

Life as an Astronaut: The Biological Ramifications of Living in Space

Lesson plan for grades 6-8

Length of lesson: 1 hour 25 minutes

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SOURCES AND RESOURCES:

- ESI Hot Science Cool Talks lecture # 89, Dr. Glenn Lightsey, Space Exploration: From Science Fiction to the Texas Spacecraft Laboratory
<http://www.esi.utexas.edu/hot-science-cool-talks/376-space-exploration-from-science-fiction-to-the-texas-spacecraft-laboratory>
- The Future of Space Travel (intro video)
https://www.youtube.com/watch?v=hh-Lv_MXsHg
- "Breathing easy on the space station" - NASA
http://science1.nasa.gov/science-news/science-at-nasa/2000/ast13nov_1/
- Life Aboard the ISS (explore video)
<https://www.youtube.com/watch?v=tgRMAVoHRbk>

POTENTIAL CONCEPTS TEKS ADDRESSED THROUGH THIS LESSON:

§112.18. Earth and Space, Grade 6: 11B, 11C

§112.18. Organisms and Environments, Grade 6: 12E

§112.19. Earth and Space, Grade 7: 9B

§112.19. Force, Motion, and Energy, Grade 7: 7C

PERFORMANCE OBJECTIVES:

Students will be able to:

- recognize gravity as prevalent force on earth and in space
- describe the history and future of space exploration, including the types of resources and equipment needed for space travel
- compare the biotic and abiotic components of the human environment on earth and in space
- identify the accommodations, considering the characteristics of our solar system, that enabled manned space exploration
- demonstrate and illustrate forces that affect motion in everyday life such as the forces on the human body

MATERIALS (enough for a groups of 2 or 3):

- NASA Researcher's Journal
- Computer access

CONCEPTS:

- **Perpetual:** never changing or never ending
- **ISS:** An acronym for the International Space Station
- **Atrophy:** the gradual decline in effectiveness or liveliness due to underuse or neglect.

BACKGROUND:

What Dr. Glenn Lightsey's lecture was about:

"Space travel and exploration are popular settings for works of science fiction and can be a source of inspiration for space technology. What scientists and engineers can actually do with space technology is different from what is presented in fiction, though the discoveries are no less fascinating.

Scientists and engineers working with small satellites are changing the nature of the space program and enhancing space missions by increasing access to space technology and encouraging innovation in spacecraft building. Advances in miniaturization, design, and electronics have led to significant discoveries in the capabilities of small satellites. Here at The University of Texas at Austin, students are sharing in the excitement of these discoveries at the Texas Spacecraft Laboratory."

Humans have found themselves staring at the stars since the beginning of recorded history; however, the mentality behind staring into space has changed as our understanding of space has changed. Going back as far as the 1960's, humanity has put forth its greatest efforts to put a man on the moon. When such a dream came to fruition, this only spiked the public and scientific community's interest to see what the limitations were for space travel. This lesson focuses on understanding the real biological ramifications of being in space and address some of the questions that scientists face when seeing if humans can safely travel in space for prolonged periods of time without suffering severe health consequences.

PREPARATION:

Teacher should have computers updated, safety-locked (parent search settings), and charged before student use. Appropriate number of worksheets should be printed off for each class.

ENGAGE: 15 minutes

Teacher: Start the lesson by playing the introductory video “The Future of Space Travel.” ([see resources section](#))

Teacher Says: That video was quite interesting, but there seems to be a few issues I noticed. What flaws did you see in what the video clip was presenting?

Possible Student Responses:

- The video said space travel for everyone would be available as early as 2014. We currently do not have this.
- I think the video was very old because their design for a spacecraft seemed very similar to the ones they used during the first space-shuttle launches.
- The video never explained how the program allowed the average person to so easily and without training go to space.

Teacher Says: These are all reasonable issues with the video. The truth is that people's imaginations and ideas for the future of space travel far exceeded the rate of scientific innovation to put the average person into space. Though international space programs have come a long way from the first shuttle launches that you saw during the Kennedy era, we are still in no situation to send untrained people into space for affordable costs.

Let's focus on one specific variable of space travel for today. Has anyone wondered what it would feel like to be in the emptiness of space? What about for prolonged periods of time?

