NASA Facts

National Aeronautics and
Space Administration

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ARC-FS-001

LIFE SCIENCES RESEARCH

NASA Ames Research Center's life sciences program studies problems in space medicine and gravitational biology. The scientists who deal with these problems include biologists, chemists, psychologists, physiologists, physicians and veterinarians at Ames and nearby universities.

One of the primary objectives of NASA-Ames life sciences research is to develop technologies and procedures to ensure the health and safety of crews while they work on board spacecraft, outside their vehicles for extended periods of time and on the surfaces of other planets.

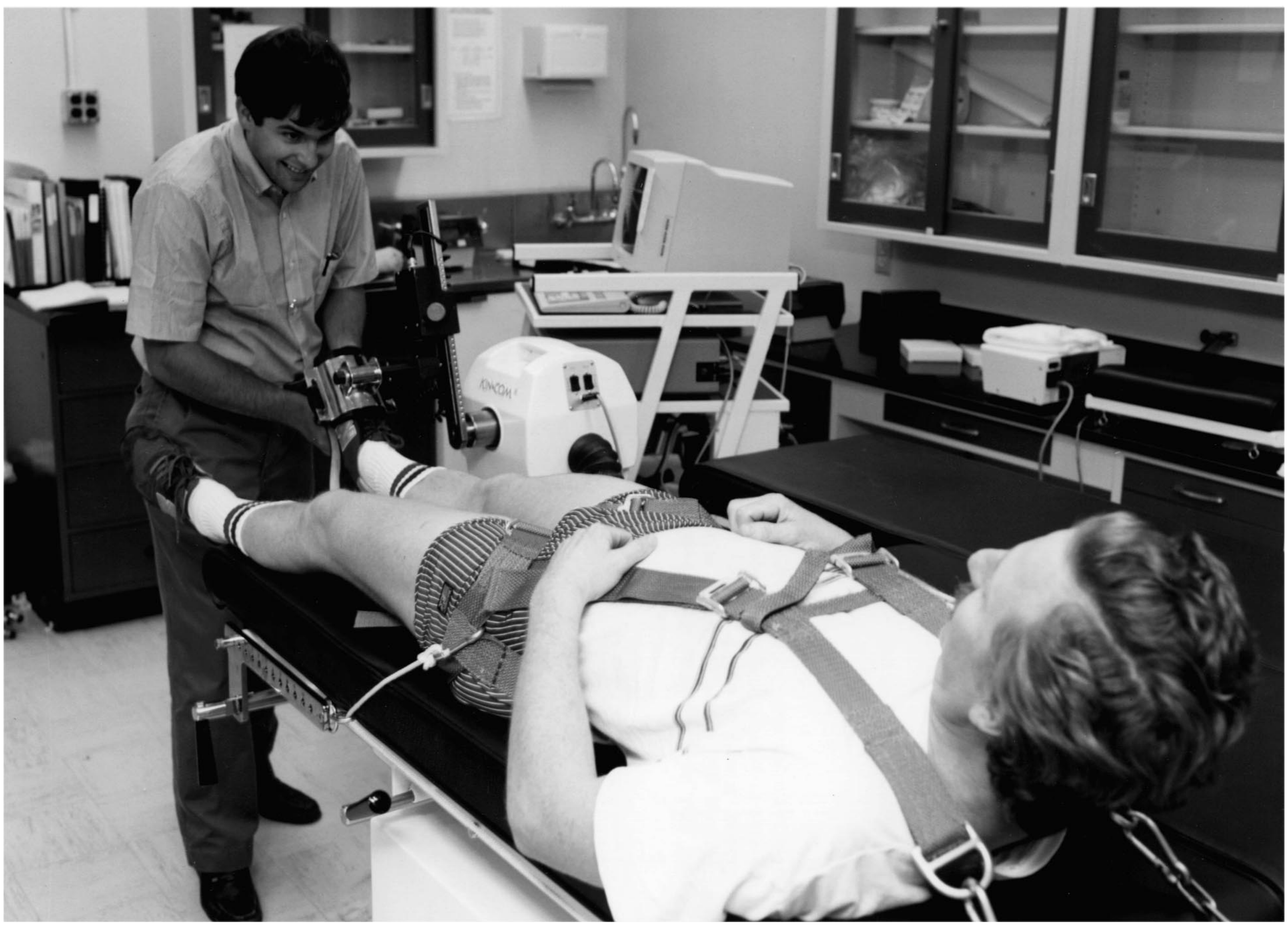
Continuous head-down (-6 degrees) bed rest is used to simulate effects of prolonged microgravity on the human body, such as cardiovascular deconditioning, muscle atrophy, decreased bone formation, and shifts in fluid and electrolyte balance. Simply lying in bed without exercising causes changes in bone formation and slight atrophy in muscles.

Medical and Physiological Effects of Space Flight

Because space is a relatively new environment for humans, there is much to learn about the effects of prolonged weightlessness, or microgravity, on the human body. NASA space medicine research focuses on maintaining the health and functional capabilities of astronauts both during space missions and after return to Earth, and on understanding the effects of gravity (or its absence) on the functions of living organisms.

