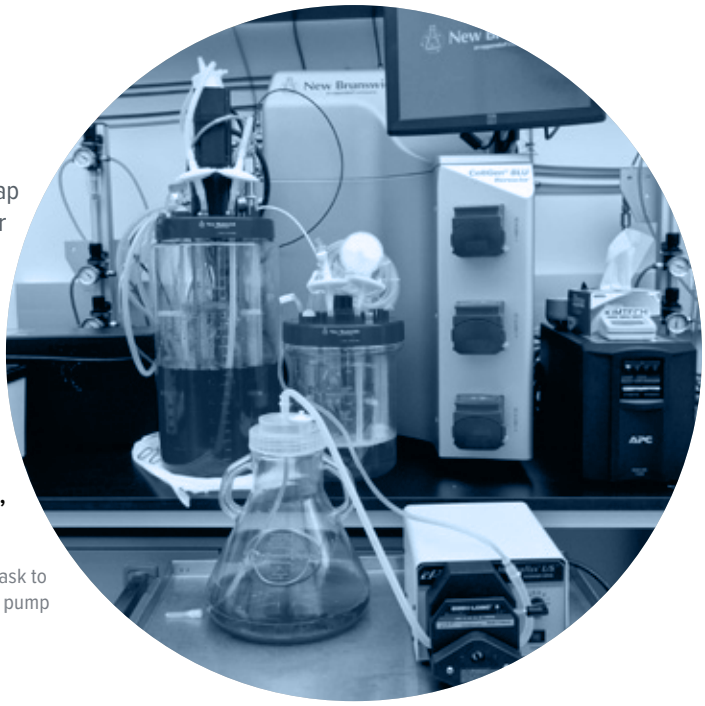
Optimum Growth™ Flasks (patented) in conjunction with the Transfer Cap System eliminates the need to move cells to an intermediate transfer for scale up or seed cultures. The ability to pump into the Optimum Growth™ Flask (patented) makes filling with media from a bulk source a simple aseptic method. The Transfer Cap in conjunction with the Thomson Optimum Growth™ Flask product line can be used for reagent addition, seeding of larger bioreactors or cell bags, pumping of media into flasks from large drums or bags of media, and other liquid media transfers into and out of bioreactors.

**The Optimum Growth™ Flasks come in multiple sizes of 125mL, 250mL, 500mL, 1.6L, 2.8L and our popular 5L.**



Transfer from flask to bioreactor with pump

Thomson Instrument Company is not affiliated with New Brunswick

| Bidirectional Transfer Cap Specifications | | | | | |
|---|---|---|---|---|---|
| **Flask Size** | **1.6L** | **1.6L** | **2.8L** | **5L** | **5L** |
| **Part #** | 931702 | 931704 | 931804 | 931618 | 931614 |
| **Image** |  |  |  |  |  |
| **Description** | Bidirectional Transfer Cap for Optimum Growth™ 1.6L Flask | Bidirectional Transfer Cap for Optimum Growth™ 1.6L Flask | Bidirectional Transfer Cap for Optimum Growth™ 2.8L Flask | Bidirectional Transfer Cap for Optimum Growth™ 5L Flask | Bidirectional Transfer Cap for Optimum Growth™ 5L Flask |
| **Tubing Connection** | Tube Fuse/Luer Lock | Tube Fuse | Tube Fuse | Tube Fuse/Luer Lock | Tube Fuse |
| **Tubing Diameter** | C-Flex® 16 ID: 1/8" (3.1mm), OD: 1/4" (6.35mm) | C-Flex® 16 ID: 1/8" (3.1mm), OD: 1/4" (6.35mm) | C-Flex® 16 ID: 1/8" (3.1mm), OD: 1/4" (6.35mm) | C-Flex® 16 ID: 1/8" (3.1mm), OD: 1/4" (6.35mm) | C-Flex® 16 ID: 1/8" (3.1mm), OD: 1/4" (6.35mm) |
| **Tubing** | Chemically resistant, heat sealable, flexible | Chemically resistant, heat sealable, flexible | Chemically resistant, heat sealable, flexible | Chemically resistant, heat sealable, flexible | Chemically resistant, heat sealable, flexible |
| **Tubing Length** | 24" (609.6mm) | 24" (609.6mm) | 24" (609.6mm) | 24" (609.6mm) | 24" (609.6mm) |
| **Top Style** | Threaded | Threaded | Threaded | Threaded | Threaded |
| **Cap Material** | PP (polypropylene) | PP (polypropylene) | PP (polypropylene) | PP (polypropylene) | PP (polypropylene) |
| **Sterility** | $10^{-6}$ | $10^{-6}$ | $10^{-6}$ | $10^{-6}$ | $10^{-6}$ |
| **Air Filter Ventilation** | 0.2µm PTFE vent filter | 0.2µm PTFE vent filter | 0.2µm PTFE vent filter | 0.2µm PTFE vent filter | 0.2µm PTFE vent filter |
| **Qty/Case** | 8 | 8 | 8 | 8 | 8 |