Possible Student Responses:

- I would feel weightless since there is no gravity in space. I would be floating around all the time.
- I would probably feel nauseous all the time since our spaceship would be moving so fast
- It would be fun. It would take less strength and energy for me to do things.

Teacher Says: It seems like most of you have the classic idea about being in space where one just floats around in a spaceship or space-station while everything else is floating around them. One of the biggest misconceptions about space is that most people believe the force of gravity only exists within the Earth's atmosphere (or a planet's atmosphere). Gravity is an attractive force that pulls objects towards each other in all the reaches of the universe. This force depends on the distance between the objects as well as the objects' masses. But if gravity still exists in space, why do the astronauts float around inside the shuttle or space-station?.... Due to the orbiting and rotational motion of the spacecraft, the astronauts are actually in a

perpetual state of falling; this is what creates that weightlessness. The astronauts, rather than being in an anti-gravity environment, are in a situation where they don't feel all the classic effects of gravity.

Perhaps one of the most intriguing aspects of space travel is how different it is from the normal environmental conditions on Earth. Today's focus will be on understanding these differences and changes and how they affect the human body.

EXPLORE: *20 minutes*

Teacher: Start the “Explore” section by playing the introductory video “Life Aboard the ISS” ([see resources section](#))

Teacher Says: Each of you should have the “NASA Researcher's Journal” ([see materials section](#)) in front of you. If you do, partner up with another person to complete the activity.

Instructions: You are NASA space-shuttle researchers and your goal is to help ensure that your astronauts will be safe in outer space for a 6 month long mission to fix a satellite. Other NASA departments have figured and prepared for every detail of the mission, from launch till landing, but are still unsure on what will happen to the astronauts in terms of their health over this long period of time.

Work through the Researcher's Journal to best predict the types of health concerns your astronauts may face in space.

Teacher Says: Now that you all have had some time to make educated and well thought out predictions, let's regroup and discuss some of the health issues that our astronauts may face.

EXPLAIN: *15 minutes*

Teacher Says: After going through the Journal, what were some predictions that you and your partner had about health concerns for astronauts?

Possible Student Responses:

- We believe that the astronauts might have lots of motion sickness problems since they are always being jostled around in the space vessel.
- It is possible that all of them suffer from serious sleep deprivation since they can't get used to their new environment.
- Maybe their bones and muscles ache because the pressure is different in the ISS
- Perhaps

Teacher Says: Interesting! Those seem like reasonable predictions for health concerns that astronauts could face while being in space for prolonged periods of time. Before we discuss the actual list of health concerns that NASA researchers have discovered, let's talk about the biotic and abiotic factors that everyone listed.

Biotic factors are fairly simple to recognize. They are the living things that affect a particular organism in its environment. For example, some of the biotic factors for spider monkeys are bacteria, jaguars, plants, trees, howler monkeys, insects, etc.... All of these organisms and living components in the spider monkey's environment play a significant role in its survival. For instance, the jaguar is one of the monkey's most common predators while insects and plants are some of the monkey's dominant food sources. Humans have analogous biotic factors on Earth, but how are they on the spaceship? Astronauts leave Earth and enter a new environment where there are much fewer biotic components. There is no prevalent foliage/plant life, there are no other creatures on board that would have a significant influence on human survival, and microbial life is often minimal and somewhat controlled. If there are so few and limited biotic factors aboard the ISS, what about the abiotic factors?

As explained in your journals, abiotic factors are non-living components that play a role in an organism's ability to survive and flourish. Your lists probably include things such as water, terrain (geographical features), sunlight, air, temperature, soil, etc... We've listed all of these factors but the question is whether they are essential for life aboard the ISS. Which of the abiotic factors you listed on Earth do you think are essential for human survival?

Possible Student Responses:

- Air is super important. Without the oxygen, humans can't breathe and function properly or even survive.
- Clean water is necessary for human survival for the body requires it to function properly.
- Our bodies can't be too cold or too hot, so temperature control is important to our survival.

Teacher Says: Of the many abiotic factors that exist on earth, there are a handful that truly determine an individual's ability to survive or not. To do so, let us think about the places on earth that are not habitable.

