Living in Space

Lesson Development

GRADES 3-5

Galaxy NGC 4013 (Image: NASA)

Orion Nebula (Image: NASA)

Instructional Objectives

Students will

- use a Venn diagram to identify similarities and differences between living on Earth and living in space;
- experiment to determine the effects of physical stress on muscle;
- record observations using data collection and digital imaging;
- analyze data using statistics and graphs;
- use Internet resources to deepen their understanding of challenges faced by astronauts living in space;
- develop a PowerPoint presentation to organize and share their understanding about how the body adapts to changes experienced when living in space; and
- design and construct exercise equipment to be used while living in space.

Background

Within your lifetime, NASA astronauts plan to return to the Moon and travel on to Mars. They will be faced with challenges of living and working in unfamiliar and sometimes hostile environments. One challenge will be adjusting to the pull of gravity unlike Earth's.

The force of gravity on astronauts living in the International Space Station (ISS) is about nine-tenths Earth's gravity. Then why does it appear that astronauts float within the ISS? They aren't really floating but actually "falling." The astronauts and the ISS are both in "free fall," as the ISS orbits around Earth, resulting in what feels like weightlessness for the astronauts.

Once on the Moon, astronauts will need to adapt to a gravitational pull about one-sixth the pull of Earth. Life on Mars includes dealing with a gravitational pull a little more than one-third Earth's gravity. Each reduced gravity environment offers unique challenges to astronauts living and working in space. Scientists wonder how astronauts will adapt to life under these conditions.

Often astronauts become disoriented while traveling in space because there is no physical sensation to let them know when they are "up" or "down." This may lead to a feeling of space sickness - something like feeling carsick and seasick. About 40 percent of the astronauts in space experience space sickness within a few hours of reaching orbit. For most, this feeling stops once they adjust to their new space home.

On Earth, the heart works against gravity as it evenly distributes blood by pushing fluids to the upper parts of the body. In less gravity, fluids are not pulled toward the lower parts of the body with the same force, so they are more equally spread throughout the body. Some astronauts talk about not feeling thirsty because of this fluid shift. The body senses this shift as an increase in blood volume and adjusts by eliminating what it thinks are extra fluids. Astronauts may also feel as if they have a cold and their faces look puffy.

Astronauts' bone density and muscle mass may also be affected by life in space. Some lesser-used muscles may lose tone and mass while astronauts live in reduced gravity. On Earth, gravity pulls on our bodies while our muscles and bones counteract that force to keep us balanced. Bones and muscles maintain their strength, rebuilding and growing as a result of physical stress.

In a reduced gravity environment, less physical stress is placed on astronauts' bones and muscles. Special exercise equipment can help prevent bones and muscles from weakening. One example, a special treadmill, uses a Teflon-coated aluminum sheet on a roller bolted to the floor. Straps tied around the astronaut's waist are attached to the floor to hold the astronaut in place. The astronauts exercise their arms by pushing on the bar while walking.

Puffy faces and space sickness are short-term changes astronauts feel as they travel in space. Within three days of returning to Earth, these changes are reversed.

Weakening bones and muscles are more long-term effects. During space missions, resistive exercises and good nutrition help offset some of these changes, but once they return to Earth, astronauts continue to exercise to strengthen their weakened bones and muscles.

The body is amazing as it adapts and changes to new environments. Scientists are working to find out all that they can about how the body adapts to new environments and to make space travel as safe and comfortable as possible.

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ENGAGE

Use the image of the ISS Expedition 9 crew to lead a discussion with students about differences between living on Earth and living in space (TEACHER RESOURCE). A Venn diagram may help students organize their ideas.

These questions may guide your discussion:

- How is life on the ISS different than life on Earth?
- How would life on the ISS compare to life on the Moon? On Mars?
- What might be some benefits to living in a reduced gravity environment?
- What might be some difficulties to living in this new environment?
- Where, on Earth, might we simulate the conditions of living in a reduced gravity environment?

ISS - Expedition 9 crew members

EXPLORE

Scientists study bones and muscles and how they might be affected when astronauts live in a reduced gravity environment. When bones and muscles work against a force, they're under physical stress. Physical stress happens when we lift something heavy, like a box of books. Gravity pulls down on the books and we work to overcome that force to lift the box.

Physical stress is also created by wind resistance when we run. Muscles and bones work together to move the body. Our bones and muscles also work to counteract gravity and help keep our balance.