## Key Features

- 0.2µm filter, eliminates multiple filtration steps and in some cases centrifugation*
- Significant time savings versus traditional spin down technique
- Cell clarification of low or high density cultures of CHO stable, CHO transient, HEK293, hybridoma, and other mammalian cell lines
- Eliminates transfer steps: The Rapid Clear® Cap screws directly onto the Optimum Growth™ Flask
- Secondary cap attaches to a new Optimum Growth™ Flask or to a storage container with a Luer lock

Current Method

New Method

# Rapid Clear®

The Thomson Optimum Growth™ Family of products is expanding into downstream processing with a revolutionary new technology that allows high speed clarification of cellular material. The filters work by simply switching the vented Optimum Growth™ Cap to the Rapid Clear® Cap. The only equipment required is a peristaltic pump. In initial testing the units can filter up to 2.5L-3L of high density culture, 6×10^6 -20×10^6 @ >70% viability, in approximately 18 minutes. This technique will transform the time consuming and laborious task of harvesting cells to a rapid walk away procedure.

| Rapid Clear® Cap 3000 Specifications | |
|---|---|
| Flask Size | 2.8L & 5L |
| Part # | 788116 |
| Image |  |
| Description | High-speed clarification of 2L–4L of cell culture \| Sterile |
| Tubing Connection | Transfer Cap |
| Tubing Diameter | Size 15 silicone tubing, ID: 3/16" (4.76mm), OD: 7/16" (11.1mm) |
| Tubing | Chemically resistant, flexible |
| Tubing Length | 48" (1219.2mm) |
| Cap Material | PP (polypropylene) |
| Qty/Case | 8 |

| Optimum Growth™ Flask Specifications | | | | | | |
|---|---|---|---|---|---|---|
| **Flask Size** | **125mL** | **250mL** | **500mL** | **1.6L** | **2.8L** | **5L** |
| **Part #** | 931110 | 931111 | 931112 | 931113 | 931114 | 931116 |
| **Image** |  |  |  |  |  |  |
| **Description** | Optimum Growth™ 125mL Flask w/ Vent Cap \| Sterile | Optimum Growth™ 250mL Flask w/ Vent Cap \| Sterile | Optimum Growth™ 500mL Flask w/ Vent Cap \| Sterile | Optimum Growth™ 1.6L Flask w/ Vent Cap \| Sterile | Optimum Growth™ 2.8L Flask w/ Vent Cap \| Sterile | Optimum Growth™ 5L Flask w/ Vent Cap \| Sterile |
| **Qty/Case** | 50 | 50 | 25 | 12 | 6 | 4 |

| Sampling Flask w/ Vented Cap Specifications | | | | |
|---|---|---|---|---|
| **Flask Size** | **125mL** | **250mL** | **500mL** | **5L** |
| **Part #** | 931110-SP | 931111-SP | 931112-SP | 931116-PORT-E |
| **Image** |  |  |  |  |
| **Description** | Optimum Growth™ 125mL Flask w/ Sampling Port & Vent Cap \| Sterile | Optimum Growth™ 250mL Flask, w/ Sampling Port & Vent Cap \| Sterile | Optimum Growth™ 500mL Flask, w/ Sampling Port & Vent Cap \| Sterile | Optimum Growth™ 5L Flask, w/ Sampling Port & Vent Cap \| Sterile |
| **Qty/Case** | 50 | 50 | 25 | 4 |

| Multiported Flask w/ Vented Cap Specifications | | |
|---|---|---|
| **Flask Size** | **1.6L** | **5L** |
| **Part #** | 931113-PORT-TRT | 931116-PORT-E-TRT |
| **Image** |  |  |
| **Description** | Multiported Optimum Growth™ 1.6L Flask w/ Bidirectional Transfer/Feed & Sampling Ability \| Sterile | Multiported Optimum Growth™ 5L Flask w/ Bidirectional Transfer/Feed & Sampling Ability \| Sterile |
| **Qty/Case** | 12 | 4 |

| Rapid Clear® Cap 3000 Specifications | |
|---|---|
| **Flask Size** | 2.8L & 5L |
| **Part #** | 788116 |
| **Image** |  |
| **Description** | High-speed clarification of 2–4L of cell culture for use with 2.8 & 5L Optimum Growth™ Flasks |
| **Qty/Case** | 8 |

| Inversion Transfer Cap Specifications | | | | |
|---|---|---|---|---|
| **Flask Size** | **1.6L & 2.8L** | **1.6L & 2.8L** | **1.6L & 2.8L** | **1.6L & 2.8L** |
| **Part #** | 931706 | 931710 | 931705 | 931708 |
| **Image** |  |  |  |  |
| **Description** | Inversion Transfer Cap for Optimum Growth™ 1.6 & 2.8L Flask, 7/16" Male Connection \| Sterile | Inversion Transfer Cap for Optimum Growth™ 1.6 & 2.8L Flask, with 2' C-Flex® 16 Tubing w/ Luer Lock \| Sterile | Inversion Transfer Cap for Optimum Growth™ 1.6 & 2.8L Flask, 2' C-Flex® 16 (1/4") Tubing \| Sterile | Inversion Transfer Cap for Optimum Growth™ 1.6 & 2.8L Flask, 2' C-Flex® 24 Tubing \| Sterile |
| **Qty/Case** | 4 | 4 | 4 | 4 |

