IMAGINING LIFE BEYOND EARTH

Lesson 3: **Astrobiology and Extreme Life (Part 2)**

ARIZONA ASTRO BIOLOGY CENTER
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OVERVIEW	This lesson builds upon students' understanding of astrobiology and extreme life by having them design their own extreme environments and the life forms that could survive there. By applying scientific reasoning and creativity, students will explore how adaptations enable organisms to survive in harsh conditions, both on Earth and beyond. Duration: 60-90 minutes.
LEARNING OBJECTIVES	• Understand the concept of extreme life and their adaptations to extreme environments. • Recognize how extreme life informs the search for extraterrestrial life. • Combine previous knowledge with creativity to design hypothetical extreme environments and life forms.
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	• "Imagining Life Beyond Earth" student booklets • Art supplies (optional, for coloring in extreme lifepictures)
VOCABULARY	• **Astrobiology**: The study of life in the universe, including its origins, evolution, and potential existence beyond Earth. • **Extreme Life**: Living organisms that thrive 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. • **Analog**: In astrobiology, an analog 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 booklets and art supplies are distributed.

LESSON PROCEDURE	**Warm Up:**
	1. Ask students to define astrobiology and discuss what they've learned about astrobiologists so far.
	2. Have students reflect on:
	  ◦ Which adaptations of sci-fi extraterrestrials (from lesson 1) they found most interesting. They should highlight these in their booklets.
	  ◦ Which real-life environments and adaptations (from lesson 2) they found most fascinating, also circling or highlighting them.
	3. If time allows, students can share their selections in small groups or with the class, explaining why they found certain adaptations interesting.
	
	Activity 1: Imagining Extreme Worlds
	4. Direct students to page 20 ("Create an Extreme World") in their booklet.
	5. Explain that they will design a planet or moon with an extreme environment. At this time, they should ONLY draw the environment, not any animals that might live on their world.
	  ◦ First, have each student write at least three key descriptive words about their world's conditions, using inspiration from the circled or highlighted words in their booklets.
	  ◦ Next, they should draw a picture of the surface of the world, making sure it matches the words they wrote at the top of the page.
	  ◦ If time, have students gather small groups to describe their worlds and explore the following questions:
	  ▪ What is the closest Earth Analog to my fictional world?
	  ▪ What types of adaptations would an organism need to survive on this world?

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LESSON PROCEDURE

Activity 2: Imagining Extreme Life

6. Turn to page 22 in their booklet titled "Create an Extreme Life Form."
7. Explain that they will design at least one organism that can survive in their extreme environment.
    - First, have each student write at least three key adaptation words about their organism, using inspiration from the circled/highlighted words in their booklets, and from their small group brainstorming.
    - Next, they should draw an illustration of their organism, ensuring that their adaptations are represented in their drawing where applicable.
    - If time, have students gather small groups to describe their organisms, and possibly brainstorm other organisms that might also live on that world.

Reflection

8. 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 was the most surprising or creative adaptation you saw?
    - Recall that sci-fi aliens are often influenced by the background of the creator, such as the designer's culture, profession, place they live, their environment, time period, background knowledge, interests, etc. How did their personal background influence the creation of their extreme world or extreme organism?
    - How do real-life extreme life forms compare to the ones we designed?
    - What can studying Earth's extreme life forms tell us about the possibility of life on other planets?
    - Reinforce the connection between astrobiology and real-world science, emphasizing how NASA and other organizations use extreme life forms as models for studying alien life.

EXTENSIONS AND TAKE HOME ACTIVITIES

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

- Create a Model: Have students create a 3D model of their extreme lifeusing clay, recycled materials, or digital drawing tools.
- Storytelling: Write a short sci-fi story featuring their extremophile, describing a "day in the life" of their creature.
- Astrobiology Research: Assign students to research a real-life extreme lifethat is similar to the fictional organism they designed.
- Ask students to recall their favorite animal, then alter that animal to survive on the extreme world they designed. What characteristics of that animal did they have to change? What stayed the same?