



# Bones of Contention

## Overview

Children make models that represent bones on Earth and bones that have been in space by poking holes into foam cups. They press down on each of the two bone models to discover that exercise and nutrition make for stronger bones.

## Activity Time

5 minutes

## Type of Program

- Facilitated hands-on experience
- Station, presented in combination with related activities
- Passive program
- Demonstration by facilitator

## Intended Audience

**Families** or other mixed-age groups, including children as young as 4 years old *with assistance from an older child, teen, or adult*  
**School-aged** children ages 5–7 and 8–9  
**Tweens** up to about age 13

## What's the Point?

- Astronauts — and kids! — need to eat a well-balanced diet and exercise to stay healthy.
- The muscles and bones in our bodies stay conditioned by resisting (*working against*) Earth's gravity.
- Astronauts experience free-fall all day, every day as they orbit the Earth. As astronauts float, their muscles don't have to work as hard, and the muscles don't have to pull as hard on the bones to support the astronauts' bodies. When bones don't get exercise, they lose minerals and become weak.

## Facility Needs

- 1 or more tables                      OR                       A large container to hold the activity materials

## Materials

### For the Facilitator

- Beans in Space Facilitator Background Information* (below)



- Explore! Health in Space Discussion Guide* (below)
- Health in Space Correlations to National Standards***  
[www.lpi.usra.edu/explore/space\\_health/space\\_stations/standards.shtml](http://www.lpi.usra.edu/explore/space_health/space_stations/standards.shtml)

### For Each Group of 15 Children

- Colored markers
- 30 pencils or dowels (slightly sharpened)
- 30 Styrofoam cups (the taller, the better)

## Preparation

### Six months before the activity

- Determine the setup of your program, including any complementary activities or extensions that you'd like to combine with this activity. This activity may be offered as a brief learning experience on its own, as part of a longer facilitator-led program, or as a station in combination with other health- and space-related activities. For passive programs, plan to provide the materials at a table that can be visited by small groups or individuals. For facilitated programs, consider using an “icebreaker” activity to help the children get to know each other. If stations are set up, it is recommended that an adult or older child is present at each station to serve as a host and to prompt the children's thinking. Station hosts may also demonstrate and/or assist younger children in completing the activity.
- Prepare and distribute publicity materials for programs based on this activity. If possible, build on the children's knowledge by offering multiple science, technology, engineering, art, and mathematics (STEAM) programs.
- Pull supporting resources out of circulation to feature during the program. If possible, integrate online videos and website resources into the program. See the *Health in Space* resource lists at [www.lpi.usra.edu/explore/space\\_health/resources](http://www.lpi.usra.edu/explore/space_health/resources) for ideas!
- Review the *Bones of Contention Facilitator Background Information* and *Explore! Health in Space Discussion Guide*.
- Plan to provide assistance for younger children, who may need an older child, teen, or adult to poke holes in their cups.

### The day before the activity

- Provide the cups, pencils or dowels in a bin or place them at a table so that participants can access them.

## Activity

### 1. Share ideas and knowledge.

- Introduce yourself. Help the children learn each other's names (if they don't know each other already).
- Use the *Explore! Health in Space Discussion Guide* to draw participants into the activity and frame the activity with the main message: Astronauts — and kids! — need to eat a well-balanced diet and exercise to stay healthy.
- Ask the participants to describe the feeling of free-fall, which they may have experienced very briefly on a free-fall ride or roller coaster at an amusement park or on an elevator, just as the car started to descend.

Earth's gravity still affects the space station and the astronauts, but since they are continually *falling* around the Earth (i.e., orbiting), they constantly experience that free-fall feeling we occasionally experience on amusement park rides. Astronauts aren't riding a roller coaster, though; they are riding the International Space Station at 17,500 miles (28,000 kilometers) per hour, 200-250 miles (about 320-400 kilometers) above the Earth! Since the astronauts, their food and supplies, and their spacecraft are all falling together in orbit around the Earth, everything appears to float.

- Explain that astronauts experience free-fall all day, every day as they orbit the Earth. As astronauts float, their muscles don't have to work as hard, and the muscles don't have to pull as hard on the bones to support the astronauts' bodies. When bones don't get exercise, they lose minerals and become weak.

