Cell Stretching Bioreactors for Life Science Research

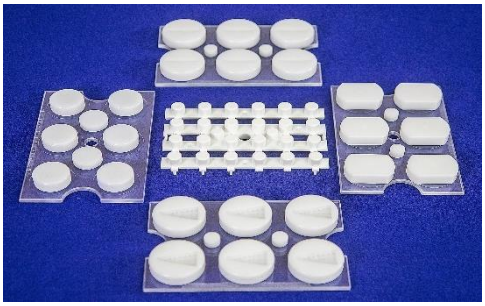
Flexcell® **Tension Systems** are computer-regulated bioreactors that apply cyclic or static strain to cells cultured *in vitro* in 4 plates. The **Tissue Train® Culture System** enables 3D cell cultures in a gel matrix. **Flex Jr.™ Tension System** with a single plate baseplate for lower throughput and budget (pages 4 - 7, 9 - 10).

Flexcell's® **Compression System** regulates positive air pressure to compress tissue samples or 3D cell cultures *in vitro*. This System compresses samples between a piston and stationary platen using BioPress™ culture plates (page 8 - 9).

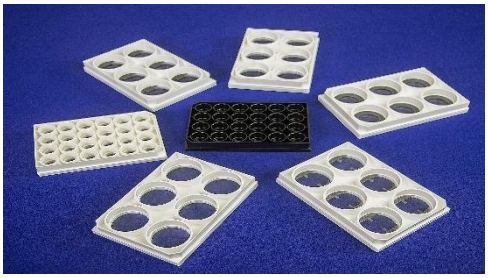
The Streamer® is a **fluid shear stress** device allowing users to regulate fluid shear stress to cells in culture with laminar, pulsatile, or oscillating flow. Together with the **Osci-Flow® Flow Controller**, researchers can regulate the frequency of oscillation or pulsatile patterns based on shear stress level applied from 0-35 dynes/cm^2 (pages 15 - 16).

Accessories and Disposables

Single-well devices designed to observe signaling responses to strain in real time on a microscope stage. The **StageFlexer®** and the **Inverted StageFlexer I®** are designed to strain cells in monolayer. The **StagePresser™** is designed to compress a single tissue sample or cell-seeded construct in 3D culture. The **FlexFlow™** is a parallel plate laminar flow device designed to apply fluid shear stress and/or cyclic strain to cells in culture. (pages 12 - 14).



Flexcell® has designed a full line of tissue engineering accessories to aid in load application, cell seeding placement plus biologicals to create hydrogel matrices and scaffolds. **Cell Seeders, Loading Stations** and a choice of **Trough Loaders** are some of these accessories – for details see pages 23, 29 - 30.



The **flexible bottomed 6-well and 24-well culture plates** (silicone elastomer membranes) are offered in a range of protein coatings. BioFlex® culture plates are used with the Tension Systems to apply **equibiaxial load**, UniFlex® culture plates are used to apply **uniaxial load**, and BioPress™ culture plates are used with the Compression System (pages 17 - 28).

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Prices: Please ask for a quotation.

➔ Choice of devices for general liquid handling, Chemistry and Protein Crystallography 24

Transwell® is a registered trademark of Corning® Inc.

Why Culture Cells in a Mechanically Active Environment?

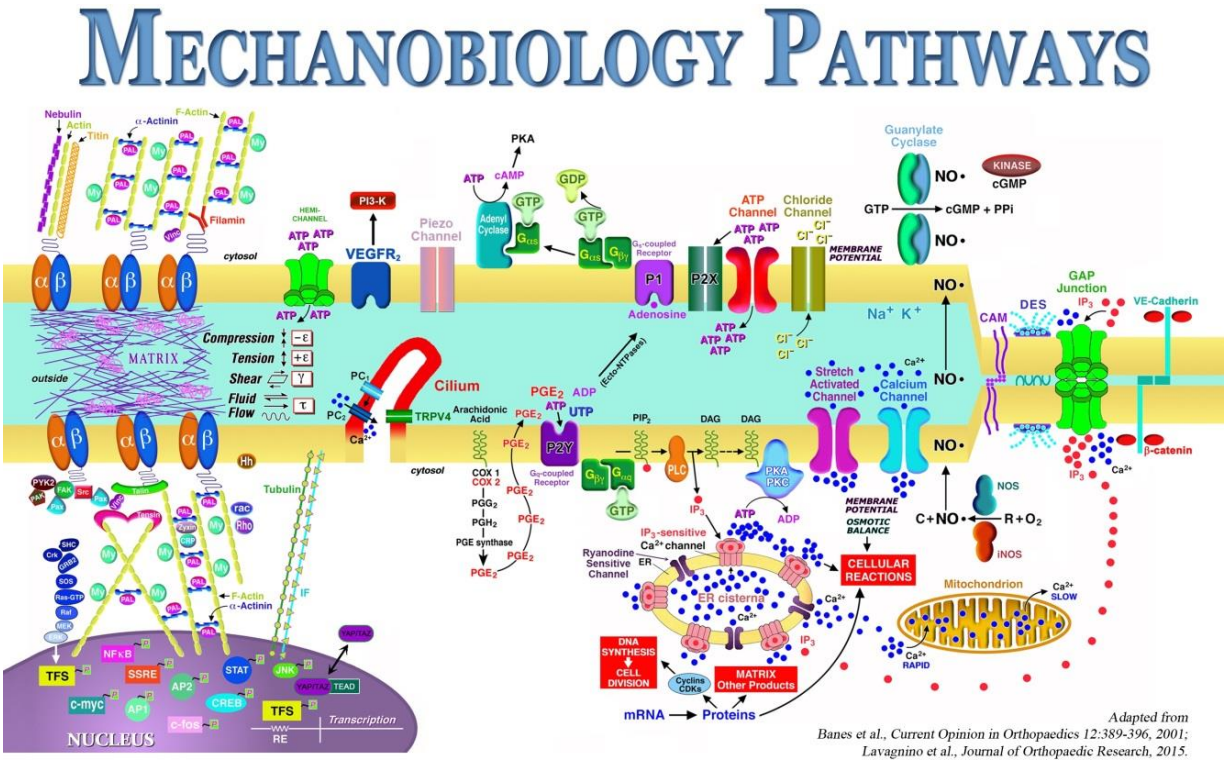
Cells are subjected to compression, tension, and shear in the body and undergo acute and adaptive biochemical changes in response to deformation. Stressing cells in culture simulates the *in vivo* environment causing dramatic morphologic and biochemical responses. Flexcell's® tension, compression, and fluid shear stress systems have broad applications since strain, compression, or fluid flow have been found to induce biochemical changes in cells derived from a variety of tissues including cardiac, skeletal, and smooth muscle, lung, vascular endothelium, skin, tendon, ligament, cartilage, and bone.

Tissue Engineering

Formation of tissues *in vitro* that are structurally and functionally viable requires several basic conditions, such as 1) cells 2) matrix 3) media and growth factors and 4) mechanical stimulation. These conditions are linked to each other and act in conjunction to form a structurally robust tissue that can withstand biomechanical forces. To generate a tissue *in vitro* that is more or less equivalent to the native tissues, one should create an environment that would mimic the *in vivo* conditions. Culturing cells in a mechanically active environment increases cell metabolism and alters cell shape and other properties. In addition, culturing cells in a 3D environment more closely simulates the native environment.

Why Fluid Shear Stress?

Fluid-induced shear stress occurs in every tissue in the body as a result of interstitial fluid movement. Tissue deformation by compression, tension or shear forces results in the movement of interstitial fluid around cells. Fluid movement acts as a transport vehicle for ions, proteins, carbohydrates and other molecules capable of movement within the matrix. As the fluid moves past cell membranes, a shear stress is generated. Applying stresses to cells in culture simulates the *in vivo* environment causing dramatic morphologic and biochemical responses.



Adapted from
Banes et al., Current Opinion in Orthopaedics 12:389-396, 2001;
Lavagnino et al., Journal of Orthopaedic Research, 2015.

FX-6000™ Tension System (FX-6000T)

Apply equibiaxial or uniaxial tension to cells in 2D or 3D culture.

- Computerized, vacuum-operated instrument that applies a defined controlled, static or variable duration cyclic tension to cells growing *in vitro*.
- Utilizes regulated vacuum **and** positive air pressure to deform cells cultured on flexible-bottomed culture plates.
- Simulate *in vivo* tissue strains and frequencies in cells from muscle, lung, heart, blood vessels, skin, tendon, ligament, cartilage, and bone.
- Contains state-of-the-art digital valve to automatically regulate and maintain vacuum **and** positive air pressure to provide the specified strain regimen.
- Multiple frequency, amplitude and waveform changes can be programmed in one regimen.
- Waveforms available: static, sinusoidal, heart stimulation, triangular, square, custom (Fig. 2).
- Supplied with cylindrical Loading Posts to provide equibiaxial strain, to be used with 6-well **BioFlex® culture plates** (page 20) for 2D cell constructs or with 6-well **Tissue Train® Circular Foam culture plates** (page 22) for 3D cell constructs.
- Optional Arctangle® Loading Posts to provide uniaxial strain, to be used with 6-well **UniFlex™ culture plates** (page 22).
- Optional Baseplate Kits (page 10) to use the FX-6000T with more than one Tension Baseplate, for Tissue Train® applications, for uniaxial strain, or for high-throughput tests.
- Drives up to four independent FlexLink® remote compression and/or tension controllers.
- Works with microscopy devices **StageFlexer®**, **StageFlexer® Jr.** (page 12), **FlexFlow™** (page 14), and **Inverted StageFlexer I®** (page 13).
- FX-6000™ Tension System includes:
  - Laptop computer with FlexSoft FX-6000™ software
  - FX-6K™ Tension FlexLink®
  - BioFlex® baseplate, four gaskets and acrylic Window
  - BioFlex® Loading Stations™ with 25 mm Loading Posts
  - Four BioFlex® culture plates and four Cell Seeders™
  - Drying filter, water trap, vacuum tubing, and grease/lubricant.

