ThermoFisher SCIENTIFIC

Single-use technologies

Modular perfusion workflow

Unlock the power of perfusion with preconfigured hardware and disposable systems

thermo scientific

Unlock the power of perfusion

Properly specified systems based on 50–500 L S.U.B.s allow rapid deployment with hassle-free compatibility

We have developed a module-based perfusion system that provides the building blocks to establish and run a 50–500 L continuous manufacturing process on your production floor. These pre-engineered modules combine to form a perfusion workflow to support high cell density and provide flexibility and configurable solutions to meet your specific needs.

Built for continuous bioproduction

Our modular perfusion workflow is ideally suited for high-density seed train intensification or as a compact production-scale bioreactor system operating at media exchange rates of 1–2 vessel volumes per day. This system allows you to realize the advantages of continuous cell culture production while helping to minimize development time and costs.

Single-use systems enable continuous processing

Thermo Scientific™ Single-Use Bioreactors (S.U.B.s), single-use mixing systems, and single-use storage solutions are widely used throughout the bioproduction industry. The combination of our hardware with Thermo Scientific™ Aegis™5-14 Bioprocess Containers (BPCs) provides a trusted backbone for continuous bioprocessing. This application-focused modular system enables completion of most process steps, including:

- Scalable media preparation and filtration
- Scalable sterile media hold
- Sterile fluid transfer
- Cell growth and monitoring
- Permeate transfer and pooling
- Cell bleed

Bioreactor enhancements and features for reliable perfusion

The Thermo Scientific™ HyPerforma™ Single-Use Bioreactor (S.U.B.) is our standard, fully functional bioreactor vessel to help ensure consistency in your perfusion workflows.

- Enhanced mixing systems, using a larger impeller
- Scalable and CO_2- and O_2-balanced sparging solution for enhanced mass transfer
- Foam sensing for automated foam control
- Simple connection to either alternating tangential flow (ATF) or tangential flow filtration (TFF) technologies
- Scalable from 50 L pilot scale to 500 L production working volumes
- Simple integration of conventional sensors, or easily customizable with single-use sensors
- Loads cells for accurately controlled liquid volume
- Integrated with best-in-class Emerson™ DeltaV™ control systems
- S.U.B. hardware ports specific to ATF perfusion systems
  - 50–250 L S.U.B. vessel with diameter cutout at 36 in. above floor for ATF6
  - 500 L S.U.B. vessel with diameter cutout at 41 in. above floor for ATF10

DynaDrive S.U.B.

Next-generation bioreactor for superior performance

The Thermo Scientific™ DynaDrive™ Single-Use Bioreactor (S.U.B.) is our latest advancement in S.U.B. technology that offers better performance and is scalable to larger volumes than previous bioreactors. This cube-shaped tank, with its unique stirred-tank design, utilizes a novel drive train with multiple impellers, which results in exceptional mixing capabilities and mass transfer. This makes it ideal for the high–cell density applications seen in perfusion cell culture workflows.

As with the standard HyPerforma S.U.B. offerings, the DynaDrive S.U.B. is compatible with conventional or single-use sensors, connects to either TFF or ATF perfusion systems, includes standard S.U.B. load cells and foam sensor, and easily integrates with Thermo Scientific™ HyPerforma™ G3Lite or G3Pro controllers. Additionally, the DynaDrive S.U.B. offers some key advantages:

- Hardware optimized for perfusion workflows with cutouts for large connectors
- Mixing times, power input per volume (PIV), and k_La performance optimized for modern cell culture processes >100 million cells/mL
- Improved seed train process—10:1 turndown ratio in the 50 L reactor and 20:1 turndown in the 500 L unit
- Ergonomically friendly hardware—designed with the user in mind and allows for consistent and uniform BPC loading
- Drive train integrated into the BPC—no external drive shaft required
- Enhanced drilled hole sparger (DHS) included for superior mass transfer performance