Possible Student Responses:

- The hottest deserts in the world are places that few people can travel through. The terrain is rough but perhaps the biggest issues with surviving in the desert have to do with the lack of water and the drastically hot day-time temperatures.
- Antarctica has similar issues. It is extremely cold, the terrain is very rough, and there is often very little food.

Teacher Says: Yeah, those are some great insights. Now that we have a better idea of how a spacecraft is similar and different than the living environments on earth, we can think about some living accommodations that have to be made for humans to endure prolonged periods in space.

ELABORATE: *20 minutes*

Teacher Says: Before we can know what kind of specific accommodations we have to make for our astronauts, we first have to concretely identify some major issues that astronauts have faced after being in space for long periods of time.

Has anyone every broken a bone and had to wear a cast for several weeks?... For those of you who had, you might have noticed that once the cast had been taken off, let's say your arm, the arm was considerably thinner and smaller than it was before the break or even compared to your other arm. The reason for this has actually little to do with the injury itself. Our bodies have a tendency to get rid of things that it thinks are no longer being used or are no longer necessary. In the broken arm, those muscles that were once being used constantly in day to day activities were confined into the immovable and tight space within the cast. Since those muscles weren't being stimulated and were inactive, the muscles began going through a process known as **atrophy** (specifically disuse atrophy).

So think about being in space again. When you are floating around, not feeling the consequences of gravity, how stimulated and active are your muscles. However, the issues go beyond even this.

Looking at the human skeleton, there are sever things that need to be understood. Bones have the ability to grow and repair themselves and are always subject to change. Think about the age and development of humans as a good example. When a child is born, their bones (especially the skull) are "rubbery" and small. Some of the finer bones haven't even developed yet in these infants. As the individual grows, their bones become denser, stronger, and often larger. Finally, a point is reached at higher ages where the bones repair themselves much slower than they used to for a multitude of physiological and biochemical reasons. The individual stops growing in terms of size and height and the bones actually begin to lose their strength and density. A condition known as **osteoporosis**.

Your objective is to get back into your groups and do some online research about what exactly osteoporosis is and why astronauts might get it from being in space for too long. Your final task will be to design something that will help eliminate this issue so that astronauts can have normal lives when they return from their long missions.

EVALUATE: *15 minutes*

Teacher: Will have all the students regroup and start a full class discussion regarding the students' findings. Teacher will call on various group to present their solutions after the class has thoroughly discussed the meaning and implications of bone disorders such as osteoporosis.

To wrap up the lesson, the teacher will ask the students how far they think science has come to allow for human travel in space and ask them to predict how long it will be before humans can travel through space for periods of years, without suffering severe health issues.

Name: _____

Date: __/__/__

Name: _____



NASA Researcher's Journal

Instructions: You are NASA space-shuttle researchers and your goal is to help ensure that your astronauts will be safe in outer space for a 6 month long mission to fix a satellite. Other NASA departments have figured and prepared for every detail of the mission, from launch till landing, but are still unsure on what will happen to the astronauts in terms of their health over this long period of time.

Work through the Researcher's Journal to best predict the types of health concerns your astronauts may face in space.

Health Concern

Cause of Problem

Ex: head injuries

*From floating around
while the astronauts
are sleeping*

Name: _____

Date: __/__/__

Name: _____



Characteristics of space:

- Temperatures inside the space station (ISS) are around a constant 22 °C while temperatures outside the ISS can range from 260 °C (in direct sunlight) to -270 °C (in the most isolated regions of the universe).
- Astronauts experience the sensation of weightlessness (don't experience the effects of gravity)
- There are no free resources (food, supplies, water, gear, etc..) floating around in space. Astronauts have to bring everything they need.

Recall the difference between biotic and abiotic factors of an environment on Earth. Use your knowledge of Earth and the ISS (from the "Life Aboard the ISS" video) to complete the tables and questions below.

Abiotic Factors: the non-living physical and chemical factors which influence the ability of organisms to survive and reproduce.

Ex: water

Biotic Factors: are all the living things or their materials that affect an organism in its environment

Ex: an astronaut

On Earth

Biotic Factors

Abiotic Factors

Name: _____

Date: __/__/__

Name: _____

In the Spaceship

Biotic Factors

Abiotic Factors

Compare and Contrast

What are some similarities and differences between the biotic and abiotic factors on Earth and aboard a spaceship?
