Select BioServe Space Technologies
Space Flight Experiment Hardware

BioServe has an extensive array of space life science hardware designed to support simple to complex life science experiments in the areas of cell culture, bacteria, virulence studies, small organisms and plants to name a few. Below is a partial list of life science hardware available through BioServe Space Technologies. All of BioServe's hardware has been used to support a wide variety of biological experiments in space.

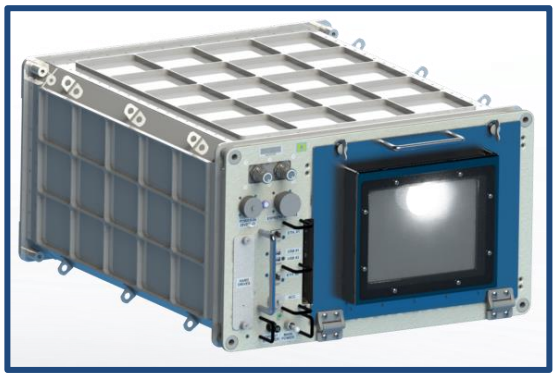
Commercial Generic Bioprocessing Apparatus (CGBA)

CGBA is a temperature-controlled microgravity research platform, developed by BioServe Space Technologies, that has hosted a variety of experiments on numerous Space Shuttle, MIR and International Space Station flights. CGBA provides power, data and video capabilities that enable operations of "smart" experiments housed inside the CGBA facilities. An array of life sciences experiments have been carried out inside CGBA over the past decade and a half. CGBA's computer system and custom developed software have enabled remote monitoring and control of experiments on the ISS from BioServe's Payload Operations and Control Center (POCC).

Currently there are two CGBA units available to support life science experiments aboard the ISS and additional units available to provide temperature control during transport to and from the station. CGBA has two configurations: the freezer unit which controls temperature from -16°C to +40°C and the refrigeration unit that controls temperature from 4°C to +40°C. The internal volume of the freezer unit is somewhat smaller than the internal volume of the refrigeration unit. All CGBAs offer a high level of autonomous operation, but also allow for remote real-time experiment control as well as real-time data downlink. CGBA also offers HD video capability as well as high resolution image capture of experiments while inside CGBA. CGBA is able to run an entire experiment from cell culture incubation at +37°C to sample fixation and storage at +4°C.

Space Automated Bioproduct Lab (SABL)

SABL is BioServe's newly updated smart incubator that can also support a wide range of life science experiments requiring temperature control (-5C to +40C). SABL provides power, data and imaging capabilities that enable operations of "smart" experiments housed inside the SABL volume. SABL, however, can reduce crew time required to conduct experiments due to the ability to access the experiment volume via the front of the payload without the need to power down or remove power or data cables. In addition, due to SABL's unique design, interior temperature gradients are virtually nonexistent. Internally powered experiments can use a small fan for additional convective cooling, if necessary. SABL has a robust computer and standardized interfaces (Ethernet, USB, display) that can support current off-the-shelf sensors, cameras, controllers, etc. Finally, SABL employs a modular design strategy so that individual components and subsystems can be changed out on orbit with relative ease. Modularity allows straight forward on orbit servicing with minimal crew time requirements.

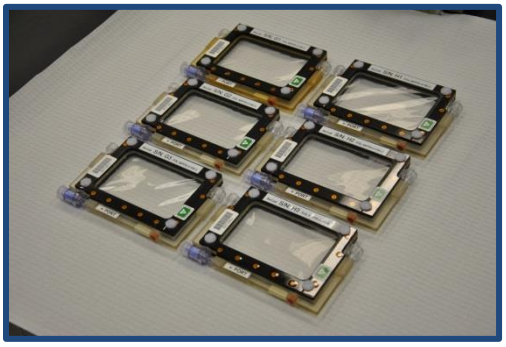


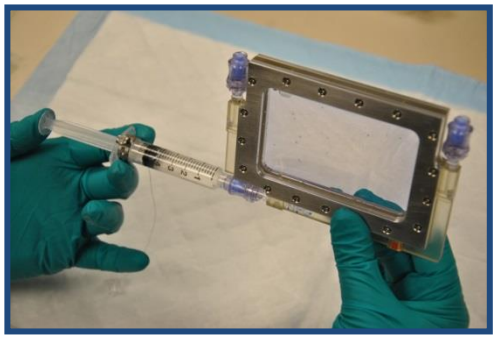
Atmosphere Control Module (ACM)

To enable successful cell culture on orbit, SABLs internal volume can be outfitted with the capability to create a controlled gas environment (e.g., 5% CO_2). Thus BioServe hardware supporting mammalian cell cultures can be incubated in the same manner and with the same expectations as petri dishes, multi-well plates and T-flasks are incubated in CO_2 incubators on the ground. The ACM effectively converts SABL into a fully capable CO_2 incubator and supports research on mammalian and other organism cell and tissue culture systems. In addition to enabling standard 5% CO_2 culture environment, the ACM can support unique gas environments such as elevated CO_2, reduced O_2, humidity addition or the addition of unique gases.