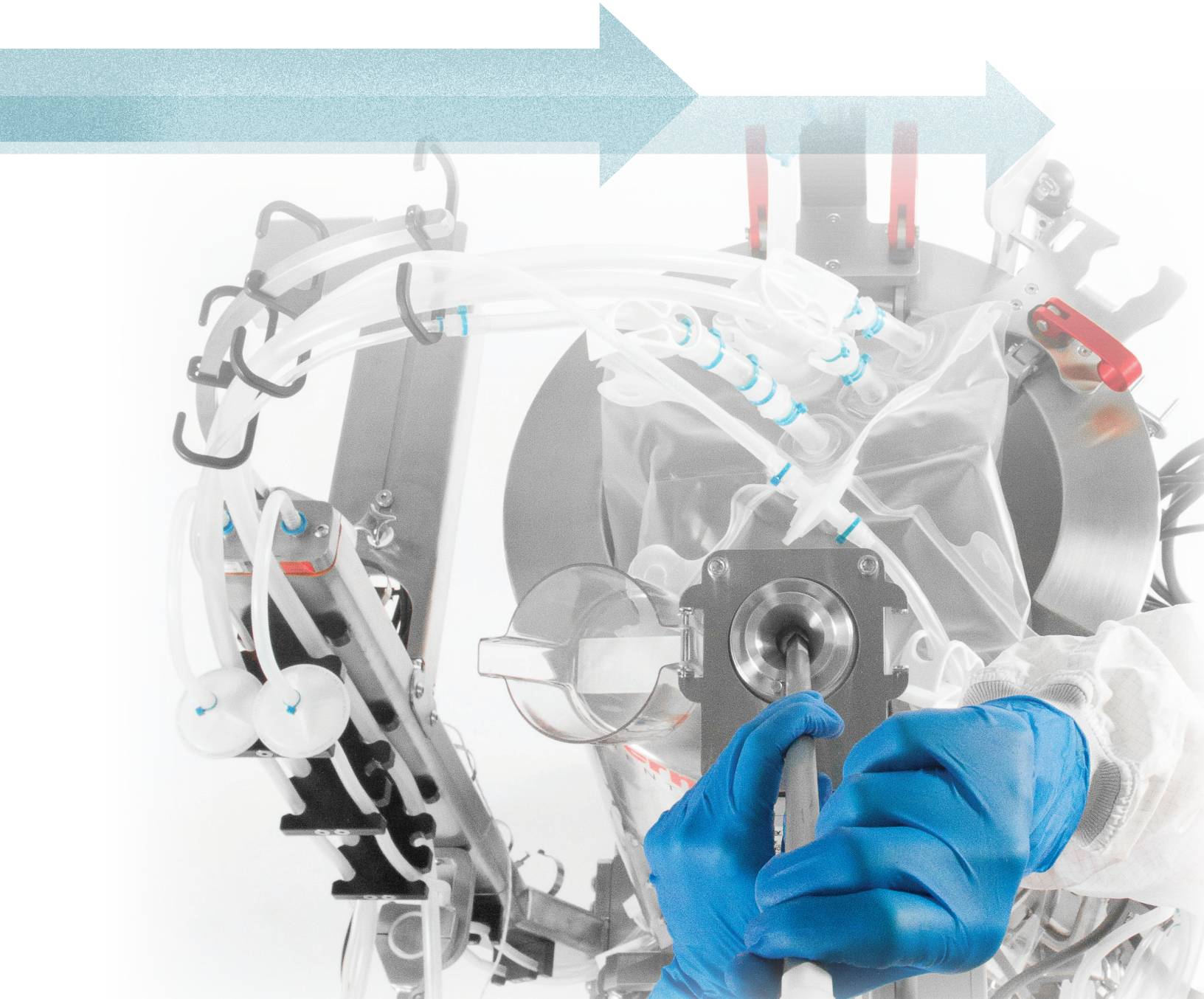
DynaDrive S.U.B. (50 L) and HyPerforma G3Lite Bioprocess Controller

DynaDrive S.U.B. (500 L) and HyPerforma G3Lite Bioprocess Controller

Continuous processing developments and advancements

While it is estimated that less than 10% of approved biologic products in the market are currently manufactured through perfusion or continuous processing, this method of production is gaining ground in its applicability for bioprocessing. Perfusion technology, the driving force for continuous manufacturing, was first used in the 1980s for the manufacture of sensitive proteins which, under traditional production, did not maintain their biological function. Later, users leveraged this method in the production of blood clotting factors, antibodies, and enzymes. The promise of greater productivity, high quality, and increased flexibility at more economical costs has renewed interest in this technology.