Figure 1. FX-6000™ Tension System

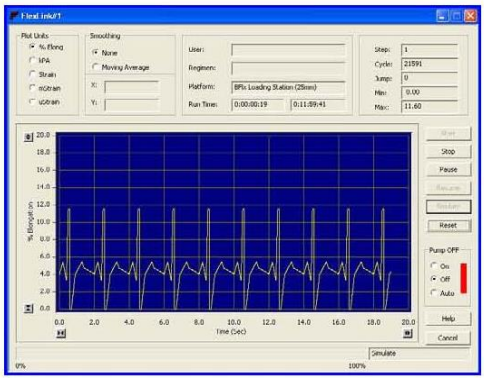


Figure 2. Waveform plot showing typical heart waveform

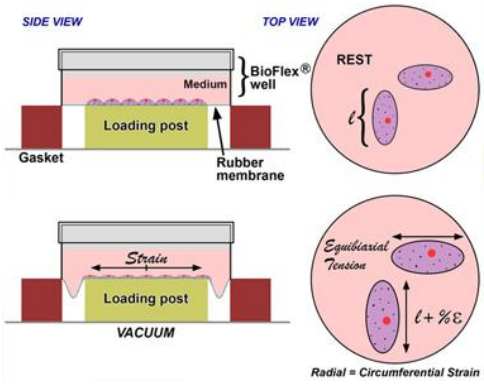


Figure 3. Equibiaxial strain application to cells in a well of a BioFlex® culture plate

Please note: For operation, the FX-6000T requires a vacuum pump, and either a compressor or, if an in-house positive air source is available, a Regulator Kit.

Advantages of the Flexcell® Tension System

- Stand-alone, computer-controlled instrument that applies a defined, controlled, static or variable duration cyclic tension to cells growing *in vitro*.
- Investigates the equibiaxial biomechanical stress applied to 2D as well as to 3D cell constructs.
- Flexcell® Tension system allows the easy creation of 2D (using the BioFlex® Culture Plates) and 3D (using the Tissue Train® Circular Foam Culture Plates) circular cell constructs without need of further equipment (except a pump delivered with the system).
- Linear cell constructs can be created and used with optionally available accessories.
- Baseplates placed inside an incubator enable a long-term culture of cells under mechanical stress.
- Optionally available FlexStops™ block stretching and offer a convenient negative control for each Flexcell® 6-well culture plate.
- Up to 24 samples can be tested simultaneously. The optionally available HT Baseplate Kit enables up to 96 samples to be tested at the same time.
- Only 3 ml medium per sample required.
- Modular, upgradeable system allows the application of further biomechanical stress investigations, such as compressed cells (requires optionally available Flexcell® Compression FlexLink® and compressor), real-time observation (requires optionally available Microscopy Devices), combination of fluid shear stress and tension stress (requires optionally available FlexFlow™ system), or high-throughput test (requires optionally available HT Baseplate Kit), co-culture assays of stressed and unstressed cultures (requires optionally available Transwell® Holders).
- Quick connect and disconnect fittings for easy connection with accessories (such as further baseplates etc.).
- Simulates *in vivo* tissue strains and frequencies in cells from muscle, lung, heart, blood vessels, skin, tendon, ligament, cartilage, and bone.
- Multiple frequencies, amplitudes and waveforms can be programmed in one regimen. Available waveforms: static, sinusoidal, heart simulation, triangular, and square.
- In addition, Flexcell® FlexSoft™ software allows users to programme their own customized waveforms.
- Wide range of plates uncoated or with different coatings (Amino, Collagen I, Collagen IV, Laminin) available to comply with users' test requirements.
- Flexcell® Tension system supplied with FlexSoft™ software includes all programmes and parameters for all optionally available accessories, upgrades, and culture plates from Flexcell® International.
- User-friendly software and handling allow simple control of tests.
- Allows elongations of up to 30 %.
- FlexSoft™ software updates free of charge.
- Requires no regular maintenance.
- Allows reliable and reproducible tests for publications.
- Established worldwide used system for high-ranking publications.

FLEXCELL® FLEX JR.™ Tension System

Stretch cells in a Single Plate Baseplate or in real-time with a microscopy device.

- Computerized, vacuum-operated instrument that applies a defined controlled, static or variable duration cyclic tension to cells growing *in vitro*.
- Regulated vacuum deforms flexible membranes in Flexcell® 6-well culture plates and in Flexcell® microscopy devices.
- Simulate *in vivo* tissue strains and frequencies in cells from muscle, lung, heart, blood vessels, skin, tendon, ligament, cartilage, and bone.
- Contains state-of-the-art digital valve to automatically regulate and maintain vacuum to provide the specified strain regimen.
- Multiple frequency, amplitude and waveform changes can be programmed in one regimen.
- Waveforms available: static, sinusoidal, heart stimulation, triangular, square, custom (Fig. 5).
- Supplied with cylindrical Loading Posts to provide equibiaxial strain, to be used with 6-well **BioFlex® culture plates** (page 20) for 2D cell constructs or with 6-well **Tissue Train® Circular Foam culture plates** (page 22) for 3D cell constructs.
- System now works with Single Plate Baseplate Kits (SPBK-1000)
- Drives up to two independent FlexLink® remote compression and/or tension controllers.
- System works with **StageFlexer®, StageFlexer® Jr.** (page 12), **FlexFlow™** (page 14), and **Inverted StageFlexer I®** (page 13) microscope devices.*

Figure 4. FLEX JR.™ Tension System

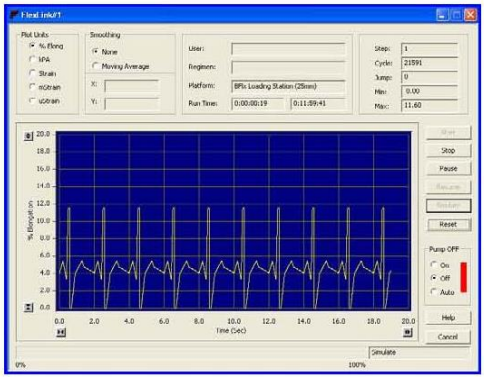


Figure 5. Waveform plot showing typical heart waveform

- Flex Jr.™ System includes:
  - Flex Jr.™ Tension FlexLink®
  - Laptop computer
  - FlexSoft® Flex Jr.™ Software
  - Single Plate Baseplate Kit
  - Tubing and Adaptor Kit

* *Microscopy devices sold separately.*

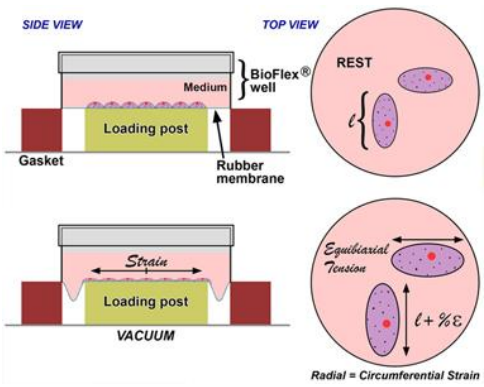


Figure 6. Equibiaxial strain application to cells in a well of a BioFlex® culture plate

Please note: For operation, the Flex Jr.™ Tension System requires a vacuum pump.

FX-6000™ Tissue Train® Culture System(FX-6000TT)

3D cell culture in a gel matrix with or without cyclic uniaxial tension.

- Stand-alone culture system to create 3D geometries for cell culture in a matrix gel or allows the cells to build a self-assembled matrix that connects to the anchors in a **Tissue Train® culture plate** (page 21).
- Utilizes regulated vacuum to deform cells cultured on flexible-bottomed culture plates.
- Simulate *in vivo* tissue strains and frequencies in various cells.
- Contains state-of-the-art digital valve to automatically regulate and maintain vacuum to provide the specified strain regimen.
- Multiple frequency, amplitude and waveform changes can be programmed in one regimen.
- Waveforms available: static, sinusoidal, heart stimulation, triangular, square, custom.
- Supplied with Arctangle® Loading Posts to provide uniaxial strain - using 6-well **Tissue Train® culture plates** (page 21) and 6-well **UniFlex™ culture plates** (page 22) - and with linear molds (Trough Loaders™) to create bioartificial tissue strips up to 35 mm length using Tissue Train® culture plates (Fig. 8).
- Optional cylindrical Loading Posts to provide equibiaxial strain in 6-well **BioFlex® culture plates** (page 20) for 2D cell constructs or in 6-well **Tissue Train® Circular Foam** culture plates (page 22) for 3D cell constructs.
- Optional Baseplate Kits (page 10) to use the FX-6000TT with more than one baseplate, for Tension applications, or high throughput tests.
- Drives up to four independent FlexLink® remote compression and/or tension controllers.
- Works with microscopy devices **StageFlexer®**, **StageFlexer® Jr.** (page 12), **FlexFlow™** (page 14), **Inverted StageFlexer I®** (page 13).
- FX-6000™ Tissue Train® System includes:
  - Host computer with flat panel monitor
  - FlexSoft FX-6000™ software
  - FX6K™ Tension FlexLink®
  - BioFlex® Baseplate and four gaskets
  - Tissue Train® Trough Loaders™
  - Arctangle® Loading Stations™
  - Four Tissue Train® culture plates
  - Drying filter, water trap, vacuum tubing, and grease/lubricant

Figure 7. FX-6000™ Tissue Train® System

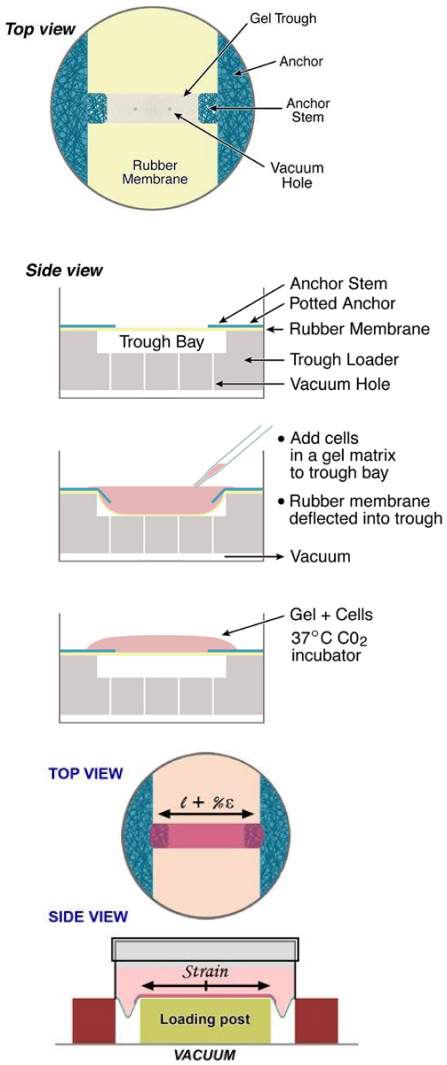


Figure 8. Bioartificial tissue development and uniaxial strain application with the Tissue Train® system

Please note: For operation, the FX-6000TT System requires a vacuum pump.

FX-5000™ Compression System (FX-5000C)

Apply cyclic or static compression to cells in 3D culture.

