Importance of Space Biology

Curricular Unit
Teacher Materials

OVERVIEW

This unit will provide students with a general understanding of space biology and why it is an important area to study. Students will compare the environments on Earth and space by learning about the International Space Station. They will explore facets of space biology and learn about current and future goals from NASA and private space industries. They will research the effects of long-term exposure to space on the human body. They will be exposed to the wide variety of careers available in space biology and what they would need to do to have one of these STEM jobs in their future.

Content Objectives

- Students will be able to identify the differences between the environment on Earth and in space.
- Students will be able to explain what space biology is, current experiments, and the future of space biology.
- Students will be able to explain what effect long term exposure to space can have on the human body.
- Students will be able to list several careers pertinent to space biology.

PACING AND SCHEDULING

This unit consists of 5 sections for approximately 120 minutes each. For schools with 60-minute classes, this unit will take 10 class periods to complete. For schools on a traditional block schedule, this unit could take 5 class periods to complete. Each section builds information on the other, however they can work as standalone lessons. The *Apply* section at the end could be used to engage students in reading graphs and analyzing data. This could be used at the end of the unit or to challenge higher performing students.

TEACHING METHODS

- This unit could be used in middle school or as an introductory lesson for high school students.
- Student worksheets could be photocopied and distributed or used digitally.
- The teacher will need a computer, speakers, and projector. Students will need computers. If computers are not available for students, the information could be adapted by completing more work as a whole class and/or photocopying and distributing articles and student worksheets.
- This unit requires internet access; the teacher as a minimum but it is easier if students have access, too.
- The lessons usually start as a whole group, break off into small groups/partners, and then return to the whole group to report out.

CURRICULAR CONTENT

Engage *(120 minutes)*

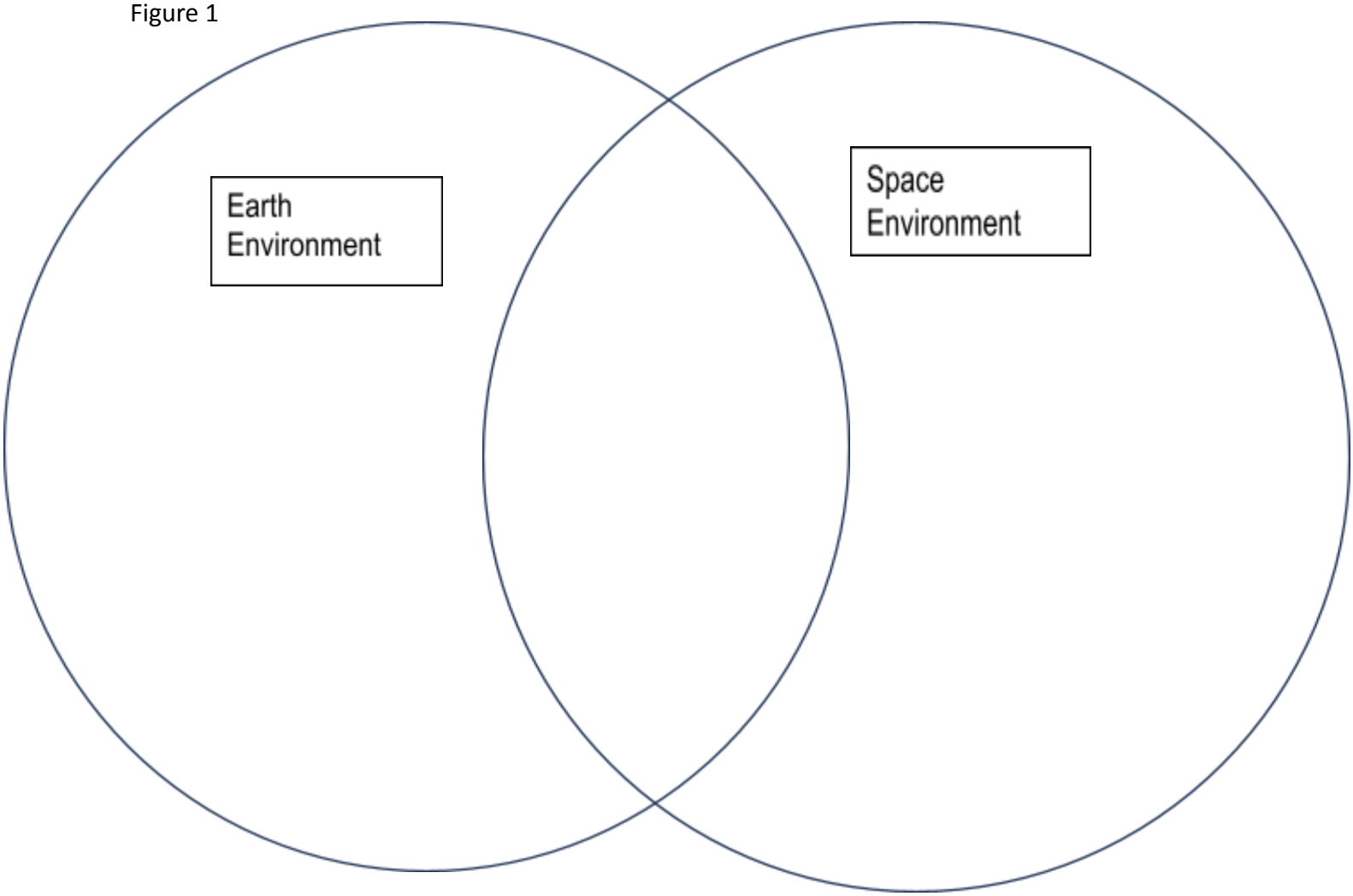
Objective: Compare and contrast the difference between the Environment in space vs Earth.