Improvements in single-use systems allow the implementation of high-density cultures through continuous manufacturing in emerging workflows. While progressive advances in media optimization and improved clone genetic selection increase stress on continuous single-use systems, strategic enhancements to the S.U.B. are integrated to counter the perceived limitations. Coupled with best-in-class media hydration, hold tanks, and bioreactor control systems, a continuous bioprocessing workflow is established.



Workflow explanation

A continuous processing workflow (Figure 1) allows cells to grow to higher cell densities within the bioreactor, in contrast to traditional batch or fed-batch processes. This is facilitated by the regular addition of fresh media and continuous removal of extracellular proteins and metabolic waste. Using perfusion, significant yields (as measured in grams of protein per cell per volume) are feasible at a smaller scale, meaning more product is produced in a reduced facility space. Due to the continuous nature of the process, increased cell production can be achieved over a shorter period of time. Regular replenishment of nutrients, combined with reduced buildup of waste products in the S.U.B., allows for consistent homogeneity in the vessel and a higher degree of control over culture conditions, which contribute to enhanced quality. Perfusion amplifies the benefits of single-use technologies, enabling more efficient use of production space and greater overall flexibility.

The resurgence in popularity of continuous manufacturing has led to increased focus on technologies that support perfusion as a complete workflow solution. With the appropriate hardware in place, those who wish to accomplish continuous manufacturing in the near future must augment their process with accessory products from a variety of sources. Thus, the selection of consumable products that both deliver high performance and connect seamlessly within your process remains a crucial decision.

