

10. Bones and Muscles in Space

Muscles and Bones

Activities Guide for Teachers



National Space Biomedical Research Institute

Houston, Texas



The National Space Biomedical Research Institute (NSBRI) is combining the basic research capabilities of some of the nation's leading biomedical research centers with operational and applied research conducted by the National Aeronautics and Space Administration (NASA) to understand and achieve safe and effective long-term human exploration and development of space. The NSBRI's discoveries and research products will help to counter the effects of weightlessness and space radiation and will contribute to the health and well-being of all mankind.



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CONCEPTS

- Lack of stress causes bones and muscles to become weak.
- Astronauts must counteract the effects of lost stress on bones and muscles.

OVERVIEW

Students will learn about the changes that occur in bones and muscles while people are in space and then apply their knowledge of muscles and bones to suggest preventative solutions for those changes.

SCIENCE, HEALTH & MATH SKILLS

- Using resources to gather information
- Applying knowledge
- Drawing conclusions
- Presenting conclusions with supporting information



10. Bones and Muscles in Space

Background

On Earth, muscles and bones are used to working against gravity to maintain posture and balance. In space, where the effects of gravity are almost absent, the muscles and bones of astronauts do not have to work as hard and become weaker. Bone rebuilding falls behind bone dismantling, and bones decrease in diameter and become less dense. The calcium removed from bones is permanently eliminated from the body in urine, leading to a condition similar to osteoporosis on Earth.

Muscles in space also become smaller and weaker through a process called atrophy. In addition, the fibers inside muscles change because most work in space involves short-duration, high intensity tasks.

The adaptation of muscles and bones to microgravity conditions does not have serious consequences in space, where astronauts do not need as much strength to keep their balance and move about. In fact, the bodies of people in space eventually reach equilibrium, called "space normal," with their new environment. This adaptation does, however, cause problems when astronauts return to an environment with the full force of gravity because their muscles and bones have become too weak to function as before.

Similar problems can be observed on Earth

among people who are bedridden during a long illness, who have part of their bodies immobilized to allow a fracture to heal or who suffer from osteoporosis. Research to develop measures that will counter changes in muscles and bones in space will benefit these and many other people directly.

Time

10 minutes for set-up; 30 minutes to conduct activity

Materials

Each student will need:

- copy of "Muscles & Bones in Space" student sheet

Set-up and Management

Provide resource materials on space topics.

Procedure

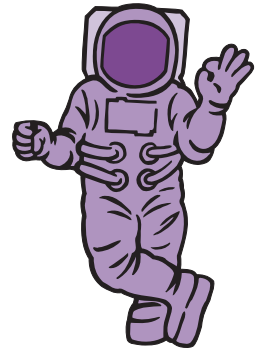
1. Review the concepts presented in this unit. Discuss how lack of stress affects bones and muscles. Ask the students to think of environments in which stress on the body is reduced. (Some examples are: on the moon, on the space shuttle or space station, or during bed rest.)
2. Hand out the "Muscles & Bones in Space" worksheet and have each student work alone.
3. Have students share their drawings with the rest of the class.

Have you or someone you know ever had a broken leg or arm? The limb probably had to be encased in a cast that would keep the broken pieces in place and allow them to mend. The lack of movement causes the muscles and bones inside the cast to become weaker. This usually can be observed once the cast is removed—the diameter of the newly healed arm or leg is noticeably smaller than the arm or leg that wasn't in a cast. Fortunately, normal use restores bone and muscle size and strength within a few weeks.

Something similar happens to the bones and muscles of astronauts who live and work in space.

Activity 10

Muscles & Bones in Space



Maria and Michelle are identical twins who live together and have similar activities. They are special student astronauts with NASA. Both are participating in an experiment on muscles and bones. Tomorrow, Maria will go up in the space shuttle for a 10-day mission. Meanwhile, Michelle will stay on Earth and maintain her normal daily routine. When Maria returns to Earth, scientists will compare the bones and muscles in Maria's and Michelle's right arms. The scientists need your help to know what to expect when the 10-day mission is over.

1. Draw an inside view of Maria's and Michelle's right arms—after the mission—in the spaces below. Label the bones and muscles.



Maria's Right Arm



Michelle's Right Arm

2. Describe how the two arms are different.

3. The scientists do not want the changes seen in Maria's arm to occur in the muscles and bones of astronauts on future missions. They need your help to design a diet and exercise program to prevent these changes. What would you suggest?
