NASAfacts

Fruit Fly Research

Aboard the International Space Station

NASA's suite of hardware for conducting fruit fly (*Drosophila melanogaster*) studies in space supports short- and long-duration studies aboard the International Space Station. Such experiments will examine how microgravity and other aspects of space affect these insects, providing information relevant to long-term human spaceflight. Approximately 75 percent of human disease genes are represented in the fruit fly genome, illustrating the genetic similarity between flies and humans.

Drosophila melanogaster, the common fruit fly. Image Credit: NASA / Dominic Hart

In addition to the genetic similarities with mammalian systems, hundreds of specimens can be flown within a small volume, which allows statistically significant data to be obtained even when the changes mediated by spaceflight are small but important. Also, the short developmental life cycle of the fly allows multiple generations to be studied within a short span of time. Fruit fly studies provide information about the effects of spaceflight at the biochemical, cellular and organismal levels. Using the fruit fly hardware, researchers are able to investigate the role of spaceflight on development, growth, reproduction, aging, neurobehavioral responses, immunity, heart function, etc. Specific research questions are defined in the National Research Council's 2011 Decadal Survey Report, "Recapturing a Future for Space Exploration: Life and Physical Sciences Research for a New Era."

There are three flight-validated hardware platforms currently available to fruit fly researchers: the Vented Fly Box (VFB), the Fly Cassette System, and the Compact Science Experiment Module. All of these platforms include environmental sensors that monitor temperature and relative humidity. Additional monitoring of oxygen and carbon dioxide levels also can be accommodated.

The unpowered VFB holds and safely transports up to 15 standard fly vials containing flies and fly food. The VFB supports fly cultures for approximately one month aboard the station. Mesh-covered vent holes facilitate airflow to the samples. The system is a simple hardware option that requires minimal crew time and no power or data connectivity. Although no observational hardware is included, windows on the sides of the box allow qualitative evaluation of fly health by station crew.

Each Vented Fly Box accommodates 15 vials containing fly cultures and food. Image Credit: NASA / Dominic Hart

The second fruit fly hardware platform, the Fly Cassette system, supports multigenerational studies of fruit flies in microgravity. This system has two major components: the Fly Cassette and the Food Changeout Platform. Fly Cassettes are compact, self-contained fly habitats. Food trays can be replaced on-orbit without breaking containment using Food Changeout Platforms. Since fresh food is introduced periodically to each cassette, use of this system requires more crew time than the VFB, but can support multigenerational and longer duration studies than the other hardware options. Each changeout operation allows separation of flies at different developmental stages (embryos and early larvae which remain on the food) from flies at later developmental stages (wandering larvae, pupae and adults which travel away from the food). The Fly Cassette system uniquely enables investigations of the effects of spaceflight expressed over multiple generations of flies and the return of frozen, fixed and live samples.

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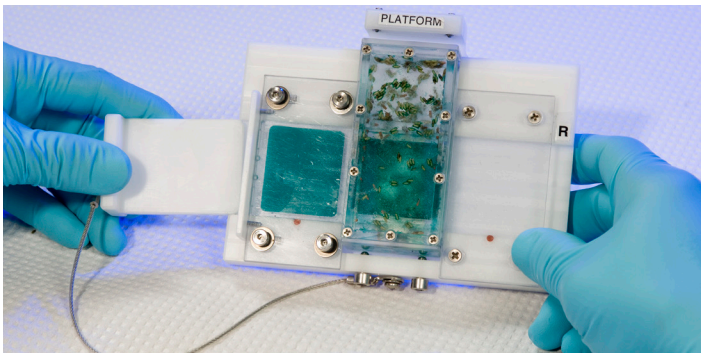

A Food Changeout Platform is used to exchange a tray of fresh fly food (left) for a food tray inside of a Fly Cassette (center) while fully containing the biospecimens. In this view, the fly food is colored with blue food dye. Image Credit: NASA / Dominic Hart

Biospecimens extracted from the Cassettes in the spent food trays can be preserved aboard the station for post-flight analysis. The system was flown on the shuttle middeck on STS-121 in 2006 and to the station in 2015 for the Fruit Fly Lab–01 mission. This system also can interface with various existing environmental chambers, centrifuge systems, and video and lighting systems that have been developed by commercial providers. Such facilities can provide additional capabilities of variable gravity levels, environmental controls and imaging during spaceflight.

The first flight experiment to use the Compact Science Experiment Module aboard the space station was designed and built by students at Ames. Image Credit: NASA / Dominic Hart

The third fruit fly hardware platform, the Compact Science Experiment Module, consists of dual fly habitats in a self-contained powered unit with lighting and imaging capability that supports behavioral analysis studies. Aboard the station, minimal crew time is needed to connect the system to USB ports for power and near-real-time data transfer.

The module includes programmable lighting to maintain a circadian cycle, automated video imaging using white or infrared light, fans for air circulation, environmental monitoring, and capabilities for data logging, download, and communication. The habitat volume is sufficient to house fly cultures for approximately one month at room temperature or longer at lower temperatures.

A Compact Science Experiment Module—built by students under the mentorship of scientists at NASA's Ames Research Center—was flown to the station in 2014 for the Ames student Fruit Fly Experiment. This project was initiated by the American Society for Gravitational and Space Research to give college students hands-on experience with spaceflight research. Ames, NanoRacks LLC and the Science and Technology Corporation supported the Ames Student Fruit Fly Experiment.

A new fruit fly experiment hardware platform is being developed for the space station under a NASA Small Business Innovation Research contract by Techshot (Greenville, IN). This is called the Multi-use Variable-gravity Platform (MVP) Drosophila Unit.

NASA Fly-hardware Capabilities

	Fly Cassette System	Compact Science Expt. Module	Vented Fly Box
Powered	YES	YES	NO
Video	YES	YES	NO
Data storage	YES	YES	NO
Data uplink	NO	YES	NO
Data downlink	YES	YES	NO
Temperature & humidity monitoring	YES	YES	YES
CO_2 and O_2 monitoring	Possible	YES	NO
Separation of generations	YES	NO	NO
Lighting control	YES	YES	NO
On-board 1 *g* control	YES	NO	NO
Crew time: installation	< 1 hour	< 1 hour	< 1 hour
Crew time: maintenance	2+ hours per changeout	None	None

Development of the Fly Cassette system and the Vented Fly Box is supported by the International Space Station Program at NASA's Johnson Space Center, Houston and the Space Biology Project at Ames. Funding for Space Biology comes from the Space Life and Physical Sciences Research and Applications Division within the Human Exploration and Operations Mission Directorate at NASA Headquarters.

For more information, visit:
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