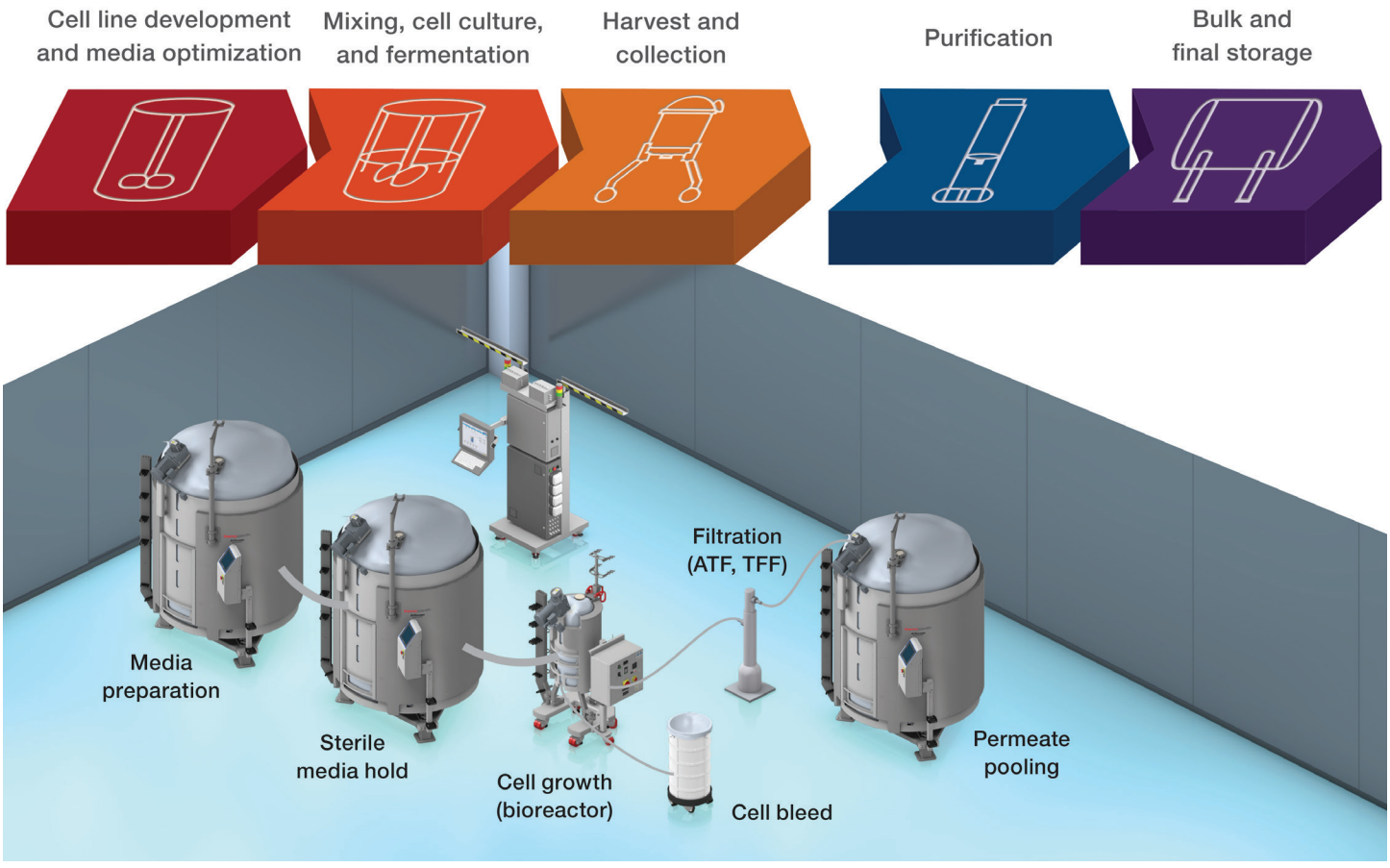


Figure 1. A continuous processing workflow.

Our open-architecture approach

Our modular workflow system offers a complete selection of consumables configured specifically for continuous processes. They provide the critical foundation for evolving your process to continuous, while leveraging our single-use mixers (S.U.M.s) and S.U.B.s. The Thermo Scientific™ Aegis™5-14 film platform provides exceptional performance and flexibility, making it the ideal choice for the demands of continuous manufacturing.

Our single-use products are configured with fit-for-purpose components sourced from approved partners. Each component is qualified to our rigorous requirements, which meet or exceed American Society of Mechanical Engineers-Bioprocessing Equipment (ASME-BPE) standards of working pressure, post-gamma stability, biocompatibility, cleanliness, and robustness. Our products are developed under the following test methods to help ensure the highest level of performance:

- International Organization for Standardization (ISO)
- United States Pharmacopeia (USP)
- European Pharmacopoeia (EP)
- American Society for Testing and Materials (ASTM)

All Thermo Scientific™ BPC products are manufactured under current good manufacturing practice (cGMP) conditions in ISO Class 7 clean areas to deliver high levels of quality and traceability. Redundant manufacturing capabilities on a global scale provide a strong assurance of product supply.

Our open-architecture approach delivers excellent options in customer choice for design optimization and risk mitigation. More than 20 years of application experience and product development in single-use systems has given us the professional experience to deliver innovative solutions and provide technical support in a variety of ways. Our investment in capacity expansion, automation, and particulate control demonstrates our strong commitment to excellence in manufacturing of consumables.

