



## Space Adaptations

### DESCRIPTION

This lesson integrates a series of activities to investigate the adaptations that humans must make during spaceflight.

### OBJECTIVES

Students will:

- Demonstrate the effects of bone loss during spaceflight.
- Investigate the effects of bone loss on bone strength.
- Explore the effects of disorientation on humans.
- Explore the effects of microgravity on the human body.
- Discover the importance the amount of oxygen needed for spacewalking.

### NASA SUMMER OF INNOVATION

#### UNIT

*Life Science – The Body*

#### GRADE LEVELS

4 – 6 and 7 – 9

#### CONNECTION TO CURRICULUM

*Science, mathematics*

#### TEACHER PREPARATION TIME

*1 hour*

#### LESSON TIME NEEDED

*3.5 hours      Complexity: Moderate*



## NATIONAL STANDARDS

### National Science Education Standards (NSTA)

Science as Inquiry

- Skills necessary to become independent inquirers about the natural world
- Understanding of scientific concepts
- An appreciation of 'how we know' what we know in science
- Understanding of the nature of science
- The dispositions to use the skills, abilities, and attitudes associated with science

Life Science Standards

- Characteristics of organisms
- Organisms and environments
- Structure and function of living organisms

History and Nature of Science Standards

- Science as a human endeavor

### Common Core State Standards for Mathematics (NCTM)

Measurement and Data

- Represent and interpret data

## MANAGEMENT

The activities in this lesson should be done with cooperative groups of two to four students. Due to the materials used in some of the activities, it is recommended to use a facility with hard floors to facilitate cleanup. During the *O<sub>2</sub> – How Much* activity, for health and safety purposes, only one student should blow into the tubing or acquire enough tubing for each student.

## CONTENT RESEARCH

These activities focus on the effects of spaceflight on the human body. Space-faring nations must better understand these phenomena and develop countermeasures for some to enable long-duration spaceflight. In addition, understanding the effects of space on the human body can lead to better understanding of Earth-based diseases such as osteoporosis.

### Key Terms:

- **Bone Marrow:** Soft tissue filling the spongy inside of bones; the purpose of bone marrow is to make new blood cells
- **Musculoskeletal System:** Network of bones and muscles that work together to move the entire body
- **Respiration:** Process of supplying oxygen to cells
- **Osteoporosis:** A bone-thinning disease in which the levels of calcium in the body drop below what is needed, resulting in weakened bones and an increased risk of fractures or breaks
- **Osteoblasts:** A bone-forming cell; these cells synthesize and deposit bone material
- **Osteocytes:** Mature osteoblasts; this bone cell type maintains mature bone tissue
- **Osteoclasts:** Bone cells that **resorb** or “eats” older bone tissue

## LESSON ACTIVITIES

The listed activities lead students to investigate the effects of spaceflight on different systems of the human body.

### Vomit Comet

Students will learn that motion can cause disorientation and understand why astronauts train to live and work in space.

[http://www.nasa.gov/pdf/663096main\\_Vomit\\_Comet\\_Activity.pdf](http://www.nasa.gov/pdf/663096main_Vomit_Comet_Activity.pdf)

### O<sub>2</sub> – How Much?

Students will discover their oxygen requirements during relaxation and during strenuous activity. Then they can determine how much air an average "student astronaut" would need on a seven-hour spacewalk.

[http://www.nasa.gov/pdf/166966main\\_O2\\_How\\_Much.pdf](http://www.nasa.gov/pdf/166966main_O2_How_Much.pdf)

### Hole-y Bones

Students will compare the amount of calcium needed by the body at different developmental stages and demonstrate the effect of calcium loss on bones.