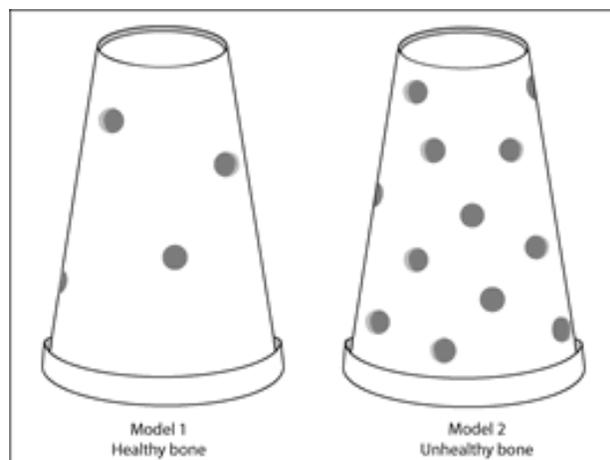
Use the terms "free-fall" and "microgravity"; the terms "zero gravity" and "weightlessness" are don't give an accurate impression about how gravity works in space.

With older children, explain that the free-fall environment that astronauts experience in space is called **microgravity**. As they orbit Earth, the effect of gravity is so small ("micro-"), that it does not matter that a feather, a person, and a spacecraft all have different masses (i.e., are made up of different amounts of matter).

### 2. Model a healthy bone on Earth and an astronaut's bone after living in space.

Encourage each pair of participants to take turns with the following steps:

- a. Take 2 Styrofoam cups and a slightly sharpened pencil or pointy stick.
- b. Poke about 5 holes, scattered randomly, in one foam cup, and poke about 25 holes in the other.
- c. Label the cup with 5 holes "Bone on Earth" and the cup with 25 holes "Bone in Space."



- d. Compare the models of the bone on Earth with the bone in space.
- e. Stand each of the “bones” (cups) upright on a flat surface.
- f. Place your hand, palm down, on top of the Earth bone. Gently press down and observe whether it is difficult or easy to crumple.
- g. Gently press down on the “space bone” and observe how difficult or easy it is to crumple.

**3. Compare observations and connect them to the “real world.”** Prompt the children to compare their experiences pressing down on each of the “bones” with other children and/or family members. Prompt them to connect that experience to what astronauts experience in space.

**4. Explain that in space (a microgravity environment), astronauts’ bones become weak.** Their muscles don’t have to work as hard, and the muscles don’t have to pull as hard on the bones to support the astronauts’ bodies. The “space bone” hadn’t gotten enough exercise, and it lost minerals and became weak. Astronauts must exercise almost two hours each day and get a diet rich in calcium to help keep their bones from getting too weak until they return to Earth.

It is important to emphasize that being in space does not put holes in your bones. This activity uses models of bones (cups) to demonstrate the effects of mineral loss in bones as a result of being in space. The “bone” (cup) with more holes models a bone that is less healthy than the “bone” (cup) with fewer holes.

**5. Conclude.** Summarize that kids and adults on Earth also get weaker bones if we don’t eat a well-balanced diet and exercise enough. Challenge the children to eat a balanced diet and exercise to keep their bones from becoming like “space bones.”

## Extension

### ***Weightlessness Demonstration***

[www.windows2universe.org/teacher\\_resources/weightlessness\\_edu.html](http://www.windows2universe.org/teacher_resources/weightlessness_edu.html)

This *Windows to the Universe*® activity outlines facilitator steps to illustrate the effects of free fall using cups and water. Appropriate for ages 10–18.



# Bones of Contention

## Facilitator Background Information

Astronauts may seem to have a lot of fun in microgravity — doing flips in mid-air, pushing off effortlessly from one part of the spacecraft to sail to another part. However, there are some down sides for astronaut health!

One of the biggest challenges facing space travelers is the loss of bone mass. The bones become brittle and are at higher risk of fracture. Bones need physical stress to maintain their health. In microgravity, bones do not get the kind of workout that they do on Earth, and they deteriorate. To counteract this bone loss, astronauts must spend up to two hours every day exercising and they must get proper nutrition (for example, adequate calcium, vitamin D, and other nutrients). And it is not just *astronauts* that need to get enough exercise and calcium. Kids on Earth do, too!

Our bones form the support structure of our bodies. They protect our organs, help us to move around, store minerals (like calcium), and produce blood cells. Bone is living material that is constantly being broken down and formed. Bones are our body's "calcium bank;" calcium is constantly being removed — or resorbed — from the bones to use for other bodily processes. To maintain healthy bones, in addition to good nutrition (like calcium and vitamin D), we also need to get lots of exercise — because building bone requires physical stress. On Earth, most of our bone growth occurs until we are about 18–20. This is why it is so important to make sure that you drink lots of milk and eat other sources of calcium and get lots of physical activity when you are young. If you don't build healthy bones by the time you are 15–20 years old, you won't be able to make it up later in life. Once you are in your 20's and older, you are no longer building bones, you are maintaining them with good nutrition, vitamin and mineral supplements, and exercise.