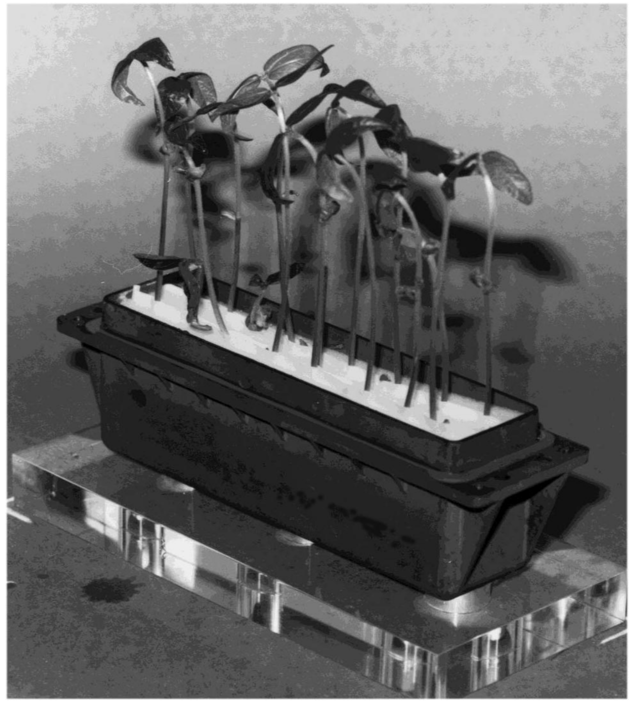
While some of this research is conducted in space, the majority is carried out on the ground. Space flight conditions are simulated in laboratories to help researchers understand and prevent the physiological changes in humans and animals observed during exposure to microgravity. These changes include space motion sickness, loss of bone and muscle mass and cardiovascular deconditioning leading to decreased blood volume, light-headedness and fainting.

Biomedical researchers are also studying space adaptation syndrome, a response to microgravity experienced by nearly half of all space travelers. The syndrome is characterized by loss of appetite, cold sweating, increased heart rate, nausea and fatigue.



Muscle strength is measured in bed-rest volunteers before and following continuous bed rest. An isokinetic exercise device is used to apply eccentric and concentric muscle contractions.

Researchers at Ames' Vestibular Research Facility use a centrifuge and a linear sled to simulate changes in gravity on the vestibular systems of animal subjects. One important objective of these simulation studies is to understand the physiological changes occurring in humans during spaceflight. Researcher in the Psychophysiology Lab use a rotating chair and a vertical acceleration device to train astronauts in the use of biofeedback techniques to control space adaptation syndrome symptoms.



A few roots of mung bean seedlings grew up out of the soil in the gravity-free environment of space. In general the plants grew to look much like control seedlings grown on Earth.

Gravitational Biology

All terrestrial organisms have evolved in the Earth's gravitational field. By going into space, humans, animals and plants experience life without this pervasive factor. If humans are to spend extended periods of time in space free from gravity, or travel to other planets with gravitational forces different from that of Earth, the most basic question of how gravity influences living organisms must be answered.

Ames scientist Dr. Patricia Cowings with volunteer in the "rotating chair" in the Psychophysiology Lab. The chair rotates to induce motion sickness, as Dr. Cowings monitors the subject's responses, such as body temperature, heart rate, respiration and muscle tension. The subject is tested again after learning to control symptoms through autogenic feedback training.

The study of how plants and animals interact with gravity begins with the question of how they sense their position and motion in the presence, or absence, of a gravity field. A second area of research focuses on ways certain tissues of terrestrial organisms have adapted to Earth's gravity and how they change when the force of gravity is suddenly removed.

On Earth, plants' roots usually grow down, toward gravity and soil nutrients. Plant stems grow up, away from gravity and toward light. Scientists are studying how plants grow without gravitational clues in the weightless environment of space.

The rodent Research Animal Holding Facility is a self-contained unit providing food, water, temperature and airflow control, waste management and an automatic 12/12 light cycle for rodents used in life sciences research onboard the space shuttle.

All animals have gravity-sensing organs which orient them and help them maintain balance in Earth's gravitational field. In vertebrates, some of these organs are found in the inner ear. Detailed modeling of the components of these organs based on animal studies at Ames have led to exciting new insights into how information on motion and gravity is processed and perceived by the brain.

Gravitational biology studies overlap with other life science research. Because some animals are biologically similar to human, they can substitute for human subjects in studies on the harmful effects of weightlessness on astronauts. Gravitational research on plants contributes to the design of self-contained agricultural systems on spacecraft.

Spaceflight Life Sciences Experiments

NASA Ames Research Center manages animal and plant studies performed in the space shuttle's Spacelab. Specialized hardware for life sciences in space developed under Ames contracts include a holding facility for housing rodents and monkeys on Spacelab and a laboratory "glovebox", a chamber for working with chemical and live specimens in microgravity.

Five Spacelab flights are scheduled in the next few years, with nearly 40 life science experiments planned. Two of these flights are dedicated space life sciences missions, SLS-1 and SLS-2. Biological investigations will also be performed on the International Microgravity Laboratory 1 and 2 and future Japanese and German missions.

In addition to the space shuttle Spacelabs, U.S. researchers have flown experiments on the Soviet Cosmos spacecraft. These unmanned mission are managed for the U.S. by NASA-Ames. Other cooperative missions are planned for the future.

Lifesat, a small spacecraft launched by a conventional rocket and able to orbit the Earth for up to 60 days, is another life sciences facility now under development. Plants and animals inside the capsule will be sustained by basic life support systems, power, lighting and monitors. Lifesat's heat shield will ensure survival of the living organisms during the capsule's reentry into the atmosphere.

The Space Station Freedom, a permanent Earth-orbiting research facility planned for the future, will allow an entirely different class of life sciences research in space. Extended duration plant and animal studies will be possible, as well as evaluation of biomedical problems encountered during long-term exposure to microgravity.

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