- Computerized, pressure-operated instrument that applies a defined controlled, static or variable duration cyclic compression to cells growing *in vitro*.
- Utilizes regulated air pressure to deflect flexible-bottomed **BioPress™ culture plates** (page 28) compressing a tissue sample or 3D culture between a piston and a stationary platen (Fig. 11).
- Can apply up to 14 pounds of applied force.
- Simulate *in vivo* tissue forces and frequencies in cells from muscle, lung, heart, blood vessels, skin, tendon, ligament, cartilage, and bone.
- Contains state-of-the-art digital valve to automatically regulate and maintain pressure for a specified compression regimen.
- Multiple frequency, amplitude and waveform changes can be programmed in one regimen (Fig. 10).
- Waveforms available: static, sinusoidal, heart stimulation, triangular, square, custom.
- Drives up to four independent FlexLink® remote compression and/or tension controllers.
- Works with **StagePresser™** microscopy device (SP-3000), a single-well embodiment of the Compression apparatus (page 14).

Figure 9. FX-5000™ Compression System

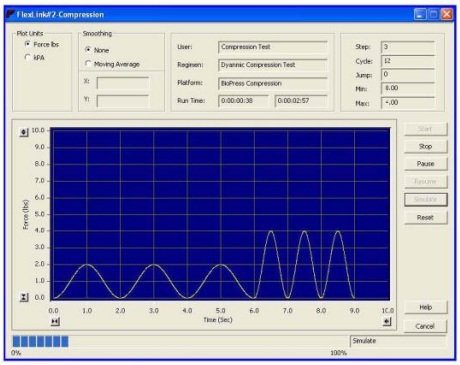


Figure 10. Waveform plot showing a sine wave with various frequency and amplitude changes

- FX-5000™ Compression System includes:
  - Host computer with flat panel monitor
  - FlexSoft FX-5000™ software
  - FX5K™ Compression FlexLink®
  - Biopress™ Baseplate and four gaskets
  - Compression clamping system
  - Four BioPress™ culture plates
  - Tubing and quick disconnects

<u>Please note:</u> For operation, the FX-5000C System requires a compressor.

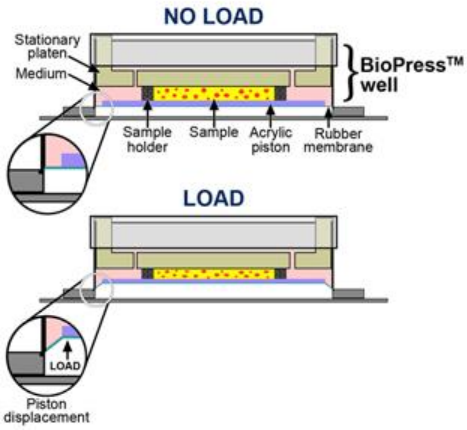


Figure 11. Application of unconfined compression to cells in a well of a BioPress™ culture plate

Flexcell® Transwell® Holder

Holds Transwells® to allow for cell migration and co-culture assays to be performed in Flexcell® culture plates.

- Analyze cell migration in response to strain.
- Available for 6- and 24-well Flexcell® culture plates.
- Compatible with standard Transwell® sizes for 6-well and 24-well culture plates.

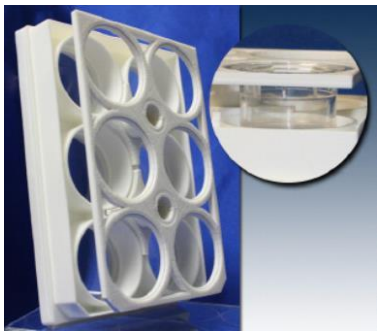


Figure 12. 6-well Transwell® Holder.

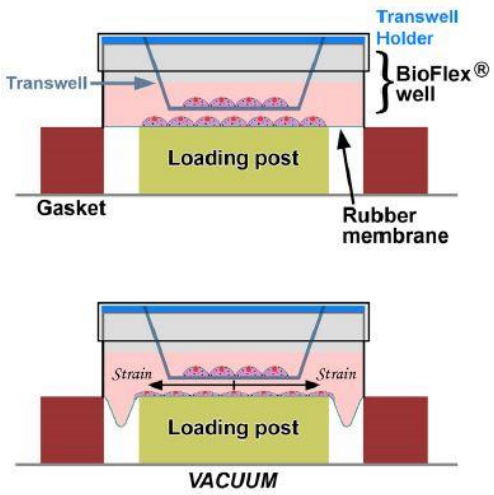


Figure 13. Diagram of a Transwell® Holder with a Transwell® supported above the rubber membrane in the well of a BioFlex® plate

Transwell® is a registered trademark of Corning® Inc.

FlexLink® for Tension or Compression (FX-6000TFL or FX-5000CFL)

Run multiple regimens at one time!

- Upgrade your existing FX-6000T or FX-5000C with a second controller that links with an FX-6000™ system computer allowing the user to simultaneously operate two different regimens on two different baseplates.
  (May require an additional vacuum pump or compressor depending on the intensity of the regimens!)
- Expand the application area of your FX-6000T system with the possibility to apply Compression tests by adding a Compression FlexLink® FX-5000CFL.
  (Requires also a compressor!)
- Expand the application area of your FX-5000C system with the possibility to apply Tension tests by adding a Tension FlexLink® FX-6000TFL.
  (Requires also a vacuum pump!)
- Connects in a series to operate up to four FlexLinks® from a central computer.

Figure 14. FX-6000T system with an additional FlexLink®

Flexcell® Baseplate Kits

Expand the application areas of your Tension or Tissue Train® System.

- BioFlex® Baseplate Kit (BFBK-4000)

  - Apply equibiaxial strain to cells cultured in monolayer in the BioFlex® culture plates (page 20) or to 3D constructs in the Tissue Train® Circular Foam culture plates (page 22).

  - Available with 25 mm, 28 mm, or 31 mm diameter cylindrical Loading Stations™.

- Tissue Train® Baseplate Kit (TTBK-4000) for creating 3D tissues

  - Create 3D cell constructs on Tissue Train® culture plates (page 21) using Trough Loaders™ (molds).

  - Apply uniaxial strain to cells cultured on Tissue Train® or cultured on UniFlex culture plates (page 22) with the supplied Arctangle® Loading Stations™.

- UniFlex® Baseplate Kit (UFBK-4000)

  - Apply uniaxial strain to cells cultured in monolayer on the membrane of the UniFlex® culture plates (page 22).

- 24-Well HT Baseplate Kit (HTBK-4000)

  - High throughput strain tests of cells cultured in Flexcell's® 24-well HT BioFlex® culture plates (page 20).

  - Kit includes Cell Seeders™ to place cells in the central region of the wells.

- Single Plate Baseplate Kit (SPBK-1000)

  - Apply cyclic or static tensile strains to cells cultured *in vitro*.

  - Sold as part of the Flex Jr. System.

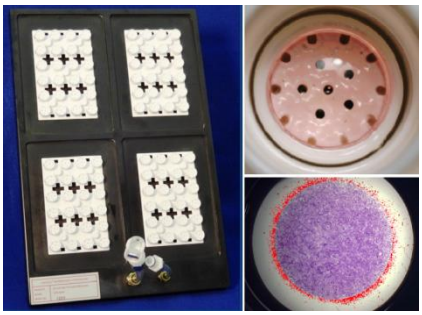


Figure 15. 24-Well HT Baseplate Kit with Cell Seeders™

All Baseplate Kits include:
- Baseplate with Loading Stations™
- Four Gaskets
- Four Sample culture plates
- Acrylic Window
- Grease
- Software update (if needed)

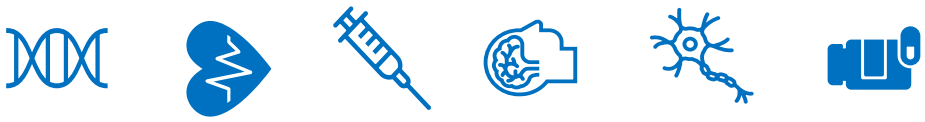
- TTBK-4000 also includes Trough Loaders™

- HTBK-4000 also includes Cell Seeders™

- SPBK-1000 includes one baseplate, 1 gasket, 1 loading station, 1 cell seeder, and two sample plates

Flexcell® Application Cases

Published Application Examples (Non-exhaustive):



- Cell Signaling Pathways
- Cell and Focal Adhesion
- Mechanotransduction Studies
- Molecular Regulation and Inhibitors
- Drug Discovery, Testing, BioPharma Therapeutics
- mRNA Expression
- Growth Factor Receptor Roles
- Mitochondrial/ Cytoskeletal Responses
- Genetic Regulation in Cells
- Tissue Engineering
- Enzyme, Gene Transcription, Protein Expression
- Bioengineering Approaches to Stem Cells
- Stem Cell Differentiation
- Strain-dependent Activation
- Mechanical Conditioning Cells and Tissues
- Viscoelasticity Studies
- Stress-induced Cardiac Hypertension Modelling
- Cardiac dysfunction and Hypertrophy
- Fluid Flow Analyses
- Cyclic stretch Cellular Structural change
- Cellular organization
- In vitro Experimental Heart Failure Synopsis
- Ventilator-induced Lung Injury
- Strain manipulation on Tissue Properties
- Elongation and Mechanical Force Studies
- ECM Secretion
- Cell Proliferation, Growth and Stemness on Soft Substrate
- Cosmetic testing

StageFlexer® Microscopy Device (SF-3000)

A single-well embodiment of a BioFlex® culture plate well.

- Designed to strain cells in monolayer while observing the cellular activity with an **upright microscope** in real-time.
- Device can be used with FX-5000™ and FX-6000™ Tension Systems, FX-5000™ and FX-6000™ Tissue Train® System, and Flex Jr. Tension System that allow the control of strain frequency, amplitude, waveform, and cycles (or time period).
- StageFlexer® consists of a single 35 mm well.
- Membranes (page 25) are moved across a cylindrical Loading Post (equibiaxial strain).
- StageFlexer® Microscopy Device includes:
  - StageFlexer® device
  - Three cylindrical Loading Posts (25 mm, 28 mm, and 31 mm) used to vary strain magnitudes
  - Gaskets, o-ring, snap ring, and pliers
  - Silicone-based lubricant
  - Six StageFlexer® membranes

Figure 19. StageFlexer®

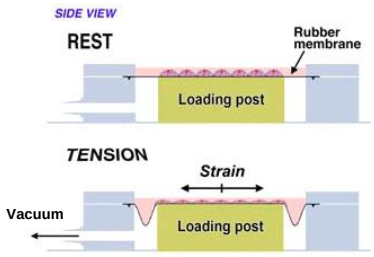


Figure 20. Strain application to cells in a StageFlexer® device

StageFlexer® Jr. Microscopy Device (SF-4000)

Microscopy device for membranes removed from Flexcell® culture plates.