[http://www.nasa.gov/pdf/663095main\\_Hole-y\\_Bones\\_Activity.pdf](http://www.nasa.gov/pdf/663095main_Hole-y_Bones_Activity.pdf)

## MATERIALS

- Flour (approx. 5kg)
- Scale or balance
- Large, zippered plastic bags
- Marker
- Science journal
- Single-hole punch
- Paper
- Pen or pencil
- Scissors
- Calculator
- Rotating chair
- Blindfold
- 2-L soda bottles
- Flexible plastic tubing
- Paper strips
- Clear tape
- Water
- Large aquarium or plastic tub
- Snack or 1 quart zip bags
- Corn puff cereal
- Heavy book
- Broom and dustpan or vacuum
- Measuring tape
- Water-soluble marker

## Bag of Bones

In this activity, students will be able to identify the effects of decreased bone mass (osteoporosis) and describe why healthy bones are important in space and on Earth.

[http://www.nasa.gov/pdf/663094main\\_Bag\\_of\\_Bones\\_Activity.pdf](http://www.nasa.gov/pdf/663094main_Bag_of_Bones_Activity.pdf)

## Get a Leg Up

During this activity, students will simulate the effects of spaceflight on the human body related to the shifting of fluids in microgravity.

Teacher Guide: [http://www.nasa.gov/pdf/146854main\\_Get\\_A\\_Leg\\_Up\\_Educator.pdf](http://www.nasa.gov/pdf/146854main_Get_A_Leg_Up_Educator.pdf)

Student Guide: [http://www.nasa.gov/pdf/146855main\\_Get\\_A\\_Leg\\_Up\\_Student.pdf](http://www.nasa.gov/pdf/146855main_Get_A_Leg_Up_Student.pdf)

## ADDITIONAL RESOURCES

National Space Biomedical Research Institute

Human Physiology in Space Outline

<http://www.nsbri.org/HumanPhysSpace/indexb.html>

Good Stress: Building Better Muscles and Bones

In NASA CONNECT™, *Good Stress: Building Better Muscles and Bones*, students will learn about the importance of building and maintaining better muscles and bones. They will learn that all stresses in life are not "bad." In fact, the body needs "good" stresses, like exercise, to be healthy. Students will see how scientists and researchers collect and analyze physiological data to understand how muscle and bones are constantly changing, especially in a microgravity environment. By conducting inquiry-based and web activities, students will make connections between NASA research and the mathematics, science, and technology they learn in their classrooms.

Educator Guide - [http://www.knowitall.org/nasa/pdf/connect/Good\\_Stress\\_Guide.pdf](http://www.knowitall.org/nasa/pdf/connect/Good_Stress_Guide.pdf)

Video - <http://www.knowitall.org/nasa/asx/goodstress.asx>

NASA Eclips Video - Our World: Exercise in Space

Find out why exercise is so important to the astronauts who travel into space. Learn how gravity affects our bodies and what astronauts must do in reduced gravity environments to keep their bodies healthy.

<http://www.nasa.gov/audience/foreducators/nasaclips/ourworld/living-in-space.html>

Keeping the Beat Activity Guide

Students measure and record their pulse rate before and after physical activity to learn more about the heart. Students have the opportunity to use a math model to look for patterns in the pulse rate data.

[http://www.nasa.gov/pdf/452974main\\_OW3-KeepingtheBeat\\_508.pdf](http://www.nasa.gov/pdf/452974main_OW3-KeepingtheBeat_508.pdf)

## DISCUSSION QUESTIONS

Each NASA activity includes discussion questions in the provided Student Data components.

Additional Questions:

- Explain the total effects of spaceflight on the human body. *Answers will vary.*
- Discuss how understanding the effect of spaceflight on the human body changes your desire to go into space. *Answers will vary.*

## ASSESSMENT ACTIVITIES

Each activity includes a "Student Data Sheet". Have students add entries to their Mission Journal from the *Train Like an Astronaut* or *Brain in Space* lesson. These entries can be used as both formative and summative assessment. Additionally, podcasting or other multimedia presentations would be good options for summative projects and assessment.

**ENRICHMENT**

Several activities have enrichment or extension activities listed. In addition, there are several good activities listed in the *Additional Resources* section.