Space Magnets Attracting Interest on Earth

Applications of Physical and Biological Techniques In the Study of Gravisensing and Response System of Plants

The BioTube/Magnetic Field Apparatus (MFA) research is designed to provide insight into the organization and operation of the gravity sensing systems of plants and other small organisms. This experiment on STS–107 uses magnetic fields to manipulate sensory cells in plant roots, thus using magnetic fields as a tool to study gravity-related phenomena. The experiment will be located in the SPACEHAB module and is about the size of a household microwave oven.

Flax root growing in Magnetic Field Chamber hardware.

The goal of the experiment is to improve our understanding of the basic phenomenon of how plants respond to gravity. The BioTube/MFA experiment specifically examines how gravitational forces serve as a directional signal for growth in the low-gravity environment of space. As with all basic research, this study will contribute to an improved understanding of how plants grow and will have important implications for improving plant growth and productivity on Earth.

In BioTube/MFA, magnetic fields will be used to determine whether the distribution of subcellular starch grains, called amyloplasts, within plant cells predicts the direction in which roots will grow and curve in microgravity.

On Earth amyloplasts in plant cells accumulate in the direction of gravity causing a change in the cell. This essentially translates to a signal indicating which direction is "up" or "down". The BioTube/MFA experiment utilizes high-gradient magnetic fields to change the distribution of amyloplasts in flax roots. The magnetic field is concentrated at a specific point which produces magnetic gradient. As the root grows, it approaches the wedge and moves into the magnetic gradient. The starch grains are then repelled by the magnetic gradient, causing the roots to curve in the direction of the displaced starch grains.

BioTube/MFA in locker.

The BioTube/MFA experiment contains dry flax seeds (also known as *Linum usitatissimum*) that will germinate in space. The seeds will be watered and the roots will begin to grow across the high-gradient magnetic field wedges in two Magnetic Field Chambers. A third Magnetic Field Chamber will provide a uniform (non-gradient) magnetic field for the roots as a comparison to the high-gradient magnetic field. Time-lapse imagery will record pictures of the roots as they grow. Approximately 48 hours after seed watering, a chemical fixative will preserve the flax specimens for microscopic analysis and the experiment will end.

The science objectives of the BioTube/MFA experiment address three major questions:

1. Are amyloplasts the organelles in plant cells that perceive gravity?
2. Does the position or movement of the amyloplasts (sedimentation on earth, or, response to a high gradient magnetic field in orbit) affect the root growth direction?
3. Does gravity exert an effect on the deposition of cell wall material and the organization of plant cells organelles?

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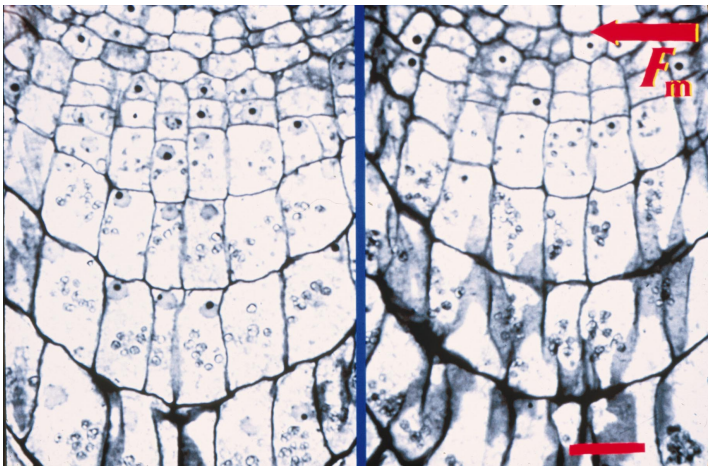
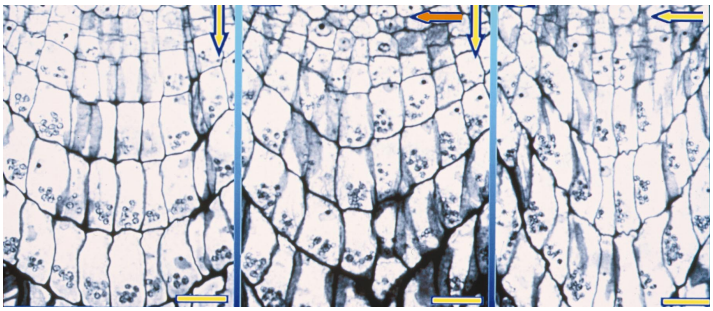
Background Information

These goals will provide insight into the fundamental organization and operation of the gravity response system of plants and determine if, other than the root cap, other parts of the plant require cues for directional growth.



The left panel depicts the random orientation of amyloplasts in a simulated spaceflight experiment. The right panel shows the effect of a magnetic force displacing amyloplasts to the left.



The left panel belongs to a normal root with the amyloplasts sedimented to the root cap region. The center panel shows a root cap with a lateral high-gradient magnetic field displacing amyloplasts to the left. The right panel shows a gravitationally affected root with amyloplasts sedimented to the left.

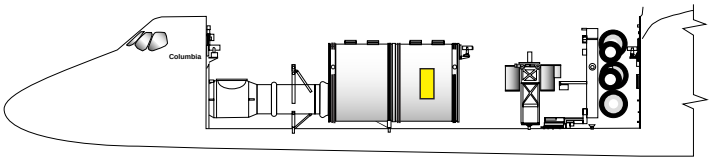
Astronauts will turn on the BioTube/MFA experiment three days prior to landing. All experiment operations will be complete within a 48 hour period. The BioTube/MFA software automatically controls a series of events that will deliver water to the seeds, take images of the growing roots and deliver a chemical fixative which preserves the roots for later analysis. The astronaut crew will periodically check on the equipment as the experiment progresses and will turn the power off following chemical fixation.

Science Discipline Supported

The BioTube/MFA research primarily addresses Fundamental Space Biology, but applies to other disciplines.

Future Similar Experiments on *International Space Station*

Similar flight experiments could be conducted on the *International Space Station* to increase the knowledge of how biological processes are affected by microgravity.



Approximate location of this payload aboard STS–107.