- Designed to strain cells in monolayer while observing the cellular activity with an **upright microscope** in real-time.
- Device can be used with FX-5000™ and FX-6000™ Tension Systems, FX-5000™ and FX-6000™ Tissue Train® System, and Flex Jr. Tension System that allow the control of strain frequency, amplitude, waveform, and cycles (or time period).
- StageFlexer® Jr. consists of a single 1-inch well designed to accept membranes removed from BioFlex®, UniFlex® or Tissue Train® culture plates.
- Continue to strain cells while observing responses in real-time on a microscope stage.
- Membranes can be moved across a cylindrical Loading Post (equibiaxial strain) or across an Arctangle® Loading Post (uniaxial strain).
- StageFlexer® Jr. Microscopy Device includes:
  - StageFlexer® Jr. device
  - One 18.5 mm diameter cylindrical Loading Post
  - One Arctangle® Loading Post
  - Gaskets, O-ring, snap ring and pliers
  - Silicone-based lubricant

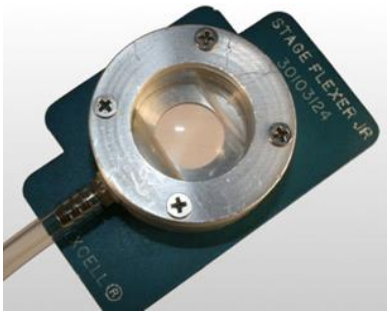


Figure 21. StageFlexer® Jr.

Inverted StageFlexer I® Microscopy Device (ISF 5000)

Observe cells stretching in real time with either an upright or inverted microscope!

- Designed to strain cells in monolayer while observing the cellular activity with either an upright or inverted microscope.
- Device can be directly attached to any microscope stage.
- Device can be used with FX-5000™ and FX-6000™ Tension Systems, FX-5000™ and FX-6000™ Tissue Train® System, and Flex Jr. Tension System that allow the control of strain frequency, amplitude, waveform, and cycles (or time period).
- Cells are grown and stretched on a 54 mm diameter silicone elastomer membrane, which has 22.9 cm^2 total cell growth area.
- Membrane stretch ranges from 1.6 % up to 12 %.
- Membranes (page 25) are moved across a cylindrical Loading Post (equibiaxial strain).
- Requires smaller Z-direction measurement to meet focal distance needs.
- Easy to use and set-up (5 component parts).
- Assembly of the StageFlexer I® will require a small screwdriver. The provided components include (see Fig. 24):
  - Inverted StageFlexer I® device
  - Sterile StageFlexer I® Membrane with protective Mylar
  - Inverted StageFlexer I® Top Ring
  - 60 mm culture plate lid
  - Top Screws (6x)

Figure 22. StageFlexer I® for use with an inverted microscope objective

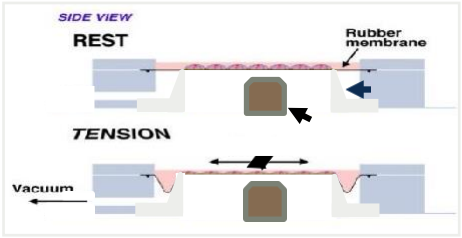


Figure 23. Strain application to cells in a StageFlexer® device

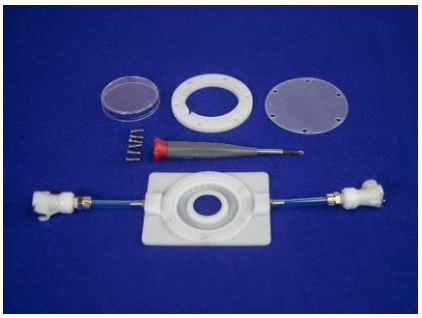


Figure 24. StageFlexer I® components prepared for assembly.

➢ Plating and Viewing cells with inverted StageFlexer I®

Note that only the cells that are situated directly in the center of the membrane will receive uniform strain. Therefore, it is best to plate, view or test the cells only in the uniformly strained area. Any cells outside of this circle will not receive uniform strain.

StagePresser™ Microscopy Device (SP-3000)

A single-well embodiment of the Compression apparatus.

- Designed to compress a single tissue sample or cells in 3D culture while viewing the cellular activity under a microscope.
- Works with the FX-5000™ Compression system.
- View compressed cells in real-time with an **upright microscope**.
- Piston and stationary platen compress samples on StagePresser™ membranes (page 28).

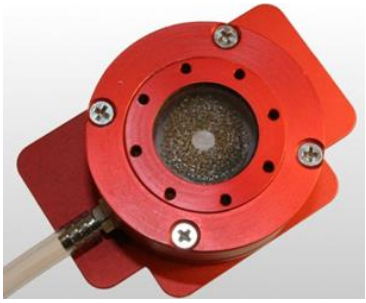


Figure 25. StagePresser™

- StagePresser™ includes:
  - StagePresser™ device
  - Three acrylic pistons and platen-loaded StagePresser™ membranes

→ Also see page 8 for FX-5000™ Compression System (FX-5000C).

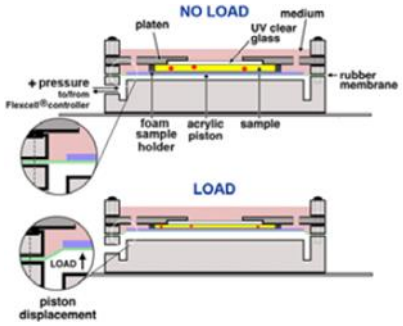


Figure 26. Compression application to cells in a StagePresser™ device

FlexFlow™ Shear Stress Device (FF-3000)

Flex your cells while applying a *shear stress*.

- Parallel plate laminar flow device designed to apply fluid shear stress and/or cyclic strain to cells in culture while providing a means for viewing cell activity under an **upright microscope** in real-time.
- Culture cells on matrix bonded rubber surfaces using StageFlexer® membranes (page 25) or on matrix treated glass Culture Slips® (page 28).
- Strain cells using the FX-5000™ and FX-6000™ Tension, Flex Jr. Tension, or Tissue Train® system before, during or after applying shear stress.
- Uses a computer controlled peristaltic pump to regulate shear stress from 0 - 35 dynes/cm^2.
- FlexFlow™ System includes:
  - FlexFlow™ device
  - Tubing and quick disconnects
  - Peristaltic pump
  - StreamSoft™ software
  - Two pulses dampeners

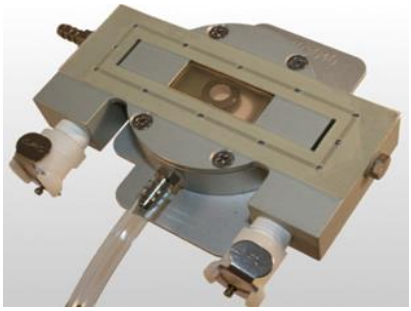


Figure 27. FlexFlow™

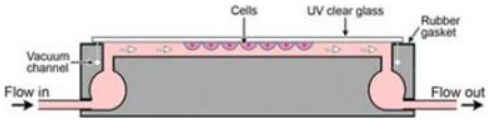


Figure 28. Shear stress application to cells in a FlexFlow™ device

Streamer® Shear Stress Device (STR-4000)

Apply fluid shear stress to cells with laminar, pulsatile, or oscillating flow

- Parallel-plate flow system used to apply fluid-induced shear stress to cells grown in a monolayer.
- Includes a six-chamber laminar flow device and can be used to apply laminar, pulsatile*, or oscillating* flow to cells cultured on special matrix coated PTFE rimmed 25 × 75 × 1 mm Culture Slips® (page 28).
- Regulation of shear stress from 0 - 35 dynes/cm^2 by computer-controlled peristaltic pump.
- Analyze effects of fluid flow on cell alignment, mRNA and protein expression, and signaling pathways.
- Remove quick disconnect fittings for easy cleaning after use.
- Streamer® device is autoclavable.
- Run up to six slides at one time.
- Comes with two pulse dampeners.

- Streamer® System includes:
  - Streamer® device
  - Notebook computer
  - Tubing and quick disconnects
  - Peristaltic pump
  - StreamSoft™ software
  - Two pulse dampeners
  - 12 Culture Slips®

*In order to apply pulsatile or oscillating flow the Osci-Flow® (page 16) is required. Osci-Flow® needs to be ordered separately in addition to the Streamer® System.

Figure 29. Streamer® Shear Stress Device

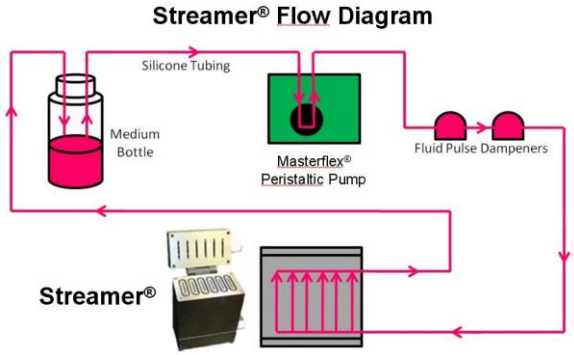


Figure 30. Streamer® system set-up without Osci-Flow® Controller

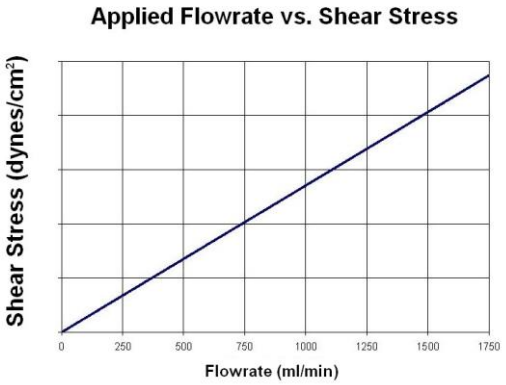


Figure 31. Representative graph of applied fluid shear stresses for a given pump flow rate for cells cultured on Culture Slips® and placed within the Streamer® device

Osci-Flow® Flow Controller (STR-4000-OFS)

The ultimate in fluid flow direction control!

- Provides regulated oscillatory and pulsatile flow control via computer-controlled action.
- Minimizes flow response lag by eliminating inertial effects of decelerating and accelerating pumps and motors.
- Reverses fluid flow instantaneously.
- Works with Streamer® and FlexFlow™ shear stress devices.
- Adapts to other perfusion systems.
- Accomodates any MasterFlex L/S series or comparable tubing.
- Interfaces with most laptops via USB.

- Osci-Flow® System includes:
  - Osci-Flow® device
  - Tubing and quick disconnects
  - StreamSoft™ software

Figure 32. Osci-Flow® Controller

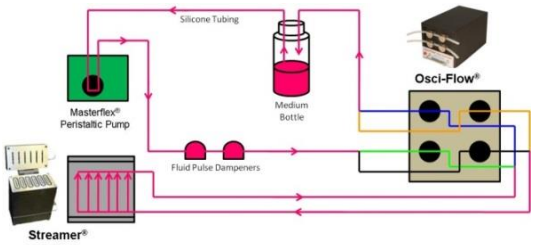


Figure 33. Set-up of the Streamer® device with Osci-Flow®

Do you require further information on the Flexcell® equipment?