Stress from physical activity strengthens and maintains bones and muscles, both on Earth and in space. This type of stress leads to changes in either muscle strength or muscle stamina. High-intensity, short-duration exercises (or stresses), like weight lifting, cause the muscles to increase in strength. Low-intensity, long-duration activities, such as running and swimming, cause muscles to increase in stamina increasing their ability to be active for a long time without becoming tired. In space, there's less physical stress due to reduced gravity. Both bone density and muscle mass may decrease while astronauts live in space.

The following activity is a modification of an activity found in NASA's education module, *Exploration: Then and Now - Human Needs*. The original activity and more information about living in space can be found at ***http://www.nasa.gov/audience/foreducators/topnav/materials/listbytype/Human_Needs_Lesson.html***

A. Click It!

1. Organize students into teams of two so that they may work with a partner to explore the effects of physical stress on the muscles in their hands. Gather these materials for each partnership:
   - One binder clip, mini size
   - Timer, watch, or stopwatch
2. Ask each team to create their own data chart to record predictions and observations. Encourage them to also take digital images of their work. If they need help taking digital images, guide them to Nortel LearniT video tutorials at: ***http://nortellearnit.org/technology/Imaging/***.
3. The first trial measures each student's initial muscle strength and stamina. Ask students to predict the number of times they think they will be able to click the binder clip between their thumb and index finger on the dominant hand in one minute.
4. One partner holds the mini clip in his or her dominant hand between the thumb and index finger.
5. The other partner times one minute, counts the number of times the first partner is able to click the binder clip and records this number in the data chart.
6. Students rest for one minute and then repeat steps 3 - 5 for the second and third trials.
7. Partners switch roles and repeat the experiment.
8. Use these questions to help lead a class discussion following the experiment:
   - How did your hand feel while you were conducting the experiment?
   - How do the muscles in your hand feel now?

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- Why do you think the feeling in your hand changed?
- Is this an example of physical strength or stamina?
- What might you do to strengthen your muscles?

9. Arrange time for the students to conduct this experiment every other day for the next two weeks. This is conditioning time. The stress on the muscles in the hand should cause the muscles to become stronger and increase stamina. Be sure students record their predictions and observations each day.
10. Explain how to calculate the "mean" for each trial and display this data in a line graph. It may be easier for your students to recognize changes in patterns by analyzing graphs.

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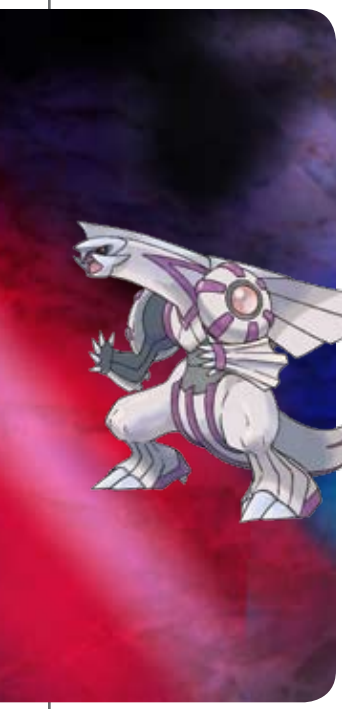

EXPLAIN

A. Use these questions to lead a discussion with your students about the EXPLORE experiences:
- How did muscle strength and stamina change in your hand over the conditioning period?
- Compare your predictions and actual results.
- Did your predictions improve over the course of the experiment?
- What changes did you observe over the two week period?
- What can you infer from the results on the graph?
- What do you predict will happen if you continued this experiment for another two weeks?

B. Guide students to these Internet resources for additional information and activities about how the human body is affected by living in space:
- For more information about NASA research into ways to counteract living and working in a reduced gravity environment encourage your students to view the NASA CONNECT video, *Good Stress: Building Better Muscles and Bones*, found at: ***http://connect.larc.nasa.gov/programs/2004-2005/good_stress/index.html***
- NASA's 21st Century Explorer program, *How Would Your Body Change in Space?*, can be viewed at: ***http://education.jsc.nasa.gov/explorers/p3.html***
- The Japan Aerospace Exploration Agency explores *What is Space Medicine?* at: ***http://iss.jaxa.jp/med/index_e.html***
- The National Space Biomedical Research Institute looks at *How the Human Body Changes in Space* at ***http://www.nsbri.org/HumanPhysSpace/***
- Learn how space travel may help scientists find a cure for osteoporosis in "Weak in the Knees – The Quest for a Cure": ***http://weboflife.ksc.nasa.gov/currentResearch/currentResearchGeneralArchives/weakKnees.htm***