1. Watch ISS tour video: https://www.nasa.gov/mission_pages/station/main/suni_iss_tour.html
2. Web Extra: International Space Station Tour: https://www.youtube.com/watch?v=AErpXJq67LM
3. Ask the class to brainstorm answers to the objective with a partner. Report to the group and record answers of the groups to reference throughout the class.
4. Self-exportation of other resources. Discussions of what was learned with table peers.

Students should navigate to the following websites:

- ISS Tour: https://www.nasa.gov/mission_pages/station/main/suni_iss_tour.html
- European Space Agency ISS Multimedia Tour: https://esamultimedia.esa.int/multimedia/virtual-tour-iss/
- -Visit the ISS using GoogleEarth https://earth.google.com/web/@20.97007048,-71.07418407,-3156.89791739a,16580443.11132057d,35y,356.00012934h,0t,0r/data=Ci4SLBIgN2Y3ZTA1ZTg2Y2E1MTFlNzk5YzI1YjJmNTFhNjA3NTIiCG92ZXJ2aWV3
- A 25-minute tour of the International Space Station with astronaut Sunita Williams: https://thekidshouldseethis.com/post/international-space-station-tour-iss

Figure 1



Explore *(120 minutes)*

Objective: Explain space biology and why it is important. Complete the chart (Figure 2).

1. Read "What We Study: Space Biology Overview" (https://science.nasa.gov/biological-physical/focus-areas) and "Space Biology Program Overview" (https://science.nasa.gov/biological-physical/programs/space-biology#:~:text=The%20overarching%20goal%20of%20Space,molecular%20biology%20techniques%20and%20measures) together as a whole class. Discuss the objective and record answers where the class can see and refer to later.
2. Divide the class into 5 groups. Each group will be assigned a section to research and discuss. They should prepare to teach the rest of the class about their assigned topic. Suggested groupings: Group 1- Animal Biology, Group 2- Cell and Molecular Biology, Group 3- Microbiology, Group 4- Plant Biology, Group 5- Developmental, Reproductive, and Evolutionary Biology.
3. Come back together as a whole class and have each group teach about their section. Students complete the questions for each section at that time.
4. Watch the video "Learning About Space Biology" (https://www.youtube.com/watch?v=P-FKMqSmbBk). Add any additional information to your student worksheet.

Figure 2

Topic	**Claim**	**Evidence**	**Reasoning**
Space Biology Overview			
Animal Biology			
Cell and Molecular Biology			
Microbiology			

Plant Biology			
Developmental, Reproductive, and Evolutionary Biology			

Explain *(120 minutes)*

Objective: Examine stresses that the human body undergo in spaceflight conditions and the long-term effects this could have on living organisms.

Directions: Use the objective to guide you as you work through each resource. Summarize what you have learned in the spaces provided.

Resources:

1. Watch the video Our Bodies in Space: Zero Gravity weighs heavy on your health https://www.cnn.com/2016/05/20/health/your-body-in-space/index.html
2. Read Human Research: Studying Astronaut Physiology https://www.nasa.gov/mission_pages/station/research/benefits/human-research-studying-astronaut-physiology as a whole group.
3. Read The Human Body in Space Introduction and figure What happens to the Human Body in Space https://www.nasa.gov/hrp/bodyinspace as a whole group.
4. Discuss the objective.
5. Divide class into 5 groups. Each group is assigned one section to research and discuss. They should prepare to teach the rest of the class about their assigned topic. Group 1- Space Radiation, Group 2- Isolation and Confinement, Group 3- Distance from Earth, Group 4- Gravity Fields, Group 5- Hostile/Closed Environments
6. Come back together as a whole class and have each group teach about their section. Students complete the questions for each section at that time.