We would be pleased to send you further information including our Flexcell® CD with videos or to contact you by phone for personal advice concerning all the Flexcell® products.

Click at the link below (or copy in your browser) and enter the password to learn more about the Flexcell® products:

Link:
https://www.magentacloud.de/share/tinsq6h.dh

Password: 19Dunn%08

Contact us by e-mail info@dunnlab.de or by phone +49 (0) 26 83 / 4 30 94.
If you send us your phone number and a suitable time, we would also be pleased to call you!

Flexcell's® Culture Plates

- Rigorously tested and guaranteed to be of the highest quality matrix-coated or untreated silicone elastomer or polystyrene culture plates.
- Well characterized elastomer properties.
- Equibiaxial or uniaxial strain applications.
- Strain applications simulating *in vivo* strains.
- Achieve a more natural environment *in vitro*.
- Gamma sterilization assures a sterile growth surface.

Matrix-Bonded and Charged Culture Plate Growth Surfaces

Flexcell's® unique culture plates provide researchers with matrix bonded growth surfaces that promote attachment and growth of a variety of cell types. Matrix coatings, such as type I collagen peptides, and laminin (as YIGSR peptides), enhance attachment of specific cell types. These specialty growth surfaces help to better simulate the *in vivo* environment.

Flexcell® culture plates including BioFlex®, Tissue Train®, UniFlex® series culture plates, StageFlexer® membranes and Culture Slips® are available with the following treatments and also as untreated versions:

- Amino
- Collagen Type I
- Collagen Type IV
- Laminin

NOTE: See the integrin table on the following page to match your cell's integrin panel with the appropriate growth surface.

Flexcell's® culture plates are stringently tested to assure the highest quality control and the best cell attachment and growth possible. Attachment factors are covalently bonded to the culture plate rubber membranes or plastics using our proprietary methods that result in optimal cell adherence and clarity for viewing cells. Culture plates are sterilized with gamma radiation and have a shelf life of one year.

The Flexcell® Tension System provides a strain component for dynamically culturing cells *in vitro*. Researchers use the Flexcell® culture plates together with the tension system to apply a defined, controlled, static or variable duration cyclic tension to cells.

The Flexcell® Streamer® applies fluid flow to cells in culture. Researchers use Culture Slips® together with the flow system to apply a controlled laminar, oscillatory, or pulsatile flow to cells.

Flexcell's® culture plates together with Flexcell's® systems for applying mechanical load provide the investigator with the ability to grow cells *in vitro* in a manner that better simulates an *in vivo* environment.

Matrix-Bonded Growth Surfaces

Flexcell® culture plates are available with the following treatments:

<u>Genetic type I collagen</u> for improved attachment and adherence of cells including:

- Continuous cell lines
- Primary cells
- Osteoblasts
- Chondrocytes
- Tendon fibroblasts
- Aortic, venous, and capillary endothelial cells
- Lung type II epithelial cells
- Ligament fibroblasts
- Smooth, striated and cardiac
- Myoblasts
- Myocytes

<u>Laminin,</u> as YIGSR peptides, for the improved attachment of cells including:

- Glial cells
- Neurons
- Cells grown on type I collagen
- Astrocytes

<u>Positively charged amino hydrophilic</u> for the improved attachment of cells including:

- Endothelial cells
- Smooth muscle cells

** See the integrin table below to match your cell's integrin panel with the appropriate growth surface.*

Vertebrate Integrins Grouped in Subfamilies Sharing a Common β Subunit			
Subunits		Ligands Sequenced	Minimal Sequence of Integrin Binding Site*
β_1^+	α_1	Collagen, Laminin	
	α_2	Collagen, Laminin	DGEA
	α_3	Fibronectin, Laminin, Collagen	RGD
	α_4	Fibronectin, VCAM-1	EILDV
	α_5	Fibronectin	RGD
	α_6^+	Laminin	
	α_7	Laminin	
	α_8	?	
	α_V	Vitronectin, Fibronectin	RGD
β_2	α_L	ICAM-1, ICAM-2	
	α_M	C3b component of complement (inactivated), Fibrinogen, Factor X, ICAM-1	
	α_X	Fibrinogen, C3b component of complement	GPRP
β_3^+	α_{IIb}	Fibrinogen, ProNectin F, von Willebrand factor, Vitronectin, Thrombospondin	RGD, KQAGDV
	α_V	Vitronectin, Fibrinogen, von Willebrand factor, Thrombospondin, Fibronectin, Osteopontin, Collagen	RGD
β_4^+	α_8^+	Laminin	
β_5	α_V	Vitronectin	RGD
β_6	α_V	Fibronectin	RGD
β_7	α_4	Fibronectin, VCAM-1	EILDV
	α_{IEL}		

Flexcell®'s Culture Plates Compatibility Guide

When using the following culture plates	Required Loading Stations	Plates usable with the following systems if upgraded with the listed accessories
BioFlex® 6-well culture plates (page 20)	BioFlex® Loading Stations™	FX-5000T, FLEX JR. and FX-6000T require no further equipment FX-5000TT and FX-6000TT require BioFlex® Baseplate Kit or optional separately available BioFlex® Loading Stations™ FX-5000C requires Tension FlexLink® with BioFlex® Baseplate and vacuum pump
BioPress™ 6-well Compression culture plates (page 28)	Not required	FX-5000T and FX-6000T require Compression FlexLink® with Compression Baseplate and compressor FX-5000TT and FX-6000TT require Compression FlexLink® with Compression Baseplate and compressor FX-5000C requires no further equipment
HT BioFlex® 24-well culture plates (page 20)	24-well Loading Stations™	FX-5000T and FX-6000T require 24-well HT Baseplate Kit FX-5000TT and FX-6000TT require 24-well HT Baseplate Kit FX-5000C requires Tension FlexLink®, vacuum pump and 24-well HT Baseplate Kit
Tissue Train® 6-well culture plates (page 21)	Arctangle® Loading Stations™, Trough Loaders™	FX-5000T and FX-6000T require Tissue Train® Baseplate Kit or optional separately available Arctangle® Loading Stations™ and Trough Loaders™ FX-5000TT and FX-6000TT require no further equipment FX-5000C requires Tension FlexLink®, vacuum pump and Tissue Train® Baseplate Kit, or Tension FlexLink®, vacuum pump and optional separately available Arctangle® Loading Stations™ and Trough Loaders™
Tissue Train® Circular Foam 6-well culture plates (page 22)	BioFlex® Loading Stations™	FX-5000T, FLEX JR. and FX-6000T require no further equipment FX-5000TT and FX-6000TT require BioFlex® Baseplate Kit or optional separately available BioFlex® Loading Stations™ FX-5000C requires Tension FlexLink® and vacuum pump
UniFlex® 6-well culture plates (page 22)	Arctangle® Loading Stations™	FX-5000T and FX-6000T require Tissue Train® Baseplate Kit or optional separately available Arctangle® Loading Stations™ FX-5000TT and FX-6000TT require no further equipment FX-5000C requires Tension FlexLink®, vacuum pump and Tissue Train® Baseplate Kit; or Tension FlexLink®, vacuum pump and optional separately available Arctangle® Loading Stations™

6-well BioFlex® Culture Plates

Flexible bottomed culture plate used with BioFlex® Loading Stations™ for providing equibiaxial strain to cells in monolayer culture.

- Flexible silicone elastomer membrane.
- 6-well culture plate with total growth surface area of 57.75 cm^2 (9.62 cm^2/well).
- Optically clear for direct viewing of cells with inverted or upright microscopes (membrane thickness: 0.020 inch/0.508 mm).
- Covalently bonded surfaces: Amino, Collagen (Type I or IV), Laminin (YIGSR).
- Low autofluorescence for use in immunohisto-chemical assays or with fluorescent probes.
- Provides uniform radial and circumferential strains when used with cylindrical BioFlex® Loading Stations™.
- Available in cases of 10 and 40 plates.

Cat. No.	Description
BF-3001U	BioFlex® Culture Plate – Untreated
BF-3001A	BioFlex® Culture Plate – Amino
BF-3001C	BioFlex® Culture Plate – Collagen I
BF-3001C/IV	BioFlex® Culture Plate – Collagen IV
BF-3001L	BioFlex® Culture Plate – Laminin

→ See page 29 - 30 for detailed information on the BioFlex® Loading Stations.

24-well HT BioFlex® Culture Plates

High throughput flexible silicone elastomer bottomed culture plates to be used only with the 24-well HT Baseplate Kit (page 10).

- Microplate reader compatible size and a total growth surface area of 37.47 cm^2 (1.56 cm^2/well).
- Optically clear for direct viewing of cells with inverted or upright microscopes (membrane thickness: 0.254 mm).
- Apply up to 8 % equibiaxial strain to cells in monolayer culture with Flexcell® Tension system and 24-well Loading Stations™.
- Covalently bonded surfaces: Amino, Collagen (Type I or IV), Laminin (YIGSR)
- Available with black or white frame in cases of 10 and 40 plates.
- **Please note:** the use of the HT BioFlex® culture plates with the Flexcell FX-5000™ and FX-6000™ Tension and Tissue Train® systems requires the 24-well HT Baseplate Kit (page 10)

Cat. No.	Cat. No.	Description
Black Frame	White Frame	
HTPB-3001U	HTPW-3001U	HT BioFlex® Culture Plate – Untreated
HTPB-3001A	HTPW-3001A	HT BioFlex® Culture Plate – Amino
HTPB-3001C	HTPW-3001C	HT BioFlex® Culture Plate – Collagen Type I
HTPB-3001C/IV	HTPW-3001C/IV	HT BioFlex® Culture Plate – Collagen Type IV
HTPB-3001L	HTPW-3001L	HT BioFlex® Culture Plate – Laminin

6-well Tissue Train® Culture Plates

Flexible bottomed culture plate used with Arctangle® Loading Stations™ and Trough Loaders™ to apply uniaxial strain to 3D cell-seeded gel constructs.

- Create 3D cell-seeded constructs on a Tissue Train® plate using a Linear Trough Loader™ (Fig. 35) as a mold
  (Trough Loaders™ not included with the plates).
- Tissue Train® Plates available with either CEREX® (a non-woven nylon mesh) or foam (open-cell porous) anchor stems. Anchor material has not been found to affect the compaction kinetics of the collagen gel. However, the foam anchor stems allow for increased construct survival time as measured by time to construct failure/detachment from the anchors.
- Apply a load regimen of uniaxial cyclic strain to the cellular construct using a Flexcell Tension system and Arctangle® Loading Stations™.
- Observe cell responses in 3D matrix with phase contrast, fluorescence or scanning confocal microscopy.
- Covalently bonded anchors: Amino, Collagen (Type I or IV), Laminin (YIGSR).
- Available in cases of 10 and 40 plates.