C. Several other Internet sites help students deepen their understanding of challenges to living in space. Encourage your students to explore some of these sites:
- This NASA Human Space Flight site, *Living in Space*, looks at "space food" and "space wear": ***http://spaceflight.nasa.gov/living/index.html***
- Select your own "astro-identity" and go on a space mission through Virtual Astronaut Interactive: ***http://www.nasa.gov/vision/space/livinginspace/index.html***
- Your students can learn more about *Living in Space* by visiting this NASA site: ***http://science.nasa.gov/LivingInSpace.htm***

ELABORATE

Challenge your students to create a brief PowerPoint presentation that demonstrates what they have learned about some of the challenges to living in space. To learn more about how to create an effective PowerPoint presentation watch several Nortel LearniT video tutorials at ***http://nortellearnit.org/technology/PowerPoint_Presentations/***

Before you begin, you may want your students to use a storyboard to help them plan and organize their slides. One example of a storyboard can be found at ***http://nortellearnit.org/resources/Handouts/***

Your students may want to use images found during their review of Websites in the EXPLAIN section of this lesson. They can either download those pictures to the hard drive, or save the URL as a "Favorite" in the Web browser.

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Encourage your students to put a descriptive title screen, credits and references at the end of the PowerPoint presentation.

Please remind students to use only images that they have permission to include. Review copyright and copywrongs by watching the Nortel LearniT video tutorial at ***http://nortellearnit.org/technology/Digital_Ethics/***

EVALUATE

Through discussion and observations, determine if your students have an accurate understanding of changes the body experiences when going from an "Earth-normal" environment to the reduced gravity environment of space.

Ask students to answer this journal prompt to assess their understanding of the differences between living on Earth and living in space, as well as the adjustments made by the body when this happens.

- Describe how the body changes in space and some of the ways astronauts counteract those changes.

To evaluate the PowerPoint slides, use a rubric found at the Nortel LearniT site:
http://nortellearnit.org/resources/Handouts/

EXTEND

Use the following activities to extend or continue your students' exploration.

A. EXPERT INTERVIEWS - WHAT DO YOU WONDER NOW?
What are your students wondering now that they have learned about the challenges of living and working in space? Generate a list of questions that your students might ask "the experts" from NASA, the National Institute of Aerospace, and research universities. Submit this list following the link on this Website. Several questions from all submitted will be used in video interviews with "experts" and posted to this site.

B. Encourage your students to view these newsbreaks at NASA's KSNN™ Website:

- Did you know astronauts bodies change in space?
  http://ksnn.larc.nasa.gov/webtext.cfm?unit=body
- Why do bones get weaker as you age?
  http://ksnn.larc.nasa.gov/webtext.cfm?unit=bones
- Do astronauts need calcium in space?
  http://ksnn.larc.nasa.gov/webtext.cfm?unit=calcium
- Why do astronauts float in space?
  http://ksnn.larc.nasa.gov/webtext.cfm?unit=float

C. NASA's *Get a Leg Up* activity helps students simulate the "fluid shift" that astronauts experience in space:
http://www.nasa.gov/audience/foreducators/topnav/materials/listbytype/Get_a_Leg_Up_Activity.html

D. Challenge your students to create their own piece of exercise equipment to help strengthen and increase muscle stamina in space. Encourage them to take digital images that reflect the process from drawing board to the product. Have them test their equipment and present their findings to the class in a PowerPoint presentation. Display their inventions throughout your school. The following sites may be helpful in constructing their exercise equipment:

- Walking on Air: NASA's Floating Treadmill:
  http://www.nasa.gov/mission_pages/station/science/eZLS_treadmill_010306.html
- Team Atlas, NASA study space exercise:
  http://media.www.thebatt.com/media/storage/paper657/news/2005/02/28/News/Team-Atlas.Nasa.Study.Space.Exercise-879612.shtml
- Exercise Countermeasures: Keeping Astronauts Healthy in Reduced Gravity:
  http://spaceflightsystems.grc.nasa.gov/Advanced/HumanResearch/Exercise/

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Teacher Resource

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Image: NASA
International Space Station - Expedition 9 crew members