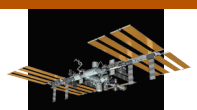


National Aeronautics and Space Administration

Biotube

Biotube was developed for plant gravitropic research investigating the potential for magnetic fields to orient plant roots as they grow in microgravity (Fig. 1). Prior to flight, experimental seeds are placed into seed cassettes, that are capable of containing up to 10 seeds, and inserted between two magnets located within one of three Magnetic Field Chamber (MFC; Fig. 2). Biotube is stored within an International Space Station (ISS) stowage locker and provides three levels of containment for chemical fixatives. Features include monitoring of temperature, fixative/ preservative delivery to specimens, and real-time video imaging downlink. Biotube's primary subsystems are (Fig. 3): (1) The **Water Delivery System** that automatically activates and controls the delivery of water (to initiate seed germination). (2) The **Fixative Storage and Delivery System** that stores and delivers chemical fixative or RNAlater to each seed cassette. (3) The **Digital Imaging System** consisting of 4 charge-coupled device (CCD) cameras, a video multiplexer, a lighting multiplexer, and 16 infrared light-emitting diodes (LEDs) that provide illumination while the photos are being captured. (4) The **Command and Data Management System** that provides overall control of the integrated subsystems, graphical user interface, system status and error message display, image display, and other functions.

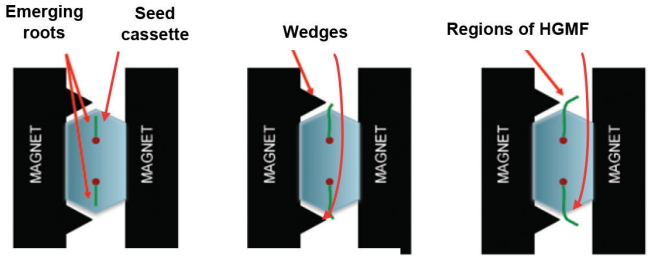


Fig. 1 Seed cassette with magnet configuration showing roots bending as they enter the High Gradient Magnetic Field (HGMF) regions.

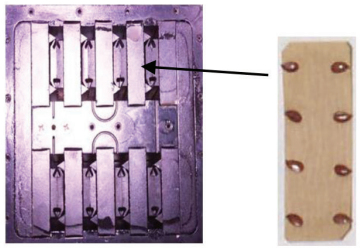
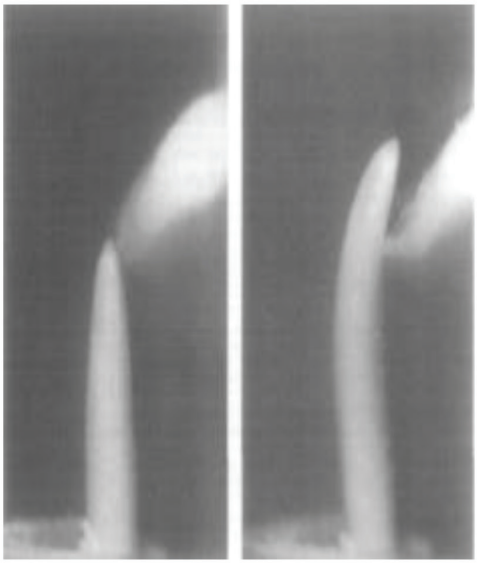


Fig. 2 MFC with 8 seed cassettes (left) and seeds attached to germination paper prior to insertion into an individual cassette (right).



Root curvature by HGMF in barley coleoptile.

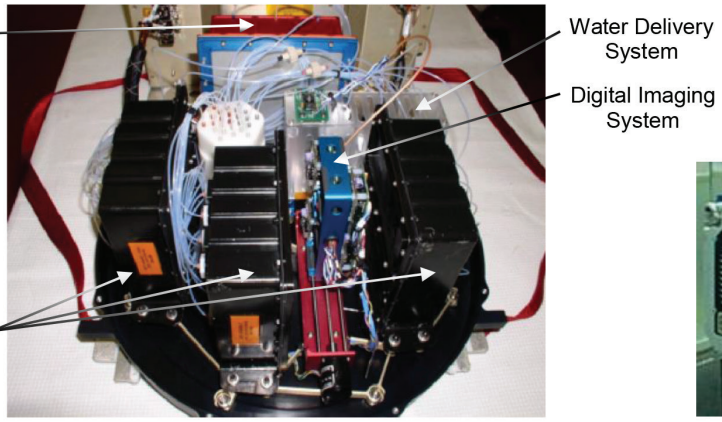
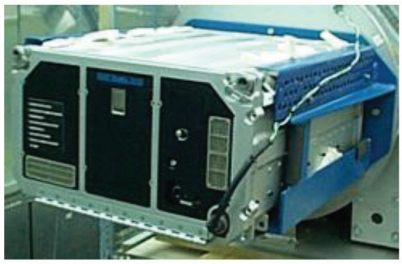


Fig. 3 Biotube prior to closure.



Biotube Middeck Locker Payload.

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