| Inversion Transfer Cap Specifications | | | | | |
|---|---|---|---|---|---|
| **Flask Size** | **5L** | **5L** | **5L** | **5L** | **5L** |
| **Part #** | 931594 | 931596 | 931616 | 931595 | 931598 |
| **Image** |  |  |  |  |  |
| **Description** | Inversion Transfer Cap for Optimum Growth™ 5L Flask, 1/4" Barb Connection \| Sterile | Inversion Transfer Cap for Optimum Growth™ 5L Flask, 7/16" Male Connection \| Sterile | Inversion Transfer Cap for Optimum Growth™ 5L Flask, w/ 2' C-Flex® 16 (1/4") Tubing w/ Luer Lock \| Sterile | Inversion Transfer Cap for Optimum Growth™ 5L Flask, 2' C-Flex® 16 (1/4") Tubing \| Sterile | Inversion Transfer Cap for Optimum Growth™ 5L Flask, 2' C-Flex® 24 Tubing \| Sterile |
| **Qty/Case** | 4 | 4 | 4 | 4 | 4 |

| Bidirectional Transfer Cap Specifications | | | | | |
|---|---|---|---|---|---|
| **Flask Size** | **1.6L** | **1.6L** | **2.8L** | **5L** | **5L** |
| **Part #** | 931702 | 931704 | 931804 | 931618 | 931614 |
| **Image** |  |  |  |  |  |
| **Description** | Bidirectional Transfer Cap for Optimum Growth™ 1.6L Flask, 2' Tubing w/ Luer Lock \| Sterile | Bidirectional Transfer Cap for Optimum Growth™ 1.6L Flask, 2' C-Flex® 16 (1/4") tubing \| Sterile | Bidirectional Transfer Cap for Optimum Growth™ 2.8L Flask, 2' C-Flex® 16 (1/4") tubing \| Sterile | Bidirectional Transfer Cap for Optimum Growth™ 5L Flask, 2' Tubing w/ Luer Lock \| Sterile | Bidirectional Transfer Cap for Optimum Growth™ 5L Flask, 2' C-Flex® 16 (1/4") tubing \| Sterile |
| **Qty/Case** | 8 | 8 | 8 | 8 | 8 |

# Accessories

| Optimum Growth™ Accessories | | |
|---|---|---|
| **Flask Size** | **125mL** | **250mL** |
| **Part #** | 1212900 | 1212905 |
| **Image** |  |  |
| **Description** | 8 Position Carrier for Optimum Growth™ 125mL Flask (931110) | 8 Position Carrier for Optimum Growth™ 250mL Flask (931111) |
| **Flask Capacity** | 8 | 8 |
| **Dimensions** | 10.75" x 5" | 13.4" x 6" |
| **Qty/Case** | 1 | 1 |

| Optimum Growth™ Accessories | | | | | |
|---|---|---|---|---|---|
| **Flask Size** | **125mL** | **250mL** | **500mL** | **1.6L, 2.8L & 5L** | **1.6L, 2.8L & 5L** |
| **Part #** | 899110 | 899111 | 899112 | 899116 | 899600-B |
| **Image** |  |  |  |  |  |
| **Description** | Thomson Vent Caps for Optimum Growth™ 125mL Flasks \| Sterile | Thomson Vent Caps for Optimum Growth™ 250mL Flasks \| Sterile | Thomson Vent Caps for Optimum Growth™ 500mL Flasks \| Sterile | Thomson Vent Caps for Optimum Growth™ 1.6, 2.8 & 5L Flasks \| Sterile | Thomson Solid Cap for Optimum Growth™ 1.6, 2.8 & 5L Flasks \| Sterile |
| **Qty/Case** | 50 | 50 | 25 | 24 | 24 |

| Inversion Transfer Cap Accessories | | | | |
|---|---|---|---|---|
| **Flask Size** | **1.6L** | **1.6L** | **5L** | **5L** |
| **Part #** | 931609 | 931700 | 931606 | 931607 |
| **Image** |  |  |  |  |
| **Description** | Stand with Ring for Inverting Optimum Growth™ 1.6 & 2.8L Flasks with Inversion Transfer Cap | Ring Only for Inverting Optimum Growth™ 1.6 & 2.8L Flasks requires a 22" stand | Stand with Ring for Inverting Optimum Growth™ 5L Flasks with Inversion Transfer Cap | Ring Only for Inverting Optimum Growth™ 5L Flask requires a 22" stand |
| **Qty/Case** | 1 | 1 | 1 | 1 |

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