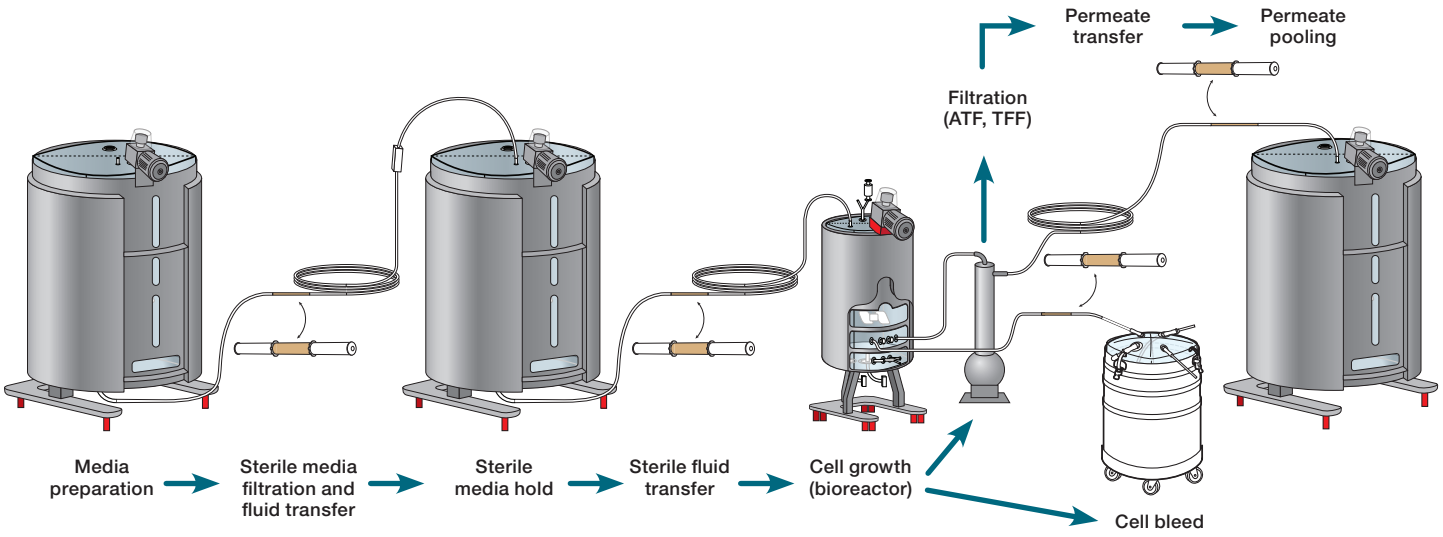


Figure 2. Open-architecture workflow approach.

Ordering information

S.U.B. hardware and enhanced S.U.B. for perfusion BPCs

See the **Bioproduction Product Offering brochure** for all BPCs and hardware options, including S.U.B. vessels, mixers, bins, and peripherals. To support the perfusion workflow and the recommended consumables outlined below, the standard 5:1 S.U.B. hardware is used as a basis for ordering, with recommended modifications including, where applicable, alternate motor mount, motor, and drive shaft. Please work with your Thermo Fisher Scientific representative to tailor a system to your process needs for each vessel size.

HyPerforma S.U.B. hardware

Size	Description	Cat. No.
50 L	50 L S.U.B. jacketed, 5:1, 120 VAC, load cell	SUB0050.8100
	50 L 2:1 drive shaft	SV50177.34
	50 L S.U.B. BPC with ATF connection	SH31170.01
	50 L S.U.B. BPC with TFF connection	SH31173.01
100 L	100 L S.U.B. jacketed, 5:1, 120 VAC, load cell	SUB0100.8200
	100 L 2:1 drive shaft	SV50177.14
	100 L S.U.B. BPC with ATF connection	SH31144.01
	100 L S.U.B. BPC with TFF connection	SH31171.01
250 L	250 L S.U.B. jacketed, 5:1, 120 VAC, load cell	SUB0250.8300
	250 L 2:1 oversized drive shaft	SV50959.09
	250 L 2:1 oversized motor block	SV50957.36
	500 L AC motor	SV50237.18
	250 L S.U.B. BPC with ATF connection	SH31143.01
	250 L S.U.B. BPC with TFF connection	SH31172.01
500 L	500 L S.U.B. jacketed, 5:1, 240 VAC, load cell	SUB0500.8400
	500 L 2:1 drive shaft	SV50177.36
	500 L S.U.B. BPC with ATF connection	SH31142.01
	500 L S.U.B. BPC with TFF connection	SH31169.01

DynaDrive S.U.B.s and BPCs

Description	Size	Cat. No.
DynaDrive Single-Use Bioreactor, 120 V	50 L	DDB0050.1011
	500 L	DDB0500.1011
DynaDrive Single-Use Bioreactor, 240 V	50 L	DDB0050.1021
	500 L	DDB0500.1021
DynaDrive Bioprocess Container, with ATF port	50 L	SH31192.02
	500 L	SH31193.02

50 L example workflow and ordering information for ATF or TFF

The following tables outline a sample workflow for a perfusion process using a 50 L S.U.B. operating at 40 L working volume, and a perfusion rate of two vessel volumes per day for 30 days. The workflow utilizes 1,000 L S.U.M.s as the main containers for media formulation, sterile media hold, and permeate pooling. Substitutions can be made as desired to meet individual process needs using alternative vessels such as Thermo Scientific™ imPULSE™ Single-Use Mixers (S.U.M.s), Thermo Scientific™ HyPerforma™ Smartainer™ BPCs, or Thermo Scientific plastic outer support containers; additionally, alternative vessel sizes are available. Work with your Thermo Fisher Scientific representative for 100 L, 250 L, and 500 L systems to tailor a system to your process.