BioCell

BioServe has created a cell culture system that is capable of supporting complex cell culture experiments. The BioCell is available in a single well version up to a 6 well version with internal liquid volumes of 1.5mls to 30+ mls. The internal volume is sealed with gas permeable membranes that can allow for sufficient gas exchange to support either suspended or attached cell cultures with a 50 cm^2 of monolayer cell growth area per membrane. The type of material utilized for the membranes can be changed depending upon experiment requirements. Typical configurations may utilize FEP Teflon, polycarbonate or polystyrene membrane materials. All of the components and membranes (except polystyrene) are readily autoclaveable for sterility requirements associated with cell culture.

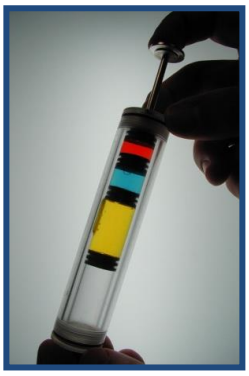




The BioCell also supports fluid injections, media exchanges, fixation and preservation of cultures. The fluid exchanges can be manual or automated. The BioCell accommodates temperature ranges from -80C to +40C

Group Activation Pack (GAP) and Fluid Processing Apparatus (FPA)

The FPA is a test tube that allows controlled, sequential mixing of two to four fluids in microgravity while maintaining appropriate levels of containment for safety purposes. A total of 6.5-ml of fluid is contained inside a glass barrel (1.35 cm inner diameter x 11.7 cm). The fluids or cultures are isolated from each other by a rubber septum. A bypass in the glass barrel allows fluid to flow into an adjacent chamber as a plunger mechanism pushes the septum forward. The FPA provides limited gas exchange. However, gas permeable membranes can be utilized with the FPA which increases gas exchange to some degree. The FPA can be flown individually or in sets of



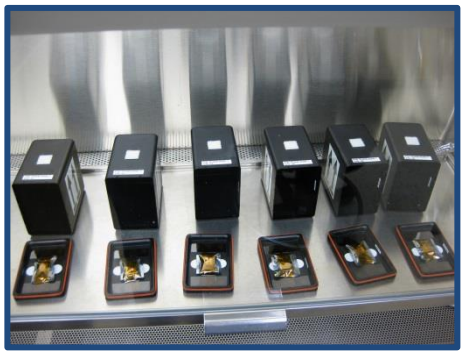
eight housed in a single GAP. The FPA and GAP configuration together provides three levels of containment and can support BSL 2 organisms or fluids. If temperature control is required, the CGBA units can hold 9 GAPs in the freezer configuration and up to 16 GAPs in the refrigeration configuration.

Multi-well Plate

The Multi-well Plate is designed to utilize the plate reader aboard the ISS. The multi-well plate utilizes FEP (fluorinated ethylene propylene) clear Teflon film to form wells within the plate frame. BioServe has developed methods to seal this film to a custom frame in a micro-plate format. FEP Teflon has a number of advantages for this design, including supporting high levels of O_2 and CO_2 gas exchange yet having a relatively low water vapor loss. In addition, FEP Teflon can be autoclaved for sterilization procedures. Finally, the film has light transmission properties consistent with the needs of investigators who might require imaging, spectroscopy or fluorescence-based assays from the cell cultures. The Multi-well Plate has a septum seal that enables injections through dual ports into each of the six wells. The plate can be loaded with reagents or inoculated with cells on orbit, processed inside CGBA for temperature control and imaging, if required, or placed in the ISS plate reader to enable a wide variety of assays.

Plate Habitat (PHAB)

The plate habitat is a sealed container that allows for gas exchange but meets NASA safety requirements for levels of containment. The PHAB can hold a number of single well or multi-well OmniTrays™. The OmniTrays™ are typically loaded with an agar growth surface and can be used to culture a wide variety of biological organisms.



More information and specifications regarding BioServe's CGBA and associated hardware can be found at the following links:

http://www.colorado.edu/engineering/BioServe/