

IMAGINING LIFE BEYOND EARTH



Astrobiology and Extreme Life

OVERVIEW	This lesson introduces students to the field of astrobiology and the study of extreme life. By examining extreme life found on Earth, students will explore how scientists search for life beyond our planet. Students will then apply scientific reasoning and creativity to design their own extreme environments and imagine life forms that could survive there. They will investigate how specific adaptations help organisms endure harsh conditions, both on Earth and in potential extraterrestrial habitats. Duration: 3 activities totaling 2-3 hours
LEARNING OBJECTIVES	• Develop a basic understanding of the word astrobiology. • Understand the concept of extreme life and their adaptations to extreme environments. • Recognize how extreme life forms inform the search for extraterrestrial life. • Identify human adaptations to environments and situations that are similar to extreme life adaptations. • 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.

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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.
MATERIALS	• "What is Astrobiology?" introductory video (available on AABC website) • "Extreme Life" slide show (available on AABC website) • "Astrobiology and Extreme Life" student worksheets (available on AABC website) • Art supplies (optional, for coloring in extreme life form 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 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 the "What is Astrobiology?" video and Extreme Life slideshow are prepared and ready for presentation. • Ensure all students have their copy of the lesson worksheet. • Prepare art supplies.

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LESSON PROCEDURE

Warm Up (15 minutes)

- Have students look at the first page of their worksheet ("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.
- 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?

Activity 1 (60-80 minutes)

- Watch the "What is Astrobiology?" introductory video.
 - Have the class come up with a definition of astrobiology to write in their worksheets.
- 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?
 - Explain to the class that when scientists study a life form on Earth to better understand what alien life forms might be like, that is called an **analog**.
 - What Earth analogs do we have that might resemble life that could survive in harsh desert such as Mars, or a cold ocean such as Jupiter's moon Europa? (Examples might be a lizard in Earth's deserts for the Mars life analog, or an arctic fish for a Europa life analog)
 - Organisms that can survive and thrive in harsh environments are called extreme life forms.
- Have students turn to page 2 of their worksheets.
- Present the "Extreme Life" slide show.
 - As you go through the slides, ask some of the following questions:
 - Have you ever seen this organism before?
 - What physical traits or behaviors help it survive?
 - What makes this organism an extreme life form?
 - How do you think scientists study this extreme life form?
 - Can you think of a place beyond Earth that resembles this environment?

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LESSON PROCEDURE

- For each slide, instruct the students to do the following in their worksheets (either as a class or in groups):
 - Draw a picture of the extreme life form
 - Write some key words describing the organism's environment.
 - Write some key words describing the organism's adaptations.
- The last four slides are extreme life 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 for brainstorming adding additional extreme life forms. This can be done as an extension activity in class, or as a take home activity.

Activity 2: (30-40 minutes)

- Direct students to "Create an Extreme World" in their worksheet.
- 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 worksheets.
 - 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 in 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 organisms need to survive here?

Activity 3: (30-40 minutes)

- Turn to page 8 in their worksheet titled "Create an Extreme Life Form."
- 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 worksheets, 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.

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LESSON PROCEDURE

Reflection (10-20 minutes)

- 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?
 - What extreme environments have you visited or lived in?
 - If you were an astrobiologist, what extreme life form 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 extreme life form?
 - How do real-life extreme life forms compare to the ones we designed?
 - What was the most surprising or creative adaptation you saw?

EXTENSIONS AND TAKE- HOME ACTIVITIES

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

- Have students create a 3D model of their extreme life using clay, recycled materials, or digital drawing tools.
- There are two blank spaces for brainstorming adding additional extreme life forms. 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 extreme life form 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 extreme life form. 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 extreme life form.
- Have students watch one or more episodes of NASA’s [Our Alien Earth](#). What is the Earth analog being studied in the episode? How can studying this environment help astrobiologists understand possible life beyond Earth?
- Write a short sci-fi story featuring their extremophile, describing a “day in the life” of their creature.
- Assign students to research a real-life extreme life that 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?