Media preparation (ATF or TFF)

Item	Description	Qty	Cat. No.
Hardware	1,000 L S.U.M., jacketed, 120 VAC	1	SUM1000.9004
BPC	1,000 L S.U.M. BPC, powder-to-liquid	3	SH30974.04

Sterile media filtration and fluid transfer (ATF or TFF)

Item	Description	Details	Qty	Cat. No.
Fluid transfer extension	12.7 mm (1/2 in.) ID x 3.2 mm (1/8 in.) wall, C-Flex™ 374 tubing	1 m Capped—for welders	3	SH31083.01
Pump set	0.25 m (10 in.) C-Flex 374 tubing to 0.5 m (19.7 in.) PharMed™ BPT tubing to 0.25 m (10 in.) C-Flex 374 tubing	12.7 mm (1/2 in.) ID x 3.2 mm (1/8 in.) wall Capped—for welders	3	SH31101.01
Filter option	10 in. Opticap™ XL filter	NA	3	SH31159.21
Fluid transfer adaptor	9.5 mm (3/8 in.) ID x 3.2 mm (1/8 in.) wall to 12.7 mm (1/2 in.) ID x 3.2 mm (1/8 in.) wall, C-Flex 374 tubing	2 m Capped—for welders	3	SH31091.01
Fluid transfer extension	9.5 mm (3/8 in.) ID x 3.2 mm (1/8 in.) wall, C-Flex 374 tubing	5 m Capped—for welders	3	SH31082.03

Sterile media hold (ATF or TFF)

Item	Description	Qty	Cat. No.
Hardware	1,000 L S.U.M., jacketed, 120 VAC	1	SUM1000.9004
BPC	1,000 L S.U.M. BPC, liquid-to-liquid	1	SH30982.04

Sterile fluid transfer (ATF or TFF)

Item	Description	Details	Qty	Cat. No.
Fluid transfer adaptor	9.5 mm (3/8 in.) ID x 3.2 mm (1/8 in.) wall to 12.7 mm (1/2 in.) ID x 3.2 mm (1/8 in.) wall, C-Flex 374 tubing	2 m Capped—for welders	1	SH31091.01
Fluid transfer adaptor	3.2 mm (1/8 in.) ID x 1.6 mm (1/16 in.) wall to 9.5 mm (3/8 in.) ID x 3.2 mm (1/8 in.) wall, C-Flex 374 tubing	2 m Capped—for welders	1	SH31086.01
Fluid transfer extension	3.2 mm (1/8 in.) ID x 1.6 mm (1/16 in.) wall, C-Flex 374 tubing	5 m Capped—for welders	1	SH31079.03
Pump set	0.25 m (10 in.) C-Flex 374 tubing to 0.5 m (19.7 in.) PharMed BPT tubing to 0.25 m (10 in.) C-Flex 374 tubing	3.2 mm (1/8 in.) ID x 1.6 mm (1/16 in.) wall Capped—for welders	1	SH31097.01
Fluid transfer extension	3.2 mm (1/8 in.) ID x 1.6 mm (1/16 in.) wall, C-Flex 374 tubing	5 m Capped—for welders	1	SH31079.03

Bioreactor (ATF or TFF)

Item	Description	Qty	Cat. No.
Hardware	50 L S.U.B., jacketed, 120 VAC, analog load cell	1	SUB0050.8100
BPC for ATF	50 L S.U.B. BPC, ATF-specific perfusion BPC	1	SH31170.01
BPC for TFF	50 L S.U.B. BPC, TFF-specific perfusion BPC	1	SH31173.01

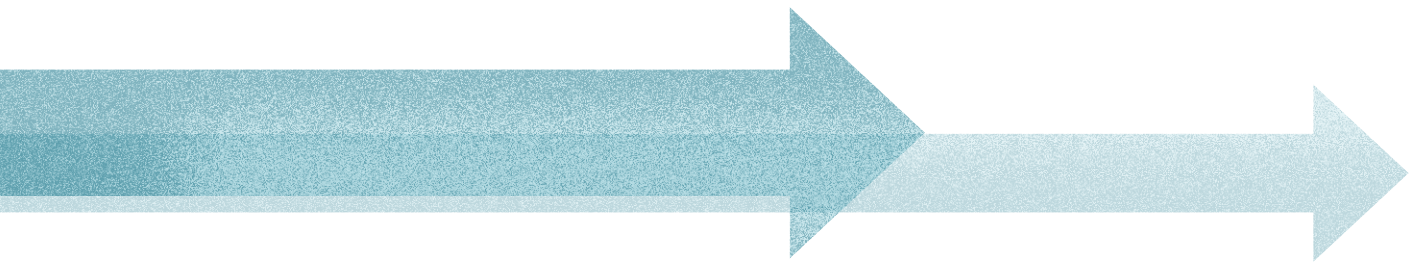
S.U.B. BPC add-ons (ATF or TFF)

