ASTROBIOLOGY AND EXTREME LIFE

Lesson 1: **What is Extreme Life?**

OVERVIEW

This lesson introduces students to the field of astrobiology and the study of extreme life—organisms that thrive in extreme conditions. By examining extreme life 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 extreme life forms and their adaptations to extreme environments.
- Recognize how extreme life forms inform the search for alien life.
- Identify human adaptations to environments and situations that are similar to extreme adaptations.

ARIZONA SCIENCE STANDARDS

3rd Grade

- **3.L1U1.5** Develop and use models to explain that plants and animals (including humans) have internal and external structures that serve various functions that aid in growth, survival, behavior, and reproduction.
- **3.L2U1.7** Develop and use system models to describe the flow of energy from the Sun to and among living organisms...Organisms can survive only in environments in which their particular needs are met.

4th Grade

- **4.L4U1.11** Analyze and interpret environmental data to demonstrate that species either adapt and survive or go extinct over time....When the environment changes in ways that affect a place's physical characteristics, temperature, or availability of resources, some organisms survive and reproduce, others move to new locations, yet others move into the transformed environment, and some die...For any particular environment, some kinds of organisms survive well, some survive less well, and some cannot survive at all.

5th Grade

- **5.L3U1.10** Construct an explanation based on evidence that the changes in an environment can affect the development of the traits in a population of organisms....The environment also affects the traits that an organism develops. Differences in where they grow or in the food they consume may cause organisms that are related to end up looking or behaving differently.

NEXT GENERATION SCIENCE STANDARDS

3rd Grade

- **4-LS1-1** Construct an argument that plants and animals have internal and external structures that function to support survival, growth, behavior, and reproduction.

4th Grade

- **3-LS4-3** Construct an argument with evidence that in a particular habitat some organisms can survive well, some survive less well, and some cannot survive at all.

5th Grade

- **3-LS3-2** Use evidence to support the explanation that traits can be influenced by the environment.

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MATERIALS	• "What is Astrobiology?" introductory video (also found on the AABC website) • "Extreme Life" slide show (found on the AABC website) • "What is Astrobiology?" and "Extreme Life" worksheets (optional) • Art supplies (optional, for coloring in extreme life pictures)
VOCABULARY	• **Astrobiology**: The study of life in the universe, including its origins, evolution, and potential existence beyond Earth. • **Extreme Life**: 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. • **Analog**: 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 analogs for potential extraterrestrial habitats on icy moons like Europa.
SET UP	• Ensure the video and Extreme Life slideshow are prepared and ready for presentation. • Ensure all students have a copy of the worksheets, if applicable. • Prepare art supplies.
LESSON PROCEDURE	**Warm Up** 1. Pass out the "What is Astrobiology" worksheet, or have students draw two boxes on a blank piece of paper, one labeled "Astro" and one labeled "Biology." ◦ Explain that in each box, 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. (Note that they do not need to include the entire definition presented in the video!)
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 place on Earth that are similar to conditions on another planet or moon, such as the cold, thin air of Mars, or the deep oceans found on Jupiter's icy moons?
        - Astrobiologists like to study these places. They are called **analogs**. Some examples include:
        - The Atacama Desert in Chile, which has thin air, and similar soil chemistry to Mars.
        - The Mojave Desert in California has a surface similar to the Moon, so we practice with moon rovers there.
        - Lake Vostok in Antarctica has a lake hidden beneath a think layer of ice, just like Jupiter's moon Europa.
    - Is there any life on Earth that they could study to help them understand what life beyond Earth might look like?
        - Astrobiologists like to study life that can survive in extreme environments. We called these **extreme life** or sometimes **extremophiles**.
5. Pass out the "Extreme Life" worksheets to students, or have them copy the format onto a plain piece of paper.
6. Present the "Extreme Life" slide show.
    - As you go through the slides, you might ask:
        - Have you ever seen this organism before?
        - What physical traits or behaviors help it survive?
        - What makes this organism "extreme life"?
        - Why might scientists study this organism?
        - Can you think of a place beyond Earth that resembles this environment?
    - For each slide, instruct the students to do the following (either as a whole class or in groups):
        - Draw a picture of the extreme organism.
        - Write some key words describing the organism's environment.
        - Write some key words describing the organism's adaptations.

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LESSON PROCEDURE

- The last four slides are extreme organisms 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 two blank spaces on the final worksheet for brainstorming adding additional extreme life forms. This can be done as an extension activity in class, or as a take home activity.

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

- 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 an extreme organism. What extreme environment or situation have they survived, and what adaptations did they utilize for survival?
- Research a specific extreme life form and what tools scientists have used to study that organism.
- 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?