



Measure Up!

Overview

Children work in pairs to measure each other's ankles with lengths of string before and after lying on their backs with their feet in the air for 1 minute. This models the microgravity of space, where everything — including body fluids — floats!

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 must be very fit to take on all the changes that happen to their bodies in space.
- Astronauts experience free-fall all day, every day as they orbit the Earth. As astronauts float, the blood and water inside of them also floats.
- This fluid shift causes the upper portion of astronauts' bodies to swell and their legs to become thinner.

Facility Needs

- Access to a 2'-wide section of wall and an adjacent 5'-square section of open floor space
- A small container or bag to hold the activity materials

Materials

For the Facilitator

- Measure Up! 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
- 1 ruler

For Each Group of 2 Children

- 2 different colors of markers
- 1 (12-18-inch) length of string that will not stretch
- A writing utensil and scrap paper
- Timer or watch

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 for ideas!
- Review the *Measure Up! Facilitator Background Information* and *Explore! Health in Space Discussion Guide*.
- Cut a 12-18" length of string for each pair of children.
- Place the materials at the station

The day before the activity

- Provide the markers, string, watch or timer in a bag or 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 keep fit to take on life’s challenges.
- 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, the blood and water inside of them also floats.

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. Measure the same changes that astronauts experience in space. Encourage each pair of participants to take turns with the following steps:

- a. While they are standing up, wrap the string once around your partner’s ankle. Make a mark where the end of the string comes back into contact with the rest of the string. Measure the distance from the end of the string to the mark and record your measurement.
- b. Have your partner lay on the floor near a wall with his or her legs in the air leaning against the wall for one minute. After one minute, measure his or her ankle again — while his or her legs still are propped against the wall —with a different color, and record that measurement. Be sure to measure the ankle at the same place.

3. Compare observations and connect them to the “real world.” Prompt the participants to compare their ankle measurements before and after lying on their backs with their legs against the wall. Prompt them to connect that experience to what astronauts experience in space.

4. Explain that in space (a microgravity environment), objects “float.” This includes fluids, such as drinking water — and fluids (blood and water) inside the human body. This fluid shift causes the upper portion of astronauts’ bodies to swell, and their lower extremities to shrink. By lying down with feet in the air, the fluid in each partner’s body shifted to their torso. It was pulled down out of his or her ankles by Earth’s gravity.

On Earth, our bodies actively pump fluids back from our arms and legs. In a microgravity environment, astronaut's bodies' do not have to fight gravity to return blood and other fluids to the torso and head. Because we are on Earth, we have to lie down to cause our bodies' fluids to shift in this same way.

Our bodies are made of 60% water, most of which is contained in our cells and circulatory system. Our bodies are well adapted to dealing with Earth's gravity; our hearts pump our blood and keep it from pooling in our feet. In microgravity conditions, however, things float. This includes the fluids in the human body! Without gravity pulling fluids into their legs, astronauts' bodies preferentially keep fluids in the torso and head. Within minutes of experiencing microgravity, fluids in the astronauts' bodies shift, causing puffy faces and shrunken legs and extremities — what they call "chicken leg syndrome!"

- 5. Conclude.** Summarize that there are many challenges astronauts face as they live and work in space, and they must be very fit to take on all the changes that happen to their bodies in space. Pictures of astronauts on the International Space Station show that their faces are fuller there than on Earth. They may also suffer from headaches and stuffy noses. The symptoms go away within a few days after they return to Earth.

Extension

Weightlessness Demonstration

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.

Measure Up!

Facilitator Background Information

On Earth, our blood tends to go toward our feet because of the pull of gravity. Our strong heart muscle keeps the blood circulating. In microgravity, however, our internal fluids — those in our cells and blood — shift from our legs toward our heads. Astronauts suffer from shrunken legs and puffy heads very soon after going into space. This can cause headaches and stuffy heads.



*Astronaut Leroy Chiao, Mission Commander, has a thinner face before traveling into space.
Credit: NASA, JSC2004-E-27099 (7 June 2004),
International Space Station Imagery*



Expedition 10 Crewmembers onboard the International Space Station. Astronaut Leroy Chiao sits in the front on the left. Living in the microgravity environment of the Space Station has caused fluid to shift to the astronauts faces and upper bodies, making them look "puffy." Their faces will return to normal when they are back on Earth.

*Credit: NASA, ISS011-E-10309 (21 April 2005)
International Space Station Imagery*

Unfortunately, there is little that can be done for any of these conditions — from swollen heads to increased height; astronauts just have to tough it out until they get back to Earth and the conditions go away.



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.