

IMAGINING LIFE BEYOND EARTH



Lesson 2: Astrobiology and Extreme Life (Part 1)

OVERVIEW	This lesson introduces students to the field of astrobiology and the study of extremophiles—organisms that thrive in extreme conditions. By examining extremophiles on Earth, students will explore how scientists search for life beyond our planet. Duration: 60–90 minutes.
LEARNING OBJECTIVES	• Develop a basic understanding of the word astrobiology. • Understand the concept of extremophiles and their adaptations to extreme environments. • Recognize how extremophiles inform the search for extraterrestrial life. • Identify human adaptations to environments and situations that are similar to extremophile adaptations.
ARIZONA SCIENCE STANDARDS	6th Grade • 6.L2U3.12 Engage in argument from evidence to support a claim about the factors that cause species to change and how humans can impact those factors. • 6.L2U1.13 Develop and use models to demonstrate the interdependence of organisms and their environment including biotic and abiotic factors. 7th Grade • 7.L1U1.11 Construct an explanation for how organisms maintain internal stability and evaluate the effect of the external factors on organisms' internal stability. Organisms respond to stimuli from their environment and actively maintain their internal environment. 8th Grade • 8.L4U1.12 Gather and communicate evidence on how the process of natural selection provides an explanation of how new species can evolve. The natural selection of organisms with certain features that enable them to survive in particular environmental conditions has been going since the first form of life appeared on Earth. Adaptation by natural selection acting over generations is one important process by which species change over time in response to changes in environmental conditions.
NEXT GENERATION SCIENCE STANDARDS	• MS-LS2-4 Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations. • MS-LS2-1 Analyze and interpret data to provide evidence for the effects of resource availability on organisms and populations of organisms in an ecosystem. • MS-LS4-4 Construct an explanation based on evidence that describes how genetic variations of traits in a population increase some individuals' probability of surviving and reproducing in a specific environment.

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MATERIALS	• "What is Astrobiology?" introductory video • "Extreme Life" slide show • "Imagining Life Beyond Earth" workbooks • Art supplies (optional, for coloring in extremophile pictures)
VOCABULARY	• Astrobiology: The study of life in the universe, including its origins, evolution, and potential existence beyond Earth. • Extremophile: A living organism that thrives in extreme environments, such as high heat, extreme cold, high radiation, or high salinity. • Adaptation: A physical or behavioral trait that helps an organism survive in its environment. • Habitat: The natural environment in which an organism lives. • Hypothesis: A testable explanation based on observations and scientific reasoning. • Analogue: In astrobiology, an analogue refers to an Earth-based environment, organism, or system that serves as a model for understanding conditions on other planets. For example, Antarctica's subglacial lakes are considered analogues for potential extraterrestrial habitats on icy moons like Europa.
SET UP	• Ensure the video and Extremophiles slideshow are prepared and ready for presentation. • Ensure all students have their copy of "Imagining Life." • Prepare art supplies.
LESSON PROCEDURE	Warm Up 1. Have students find page 10 of their Imagining Life booklet ("What is Astrobiology?"). ◦ Explain that in the first two boxes, they should draw pictures or write the words that come to mind when they hear the prefix "Astro" or the word "Biology." ◦ Reassure them that there are no wrong answers! ◦ This can be done as a "bell ringer" activity or in small groups. 2. Afterwards, discuss answers as a class. ◦ What comes to mind when you hear "astro"? What comes to mind when you hear the word "biology"? ◦ If we're combining these two terms into one word, what do you think the word "astrobiology" means?

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LESSON PROCEDURE

Activity

3. Watch the "What is Astrobiology?" introductory video.

- Have the class come up with a definition of astrobiology to write in their booklets.
- Note that they do not need to include the entire definition presented in the video; these details will be reviewed at the start of the fourth class.

4. Explore the following concepts with the class:

- Since we haven't discovered extraterrestrial life yet, what do you think astrobiologists study?
- Is there any life on Earth that they could study to help them understand what life beyond Earth might look like?
- Review the word "analogue" from the last lesson. What Earth analogues do we have that might resemble life that could survive on a harsh world such as Mars, or Jupiter's icy moons?
- Organisms that can survive and thrive in harsh environments are called extremophiles.

5. Have students turn to page 13 of their booklets.

6. Present the "Extremophiles" slide show.

- As you go through the slides, ask:
 - Have you ever seen this organism before?
 - What physical traits or behaviors help it survive?
 - What makes this organism an extremophile?
 - How do you think scientists study this extremophile?
 - Can you think of a place beyond Earth that resembles this environment?
- For each slide, instruct the students to do the following in their booklets (either as a class or in groups):
 - Draw a picture of the extremophile
 - Write some key words describing the organism's environment.
 - Write some key words describing the organism's adaptations.
- The last four slides are extremophiles that live in the Sonoran Desert. If you live in the Sonoran Desert, ask the students if they've seen these organisms around their school or home, and what else they know about these organisms.
- There are four blank spaces for brainstorming adding additional extremophiles. This can be done as an extension activity in class, or as a take home activity.

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LESSON PROCEDURE

Reflection

7. Explore the following questions with the students as time and interest levels allow. You might also choose one of these questions as an “exit ticket” type of activity.

- What are some things that make you an extremophile?
- How have you adapted to extreme situations or environments?
- What extreme environments have you visited or lived in?
- If you were an astrobiologist, what extremophile would you choose to study? How could studying that extremophile help you understand what life might be like beyond Earth? What tools would an astrobiologist need to study this extremophile?
- Choose your favorite planet. What type of extremophile might live on that planet?

EXTENSIONS AND TAKE HOME ACTIVITIES

Here are some additional activities you might consider to extend the lesson or expand learning beyond the classroom.

- There are four blank spaces for brainstorming adding additional extremophiles. This can be done as an extension activity in class, or as a take home activity. One great option is to have them research an extremophile that lives in your local environment.
- Research a specific planet or moon of the solar system, and then speculate on what extreme adaptations an organism would need to survive in that environment.
- Interview a family member about how they are similar to an extremophile. What extreme environment or situation have they survived, and what adaptations did they utilize for survival?
- Research a specific extremophile and what tools scientists have used to study that extremophile.
- Have students watch one or more episodes of NASA’s [Our Alien Earth](#). What is the Earth Analogue being studied in the episode? How can studying this environment help astrobiologists understand the possibilities for life beyond Earth?