In microgravity, little physical effort is needed to move around or perform tasks or to hold our body in a rigid posture. Because we don't need bones in space, our body stops devoting resources and energy to maintain them. Astronauts lose approximately 1 to 2% of their bone mass for each month they are in space. This means that they lose 10% of their bone mass in less than a year — on Earth, humans over the age of 50 lose about 10% of their bone mass over a period of 10 years! Too much bone loss can lead to a disease called osteoporosis — where the bones are at much higher risk for fractures and breaks.

Bone mass loss — on Earth or in space — means that bones become more brittle, they fracture and break more easily when stressed. To make the challenge to health even more complex, that calcium coming from bones can be deposited elsewhere in the body and cause problems — like kidney stones. To counter bone loss astronauts undergo almost two hours of exercise each day, including resistive exercises — strength training — and aerobic exercises — bicycling and walking or running on the treadmill. This physical stress helps to reduce bone loss. NASA medical researchers define how much calcium and other minerals and vitamins are needed by each astronaut, and their meal plans are adjusted to meet these requirements.

Once the astronauts return to Earth, the bone loss stops. Scientists are working to understand if the lost bone can be completely replaced, and if the new bone is the as strong as the original bone. Because space travel has been limited to relatively short visits — very few people have flown more than 6 months, and the longest has been about 14 months — we are still working to understand the impact of extended weightlessness on the human body. NASA is testing new exercise equipment and routines, nutrition, medications, and other ways to help combat the changes to the human body in space.



# Health in Space

## Brief Discussion Guide

**Draw participants into the activity and frame the activity with the main message:**

**Astronauts — and kids! — need to exercise to stay healthy.** Use discussion to help them start to think about prior experiences and build new understandings about health and the importance of exercise —both on Earth and in space. Some conversation-starters are:

- Invite the children to tell another child or family member one thing that they do to stay healthy and one thing that an astronaut would do to stay healthy.
- Suggest that they think of the things they do every single day, starting with the minute they wake up to the very last thing they do at night. Ask which of those things, if they didn't *do* or *have* them on a regular basis, would *sooner* or *later* make them either physically sick — or just plain miserable. Answers will vary, but probably will include things like breathing, eating, sleeping, bathing, brushing your teeth, exercising and playing.
- Both kids and astronauts have to...
  - *Keep clean.* Cleanliness is an important factor for maintaining a healthy life! Bacteria can thrive in space as well as on Earth, particularly on unclean surfaces, and that includes your body! Colds can spread in space, just like they can on Earth; it is necessary for astronauts to stay clean to stay healthy. Being clean also makes you feel good! There are no showers or baths in space, so astronauts use wipes to keep their bodies clean.
  - *Sleep.* Children, particularly teenagers, need at least 8 hours of sleep each night. Astronauts also need to get enough sleep because, without sleep, it is difficult to think clearly.
  - *Have fun.* No matter what your age or location, fun — and relaxation — is important for good mental health. All people need time out — to rest, relax, and have fun. Astronauts and kids share a lot of fun things in common, like playing Frisbee, cards, guitar, juggling, tossing food and catching it in their mouths (or trying!), watching movies, listening to music, reading books, and sending e-mails to family and friends!
  - *Eat a well-balanced diet.* Meals should follow a schedule and be nutritious and well balanced. They should be rich in vitamins, minerals, and other nutrients, and should be balanced for calories/energy. Calcium, in particular, is an important mineral for both kids and astronauts to build and maintain bone mass. Another vital ingredient for health is drinking plenty of water. Without a healthy diet, we would not have the energy to work and play and we would be more susceptible to diseases.
  - *Eat foods that are rich in calcium and help healthy bones to grow and stay healthy.* Dairy foods, like cheese and yogurt, as well as broccoli and brussel sprouts have lots of calcium.
  - *Exercise.* Exercise keeps bones and muscles strong and keeps our heart — and brain! — healthy. Exercise helps keep astronauts' bones and muscles from weakening while they are in the reduced gravity conditions of space. You may want to mention to the children that "exercise" and "play" are not necessarily the same



things. There can be overlap, but activities like video games could be considered play; doing jumping jacks for 30 minutes would be exercise.

- Protect ourselves from ultraviolet radiation. Too much exposure to UV radiation results in sunburn and skin diseases. A little UV radiation is needed by all humans, but we need to limit our exposure by using sun block, covering up with clothing and space suits, and wearing protective sunglasses and visors on our space helmets.