

Earth Space Science

STEM Cases

5E Lesson Plan

Lesson Overview

To fully understand the relationship between radiation and biology, and to solve problems in this field, researchers incorporate fundamentals of biology, physics, astrophysics, planetary science, and engineering. [The Space Faring: The Radiation Challenge](#) educator guide helps to link these disciplines by providing background, discussion questions, objectives, research questions, and inquiry-based activities to introduce radiation biology into your middle school science classroom. The suggested activities are hands-on investigations that encourage the use of science, mathematics, engineering, technology, problem solving, and inquiry skills. The activities provide a general framework that can be modified based on student needs and classroom resources.

NASA Connection

[Space radiation](#) is distinct from common terrestrial forms of radiation. Our magnetosphere protects us from significant exposure to radiation from the Sun and from space. Radiation that is emitted from the Sun is composed of fluctuating levels of high-energy protons. Space radiation consists of low levels of heavy charged particles. High-energy protons and charged particles can damage both shielding materials and biological systems. The amount, or dose, of space radiation is typically low, but the effects are cumulative. Solar activity fluctuates, and so the risk of exposure increases with the amount of time spent in space. Therefore, there is significant concern for long-term human space travel.

Possible health risks include cancer, damage to the central nervous system, cataracts, risk of acute radiation sickness, and hereditary effects. Because there is limited data on human response to space radiation, scientists have developed methods to estimate the risk. This is based on theoretical calculations and biological experimentation.

NASA supports research to analyze biological effects at ground-based research facilities where the space radiation environment can be simulated. Research performed at these facilities is helping us to

understand and reduce the risk for astronauts to develop biological effects from space radiation, to ensure proper measurement of the doses received by astronauts on the International Space Station (ISS) and in future spacecraft, and to develop advanced materials that improve radiation shielding for future long-duration space exploration on the Moon and possibly on Mars.

Source Material: [Space Faring: The Radiation Challenge](#)

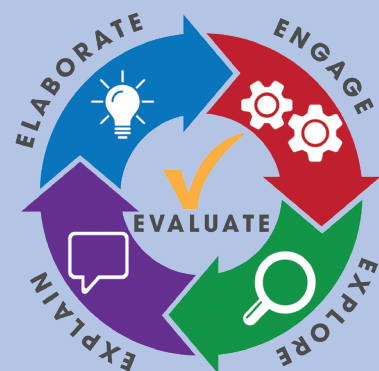
Mission Focused Area: [Earth's Science/Solar System and Beyond](#)

National STEM Standards

NGSS

- **MS-ETS1-1** Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.
- **MS-ETS1-2** Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.
- **MS-ETS1-3** Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success.
- **MS-ETS1-4** Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved.

5E Instructional Model



Objectives

- Students discover the effects of radiation on the human body
- Students analyze radiation exposure on Earth and in space
- Students research the beneficial uses of radiation in everyday life

Guiding Questions

- What is radiation?
- Where does radiation come from?
- What are the different kinds of radiation?
- How is radiation on Earth different from space radiation?
- How does radiation damage DNA?

Materials

- [Space Faring: The Radiation Challenge](#)
- Access to the internet
- Gum drops, five colors minimum (As an alternative, marshmallows could be used)
- Candy orange slices, (or other soft candy that is larger than gum drops)
- Plain flat toothpicks (may be cut in half)
- Colored pencils
- 4-5 Paper towels each, or a large piece of paper, to provide working space
- Large table (or space on floor) to place long DNA models

Teacher Action



Engage - Pretest

- Distribute the pretest activity on pages 10 and 12 of the Space Faring Guide

Scripted CFU questions

- What are some ways we are exposed to radiation on Earth?
- Is this radiation harmful?



Explore - DNA Models

- Distribute pages 35-39 of the Space Faring Guide
- Provide materials to complete the DNA Modeling activity
- Complete the four DNA nucleotides on page 35 with students as a guided practice
- Actively monitor and check for understanding as students complete the activity

Scripted CFU questions

- What types of bonds are broken between nucleotides?
- What types of bonds are broken between base pairs?
- Which type of break is more harmful, double-strand or single-strand?



Explain - What is radiation?

- Provide access to the internet
- Provide a video note taking guide

Scripted CFU questions

- What is radiation?
- Where does radiation come from?
- What are the different kinds of radiation?



Elaborate - Radiation Research

- Provide access to the internet
- Provide a presentation rubric for the research

Scripted CFU questions

- How is radiation on Earth different from space radiation?
- How can radiation be used as a tool?
- How can we protect ourselves from radiation exposure in our everyday lives?



Evaluate - Research Presentations

- Evaluate student presentations.

Scripted CFU questions

- Did the students meet the minimum requirements outlined in the rubric?

Student Action



Engage - Pretest

- Complete the pretest activity



Explore - DNA Models

- Follow the directions to construct a DNA model
- Complete the Modeling Radiation Damaged DNA Discussion Sheet



Explain - What is radiation?

- Watch video “[What is radiation and where does it come from?](#)”
- Take notes using the note taking guide
- Retake the pretest



Elaborate - Radiation Research

- Research ways that we use radiation as a tool on Earth



Evaluate - Research Presentations

- Present radiation research to the class

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<https://stemgateway.nasa.gov/connects/s>