Figure 34. Linear Tissue Train® culture plates with **CEREX®**

Figure 35. Representative image of 3D cell-seeded gel construct created in a Tissue Train® culture plate

Cat. No. **CEREX®**	**Description**
TTLC-4001U	Tissue Train® Culture Plate – Untreated
TTLC-4001A	Tissue Train® Culture Plate – Amino
TTLC-4001C	Tissue Train® Culture Plate – Collagen Type I
TTLC-4001L	Tissue Train® Culture Plate – Laminin
TTLC-4001C/IV	Tissue Train® Culture Plate – Collagen Type IV

Cat. No. **Foam**	**Description**
TTLF-5001U	Tissue Train® Culture Plate – Untreated
TTLF-5001A	Tissue Train® Culture Plate – Amino
TTLF-5001C	Tissue Train® Culture Plate – Collagen Type I
TTLF-5001L	Tissue Train® Culture Plate – Laminin
TTLF-5001C/IV	Tissue Train® Culture Plate – Collagen Type IV

6-well Tissue Train® Circular Foam Culture Plates

Flexible bottomed culture plate used with BioFlex® Loading Stations™ for providing biaxial strain to circular 3D cell-seeded gel constructs.

- Create circular 3D cell-seeded gel constructs (no Trough Loader™ required).
- Apply a load regimen of biaxial cyclic strain to the cellular construct using a Tension or Tissue Train® system with cylindrical Loading Stations™.
- Matrix-bonded foam circular anchor for improved cell attachment.
- Observe cell responses in 3D matrix with phase contrast, fluorescence or scanning confocal microscopy.
- Monitor changes in cell shape, tissue organization, cell migration, division, gene expression, protein expression and secretion.
- Covalently bonded anchors: Amino, Collagen (Type I or IV), Laminin (YIGSR).
- Available in cases of 10 and 40 plates.

Cat. No.	Description
TTCF-5001U	Circular Foam Culture Plate – Untreated
TTCF-5001A	Circular Foam Culture Plate – Amino
TTCF-5001C	Circular Foam Culture Plate – Collagen Type I
TTCF-5001C/IV	Circular Foam Culture Plate – Collagen Type IV
TTCF-5001L	Circular Foam Culture Plate – Laminin

Please note that the cat. nos. for these plates have changed.

6-well UniFlex® Culture Plates

Flexible bottomed culture plate used with Arctangle® Loading Stations™ to provide uniaxial strain to cells in monolayer culture.

- Compatible with the Flexcell® Tension and Tissue Train® systems.
- Relationship of strain to vacuum well characterized.
- Strain field represented by a 0.6" wide x 0.952" (3.68 cm^2) long centrally located rectangular region (Fig. 36).
- Uniaxial strain varies by only +/- 1.5 % across the designated uniaxial strain region.
- Covalently bonded surfaces: Amino, Collagen (Type I or IV) , Laminin (YIGSR).
- Available in cases of 10 and 40 plates.

** Arctangle®Loading Stations™ required for correct application of uniaxial strain.*

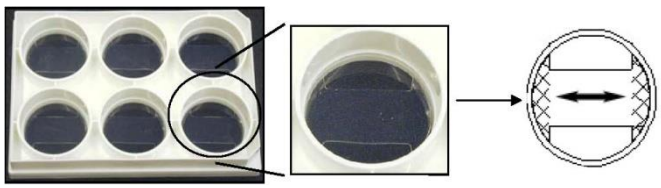


Figure 36. UniFlex® culture plate with schematic of the strain region

Cat. No.	Description
UF-4001U	UniFlex® Culture Plate – Untreated
UF-4001A	UniFlex® Culture Plate – Amino
UF-4001C	UniFlex® Culture Plate – Collagen Type I
UF-4001C/IV	UniFlex® Culture Plate – Collagen Type IV
UF-4001L	UniFlex® Culture Plate – Laminin

6-well BioFlex® Cell Seeder

Optimizes plating of cells to the central area of a 6-well BioFlex® membrane for uniform application of strain.

- Confines cells during plating and adhesion to the central area of the BioFlex® membrane that will glide over the 25 mm Loading Station™ during strain.
- Cells in the central area are subjected to well defined equibiaxial strains.
- The BioFlex® Cell Seeder is only required for seeding cells onto the membrane during the cell adhesion process. After cell attachment, cell feedings and experiments can be conducted according to the users' established protocols.
- Available individually or as a set of 4.

Cat. No.	Description
BFCS-1000	BioFlex® Cell Seeder (1 piece)
BFCS-4000	BioFlex® Cell Seeder (set of 4)

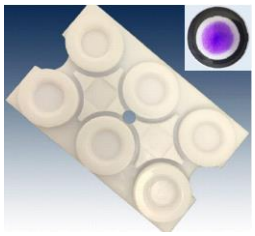


Figure 37. 6-well BioFlex® Cell Seeder. Inset shows crystal violet stained monolayer plated using Cell Seeder over a 25 mm cylindrical loading post of the Flexcell® Tension System.

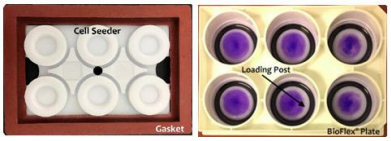


Figure 38. 6-well BioFlex® Cell Seeder station in a BioFlex® baseplate well (left picture) and the results of using a BioFlex® Cell Seeder when plating cells to confine them to the area directly above the 25 mm cylindrical loading posts, crystal violet stained cells (right picture).

24-well HT BioFlex® Cell Seeder

Plate cells in the central area of the HT BioFlex® membrane where strains are uniform.

- Confines cells during plating to the area of the HT BioFlex® membrane that is directly over the 24-well Loading Station™.
- Prevents cells from being subjected to undefined strains during strain application.
- The HT Cell Seeder™ is only required for seeding cells onto the membrane. After cell attachment, cell feedings and experiments can be conducted according to the users' established protocols.
- Available as a set of 4.

Cat. No.	Description
HTCS-3000	HT BioFlex® Cell Seeder (set of 4)

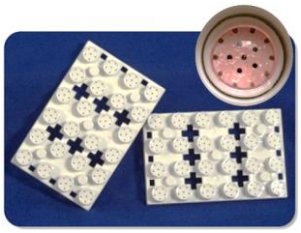


Figure 39. 24-well HT Cell Seeders™. The inset shows the suspension volume within the HT Cell Seeder™.

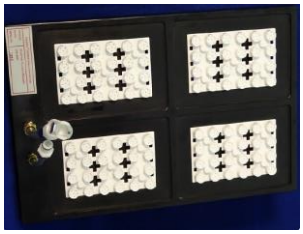
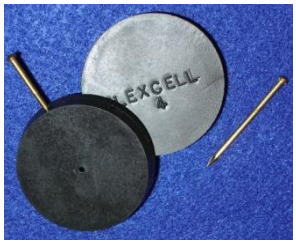


Figure 40. HT Cell Seeders™ in a 24-well HT Baseplate.

FlexStop™ (BFS-3000)

Be Selective! Use a FlexStop™ to block stretching.

- Reusable valved rubber stopper that inserts into the underside of a BioFlex® culture plate well to prevent vacuum-induced deformation (Fig. 41).
- Provides a convenient negative control when testing mechanical load effects on cells in the same BioFlex® culture plate.
- Designed to work in conjunction with the BioFlex® culture plates and BioFlex® Loading Stations™.
- Also works with Tissue Train® und UniFlex® culture plates.
- FlexStop™ includes:
  - Twelve rubber stoppers
  - Twelve brass pins



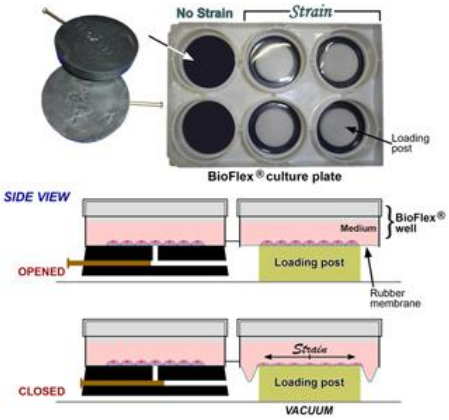
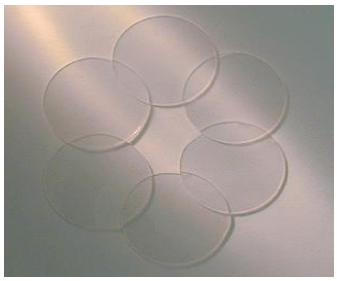


Figure 41. Schematic of strain inhibition with the use of a FlexStop™ on the underside of a BioFlex® culture plate well

StageFlexer® Membranes

Flexible growth surface for the StageFlexer® and FlexFlow™ devices.

- Individually packaged 43 mm silicone rubber membranes (come in sterile culture dishes).
- Clear for direct viewing of cells optically.
- Viscoelastic under mechanical loading.
- Same growth surfaces as the BioFlex® culture plates.
- Covalently bonded surfaces: Amino, Collagen (Type I or IV), Laminin (YIGSR).
- Available in cases of 6 and 36 membranes.

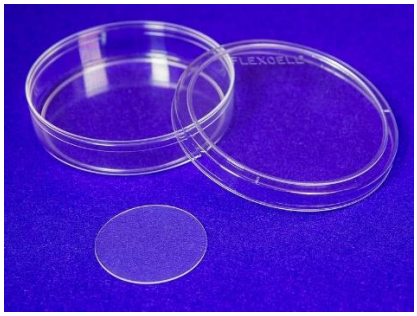


Cat. No.	Description
SFM-U	StageFlexer® Membrane – Untreated
SFM-A	StageFlexer® Membrane – Amino
SFM-C	StageFlexer® Membrane – Collagen Type I
SFM-C/IV	StageFlexer® Membrane – Collagen Type IV
SFM-L	StageFlexer® Membrane – Laminin

StageFlexer I® Membranes

StageFlexer I® Membranes, round, for use only with Inverted StageFlexer I®.

- Individually packaged 54 mm silicone rubber membranes (come in sterile culture dishes).
- Clear for direct viewing of cells optically.
- Viscoelastic under mechanical loading.
- Same growth surfaces as the BioFlex® culture plates.
- Covalently bonded surfaces: Amino, Collagen (Type I or IV), Laminin (YIGSR).
- Available in cases of 6 and 36 membranes.