Item	Description	Qty	Cat. No.
Tubing assembly	Aseptic connector, connects to Thermo Scientific™ TruTorr™ single-use pressure sensor	1	SH31134.02
Probe assembly	Bioreactor probe assembly with AseptiQuik™ connector—nonsterile (allows connecting conventional probes to S.U.B. BPC)	2	SH30720.02

ATF-SU connections (for Repligen™ XCell ATF™ 6 technology only)

Item	Description	Qty	Cat. No.
Top permeate	Permeate connection for filter wetting and permeate connection	1	SH31159.01
Bottom permeate	Plug for ATF permeate	1	SH31159.05
Top retentate	ATF to BPC connection 1	1	SH31159.02
Bioreactor	ATF to BPC connection 2	1	SH31159.03
Flush/drain port	Connection for filter wetting	1	SH31159.04

Note: Work with TFF supplier for proper single-use connections from S.U.B. BPC to TFF.



Permeate transfer (ATF or TFF)

Item	Description	Details	Qty	Cat. No.
Fluid transfer adaptor (ATF only)	3.2 mm (1/8 in.) ID x 1.6 mm (1/16 in.) wall to 9.52 mm (3/8 in.) ID x 3.2 mm (1/8 in.) wall, C-Flex 374 tubing	2 m Capped—for welders	1	SH31086.01
Fluid transfer extension	3.2 mm (1/8 in.) ID x 1.6 mm (1/16 in.) wall, C-Flex 374 tubing	5 m Capped—for welders	1	SH31079.03
Pump set	0.25 m (10 in.) C-Flex 374 tubing to 0.5 m (19.7 in.) PharMed BPT tubing to 0.25 m (10 in.) C-Flex 374 tubing	3.2 mm (1/8 in.) ID x 1.6 mm (1/16 in.) wall Capped—for welders	1	SH31097.01
Fluid transfer extension	3.2 mm (1/8 in.) ID x 1.6 mm (1/16 in.) wall, C-Flex 374 tubing	5 m Capped—for welders	1	SH31079.03
Fluid transfer adaptor	3.2 mm (1/8 in.) ID x 1.6 mm (1/16 in.) wall to 9.5 mm (3/8 in.) ID x 3.2 mm (1/8 in.) wall, C-Flex 374 tubing	2 m Capped—for welders	1	SH31086.01
Fluid transfer adaptor	9.5 mm (3/8 in.) ID x 3.2 mm (1/8 in.) wall to 12.7 mm (1/2 in.) ID x 3.2 mm (1/8 in.) wall, C-Flex 374 tubing	2 m Capped—for welders	1	SH31091.01

Permeate pooling

Item	Description	Qty	Cat. No.
Hardware	1,000 L S.U.M., jacketed, 120 VAC	1	SUM1000.9004
BPC	1,000 L S.U.M. BPC, liquid-to-liquid	1	SH30982.04

Cell bleed

Item	Description	Details	Qty	Cat. No.
Fluid transfer extension	3.2 mm (1/8 in.) ID x 1.6 mm (1/16 in.) wall, C-Flex 374 tubing	5 m Capped—for welders	1	SH31086.01
Pump set	0.25 m (10 in.) C-Flex 374 tubing to 0.5 m (19.7 in.) PharMed BPT tubing to 0.25 m (10 in.) C-Flex 374 tubing	3.2 mm (1/8 in.) ID x 1.6 mm (1/16 in.) wall Capped—for welders	1	SH31079.03
Fluid transfer extension	3.2 mm (1/8 in.) ID x1.6 mm (1/16 in.) wall, C-Flex 374 tubing	5 m Capped—for welders	1	SH31097.01
Fluid transfer adaptor	3.2 mm (1/8 in.) ID x 1.6 mm (1/16 in.) wall to 6.35 mm (1/4 in.) ID x 1.6 mm (1/16 in.) wall, C-Flex 374 tubing	2 m Capped—for welders	1	SH31084.01
Plastic drum	200 L Thermo Scientific™ conical LLDPE drum		1	SV50517.10
BPC	200 L BPC	Sterile liquid hold	1	SH30967.03
Plastic drum dolly			1	SV50029.03

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