Summaries

1. Our Bodies in Space: Zero Gravity weighs heavy on your health

2. Human Research: Studying Astronaut Physiology

3. The Human Body in Space Introduction

4. Space Radiation

5. Isolation and Confinement

6. Distance from Earth

7. Gravity Fields

8. Hostile/Closed Environments

Extend *(120 minutes)*

Objective: Analyze what is currently happening with space biology.

Directions: Watch the videos about current space biology research and complete the table (Figure 3). Then go to NASA Space Missions, select a mission, and answer the questions.

1. Watch the video clips about current space biology: Fresh Food for the Ride to Mars, Microbes on the International Space Station, Skeletons in Space, The Search for Life on Far Away Planets, Heart Cells Beating in Orbit, Genetic Data from Space. https://www.genesinspace.org/educational-videos/
2. Go to NASA Science Space Missions. https://science.nasa.gov/missions-page?field_division_tid=11253 Choose one of the missions and answer the following questions.
3. Share the information about your chosen mission with a partner. What are some similarities and differences between the 2 missions?

Figure 3

Research	Goal/Overview	Applications
Fresh Food for the Ride to Mars		
Microbes on the International Space Station		
Skeleton in Space		
The Search for Life on Far Away Planets		
Heart Cells Beating in Orbit		
Genetic Data from Space		

NASA Space Missions

1. What is the name of the mission?

2. What is the goal of the mission?

3. Why is the mission important?

4. What are the space and Earth applications?

5. What were some investigations that occurred and what were their outcomes?

6. What were some similarities and differences between your partner's and your mission?

Evaluate *(120 minutes)*

Objective: Explain the future of space biology. Research some career paths in space biology.
Directions: Conduct research about Artemis and different careers in Space Biology. Answer the questions that follow.

1. Research about the Artemis mission: https://www.nasa.gov/specials/artemis/
2. Choose one of the careers in space biology and research it. https://www.bls.gov/careeroutlook/2016/article/careers-in-space.htm
3. Share with a partner information about Artemis and space biology careers.

Artemis

1. Why are we going to the moon?

2. How are we going to the moon?

3. Research each category and give a summary.
    a. Orion SpaceCraft

    b. Space Launch System Rocket

    c. Exploration Ground Systems

    d. Gateway

    e. Human Landing System

    f. Artemis Base Camp

Space Biology Careers

1. What space biology career did you choose?

2. What kind of work do people in this career do?

3. What education or experience is needed for this career?

Apply

Objective: Evaluate current data and experiments. Learn from experts in the field.

1. Use the GeneLab visualization tool to analyze graphs from various studies. The teacher could pick the study to analyze together, or the students could pick a study to analyze individually.
   Visualization portal: https://visualization.genelab.nasa.gov/data/
   Example graphs from GLDS-251- https://visualization.genelab.nasa.gov/data/GLDS-251
2. Arrange for experts in the field or those who have participated in missions through the following contacts:
   a. GeneLab: https://genelab.nasa.gov/help/contact
   b. NASA Astronaut Appearances: https://astronautappearances.nasa.gov/

REFERENCES TO DATA SETS

This lesson is an overview of space biology. In the *Apply* section students could analyze the graphs from different GeneLab data sets. The example data set in the lesson is GLDS-251 https://osdr.nasa.gov/bio/repo/data/studies/OSD-251

STANDARDS ALIGNMENT- NGSS

Science and Engineering Practices (SEP):

1. Asking questions and defining problems
4. Analyzing and interpreting data
6. Constructing explanations and designing solutions
7. Engaging in argument from evidence
8. Obtaining, evaluating, and communicating info

Disciplinary Core Ideas (DCI):

MS-LS1-4

Use argument based on empirical evidence and scientific reasoning to support an explanation for how characteristic animal behaviors and specialized plant structures affect the probability of successful reproduction of animals and plants respectively.

MS-LS1-8

Gather and synthesize information that sensory receptors respond to stimuli by sending messages to the brain for immediate behavior or storage as memories.

HS-LS2-6

Evaluate the claims, evidence, and reasoning that the complex interactions in ecosystems maintain relatively consistent numbers and types of organisms in stable conditions, but changing conditions may result in a new ecosystem.

HS-LS4-6

Create or revise a simulation to test a solution to mitigate adverse impacts of human activity on biodiversity.

HS-ESS1-6
Apply Scientific reasoning and evidence from ancient Earth materials, meteorites, and other planetary surfaces to construct an account of Earth's formation and early history.

Crosscutting Concepts (CCC):

2. Cause and Effect
4. Systems and System models
5. Energy and Matter
6. Structure and Function
7. Stability and Change

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