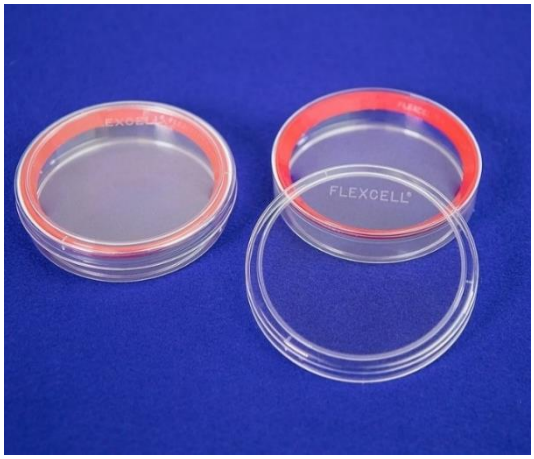


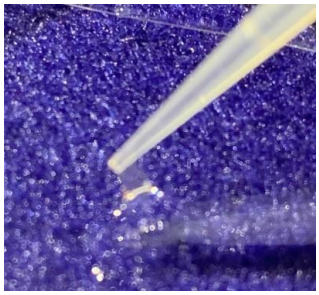
Cat. No.	Description
I-SFM-U	StageFlexer I® Membranes – Untreated
I-SFM-A	StageFlexer I® Membranes – Amino
I-SFM-C	StageFlexer I® Membranes – Collagen Type I
I-SFM- C/IV	StageFlexer I® Membranes – Collagen Type IV
I-SFM-L	StageFlexer I® Membranes – Laminin

CellSoft™ Culture Ware

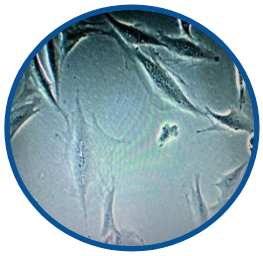
CellSoft™ offers softer substrates to match the material properties of tissue niches to better meet the needs of biological laboratories wanting to grow their cells on native stiffness.

- Soft silicone elastomer coated membranes.
- 100 mm dia. dishes (optically clear for direct viewing of cells with inverted or upright microscopes).
- BioFlex® CellSoft™ 6-well plates.
- Chamber slides CellSoft™.
- Moduli from 1-60 kPa.
- Ideal for passaging cell lines for expansion.
- Low autofluorescence for use in immunohistochemical assays or with fluorescent probes.
- Covalently bonded surfaces: Collagen (Type I) and untreated.
- Store at room temperature or 4 °C in the dark or out of direct light for up to 1 year.



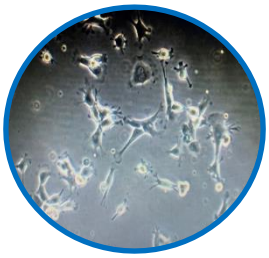


Cellsoft™ soft substrate culture ware shown with 0.5 kPa stiffness!



Polystyrene 2gP

vs.



CellSoft™

Tissue Moduli Ranges in kPa

0.2 – 0.5 kPa

0.5 – 2.0 kPa

2 – 8 kPa

8 – 16 kPa

16 – 32 kPa

32 – 64 kPa

➔ Flexcell® recommends that users culture their stock cells on a given stiffness substrate matrix coating and conduct their experiment on the same type of surface. In this way, the cells do not experience “substrate shock” moving from one stiffness and matrix coating to another.

Ordering Information

CellSoft™ culture dishes and plates are sold in packs of 5. Each plate is sterile and individually packaged in a sealed bag. See the table below for catalogue numbers and corresponding protein coatings.

➔ *Please note that all culture dishes and plates in the table below are available in various ranges of stiffness:* ***1, 5, 10, 20, 40 and 60 kPa.***

Cat. No.	Description
	100 mm dia. round dish
CSoft100mm-U	Untreated 100 mm dia. round dish
CSoft100mm-C	Collagen I coated 100 mm dia. round dish
	6-well polystyrene plate
CSoft06-U	Untreated 6-well polystyrene plate
CSoft06-C	Collagen I coated 6-well polystyrene plate
	6-well BioFlex® plate
CSoftBF-U	Untreated 6-well BioFlex® plate
CSoftBF-C	Collagen I coated 6-well BioFlex® plate

6-well BioPress™ Culture Plates (BP-3000U)

Culture plate for use with the Flexcell® Compression system.

- Each well contains an acrylic piston used with a stationary platen (supplied with the Compression system, not included with the plates) to deform 3D tissue samples or cell seeded constructs using the FX-5000™ Compression system.
- Ring foam holders keep samples confined to central region of each well.
- All plates come pre-sterilized.
- Available in cases of 10 or 40 plates.

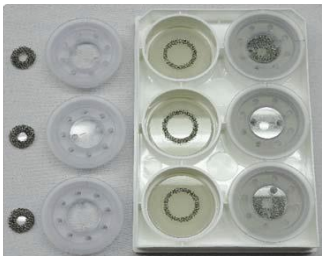
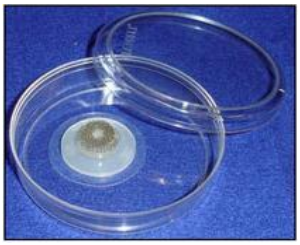


Figure 42. BioPress™ culture plate with acrylic pistons adhered to the silicone elastomer well bottom, foam sample holders (far left), and stationary platens (left of plate)

StagePresser™ Membranes (SPM-3000)

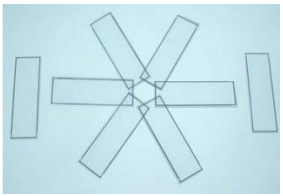
Flexible growth surface for use with the StagePresser™ device.

- Each membrane contains an acrylic piston which is compressed against a stationary platen on the StagePresser™ device to deform 3D tissue samples or cell-seeded constructs.
- Ring foam holders keep samples confined to central region of each membrane.
- Each membrane comes individually packaged in a sterile cell culture dish.
- Available in cases of 6 membranes with piston and foam retainer.



Culture Slips®

Surface treated slides for use with Streamer® and FlexFlow™.



- Available in two sizes:
  75 × 25 × 1,0 mm (for Streamer® or FlexFlow™),
  75 × 24 × 0,2 mm (for FlexFlow™ only).
- 75 × 25 x 1,0 mm Culture Slips® are rimmed with a 1,0 mm wide PTFE border to help limit cell culture growth to the portion of the slip exposed to fluid flow.
- Low autofluorescence.
- Matrix-treated to promote cell attachment.
- Covalently bonded surfaces: Amino, Collagen (Type I or IV), Laminin (YIGSR).
- Delivered in sterile twin packs for one time immediate use.
- Available in cases of 6 and 36 culture slips.

75 x 25 x 1,0 mm for Streamer® or FlexFlow™	
Cat. No.	**Description**
CS-U	Culture Slips® – Untreated
CS-A	Culture Slips® – Amino
CS-C	Culture Slips® – Collagen Type I
CS-C/IV	Culture Slips® – Collagen Type IV
CS-L	Culture Slips® – Laminin

75 x 24 x 0,2 mm for FlexFlow™	
Cat. No.	**Description**
FFCS-U	Culture Slips® – Untreated
FFCS-C	Culture Slips® – Collagen Type I

Principle of Loading Stations™ and Equibiaxial Strain

BioFlex® Loading Stations™ provide uniform radial and circumferential strains to cells cultured on flexible membranes. Loading Stations™ are designed for use with BioFlex®, flexible-bottomed culture plates and the Flexcell® Tension system to provide regulated strain to cultured cells. The Loading Stations™ are comprised of a 3.3" x 5" Lexan® plate and six removable Delrin® planar faced cylinders or posts (Fig. 43). The posts are positioned on the Lexan® plate such that each is centered beneath the rubber membrane of each well of a 35 mm BioFlex® culture plate (Fig. 44). When vacuum is applied to a BioFlex® culture plate* with a Flexcell® Tension System, the membrane deforms across the post face creating uniform equibiaxial strain (Fig. 44).

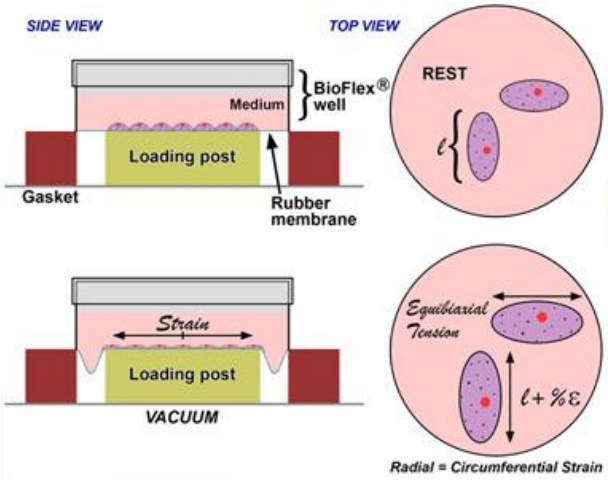


Figure 44. Schematic of the BioFlex® membrane deformed across a loading post.

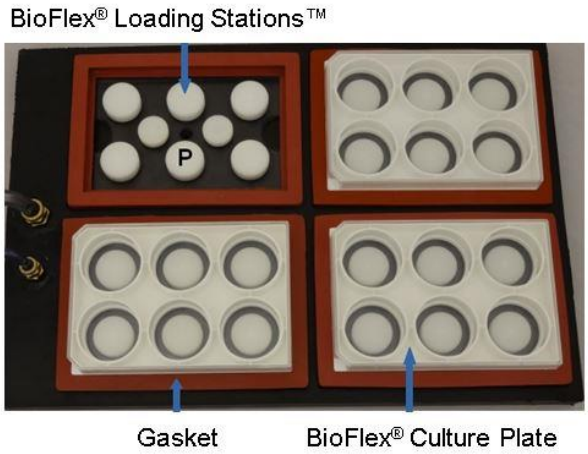


Figure 43. BioFlex® baseplate showing the Loading Stations™ with six loading posts (P) and BioFlex® culture plates in red rubber gaskets

Loading posts are available in three standard diameters: 25, 28, and 31 mm. Use of loading posts provides: 1) constrained distension to the flexible membrane, and 2) nominal fluid shear stress because the medium is not moving up and down over the field. A silicone-based lubricant is used to minimize friction between the membrane and post.

Please note: Flexcell® ships the 25 mm Loading Stations™ as standard with the FX-6000™ Tension system unless the 28 mm or 31 mm Loading Stations™ are requested upon ordering.

24-well High Throughput Plates. The 24-well HT BioFlex® plate (Fig. 45) is designed with a flexible silicone membrane well bottom and with standard industry perimeter dimensions. The standard size allows the plate to be utilized with plate readers and other standard culture plate devices. The total growth surface area for these plates is 37.47 cm^2 (or 1.56 cm^2/well). The 24-well Loading Stations™ have 10 mm diameter loading posts made of polystyrene. Equibiaxial strain is applied in the same manner as depicted in Figure 44.

Figure 45. 24-Well HT BioFlex® culture plate

** Flexcell culture plates are good for 1 year when stored at room temperature in the dark or out of direct light.*

⟶ Please see pages 4 – 6 for further information on the Tension systems.

Principle of Loading Stations™ Expanded to Uniaxial Strain

3D Tissue Constructs with Tissue Train®.
The above concept of strain application has been expanded to enable uniaxial strain to both 3D tissue cultures and monolayer cell cultures. Uniaxial strain is achieved through selectively controlling the portion of the flexible membrane that is exposed to the regulated vacuum. This is achieved through the use of special designed Arctangle® Loading Stations™ (Fig. 46). In addition to the Arctangle® Loading Stations™, specially configured culture plates are required to facilitate the uniaxial strain to the cell or tissue cultures. Tissue Train® culture plates are used in combination with Arctangle® Loading Stations™ (Fig. 47) to achieve uniaxial strain in a 3 dimensional tissue construct. Please note that the Trough Loader™ also shown in Figure 49 is used to develop three dimensional tissue constructs.

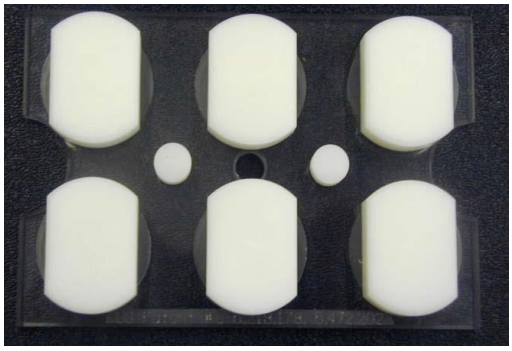


Figure 46. Arctangle® Loading Stations™

Figure 47. Tissue Train® culture plate from 3D culture of cell-matrix constructs. The top left well has a Trough Loader™ beneath the flexible membrane. The 4 adjacent wells show the anchors for attachment of cells and gel from an uniaxial, linear construct. The bottom left well shows an Arctangle® loading post to deliver uniaxial strain

Monolayer Cell Cultures with UniFlex®.
Uniaxial strain is achieved in monolayer cell cultures through the combined use of UniFlex® culture plates and Arctangle® Loading Stations™ (Fig. 48 and 49). UniFlex® culture plates are 35 mm 6-well culture plates with the same overall dimensional configuration as the BioFlex® and Tissue Train® culture plates. Uniaxial strain is achieved on a centrally located rectangular portion of the UniFlex® well (Fig. 50). The dimensions of this region are 15.25 mm x 24.18 mm (0.600" x 0.952"). The uniaxial strain orientation is along the 24.18 mm axis. This region provides a total uniaxial strain area of 3.68 cm^2 (0.57 in^2).

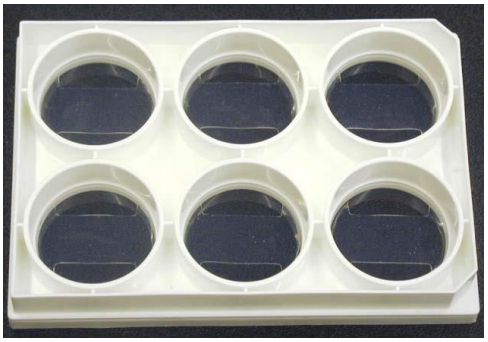


Figure 48. UniFlex® cell culture plate

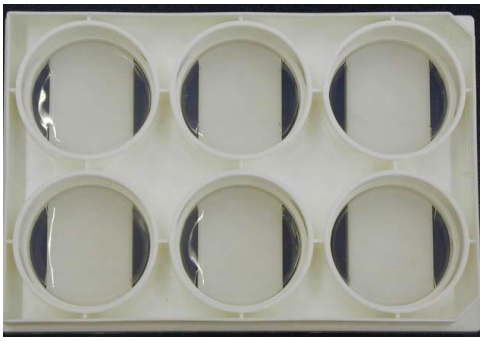


Figure 49. UniFlex® culture plate on Arctrangle® Loading Stations™

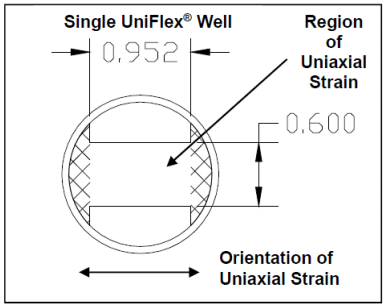


Figure 50. Dimensioned UniFlex® well showing region and orientation of uniaxial strain. Total area = 3.68cm^2

⟶ Please see page 7 for further information on the Tissue Train® system.

CO_2 Incubators for your Flexcell® System

Air Jacketed CO_2 Incubators from ShelLab and N-Biotek

The different baseplates used with the Flexcell® systems are usually placed inside an incubator. Therefore, the incubator needs to have an access port for the tubing between the baseplate, which is stored inside the incubator, and the FlexLink®, which remains outside the incubator.

SHELLAB®

Features:

- CO_2 range: 0 - 20 %, infrared CO_2 sensor
- CO_2 recovery rate: < 5 minutes
- Stainless steel interior/shelves, copper shelves on request
- Heated outer door, inner glass door
- Independent over temperature thermostat
- Over temperature and CO_2 alarm
- Supplied with water tray for natural humidity
- SCO5A-2 und SCO10A-2: Temperature range: ambient + 5 °C to 60 °C. Copper coated HEPA filter to reduce risk of contamination
- SCO10A-2: Incubator with 2 stacked separate chambers
- SCO6AD-2: Incubator with dry heat decontamination. Temperature range: ambient + 5 °C to 50 °C. Dry heat decontamination cycle (180 °C for 120 minutes)

SCO5A-2

SCO10A-2

SCO6AD-2

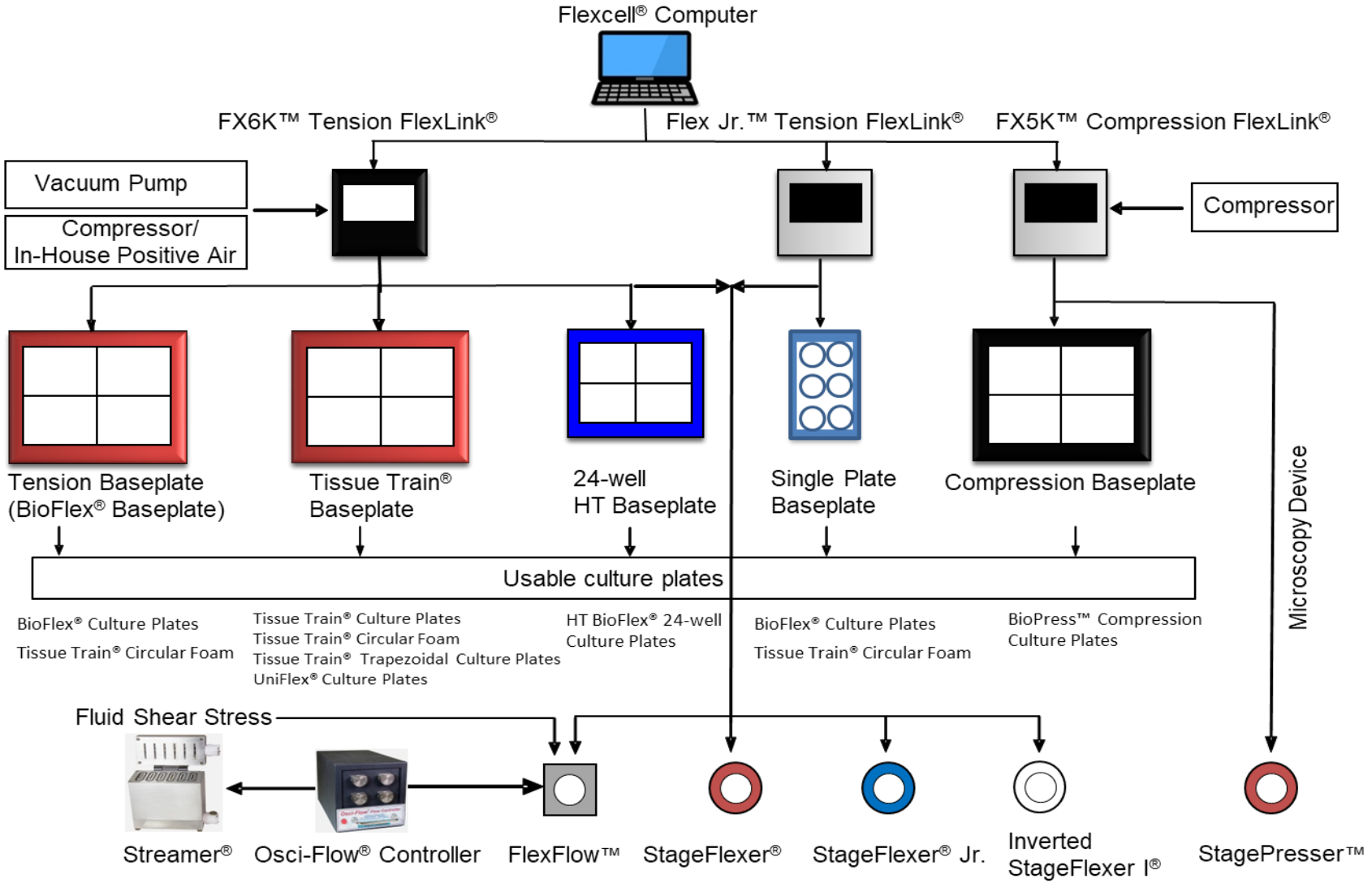
N-BIOTEK Leading Biotechnology

- NB203XL: CO_2 incubator with Access Port, supplied with 3 shelves (max. 8 shelves usable). Temperature range: 5 °C above ambient to 60 °C (± 0.25 °C at 37 °C). Optional features on request. Touchscreen versions are also available.

Cat. No.	Manufacturer	Chamber capacity	Shelves	Dimensions exterior (chamber) w x d x h
SCO5A-2	ShelLab	142 l	3	approx. 70 x 72 x 96 (52 x 50 x 55) cm
SCO10A-2	ShelLab	2 x 142 l	2 x 3	approx. 70 x 72 x 192 (52 x 50 x 55) cm
SCO6AD-2	ShelLab	167 l	3	approx. 73 x 78 x 100 (51 x 51 x 65) cm
NB203XL	N-Biotek	179 l	3	approx. 56 x 66,5 x 94,5 (47,3 x 52,8 x 71) cm

Also available from us: Many more incubators from both ShelLab and N-Biotek, fitting your special requirements. Please contact us.

Compatibility of Flexcell® Tension, Compression and Fluid Shear Stress Equipment



Please note: Depending on the number of baseplates used, additional FlexLinks® and pumps/compressors might be required. The Flexcell® computer can operate with up to 4 FlexLinks®, 1 Link can be used for 2 baseplates if running the same programme, different programmes at the same time only with different FlexLink®.