

ASTROBIOLOGY, OSIRIS-REX AND THE SEARCH FOR THE ORIGINS OF LIFE



OVERVIEW	By delving into the realm of Astrobiology research, students will explore how scientific choices are shaped when investigating the origins of life on Earth and beyond. Through this lesson, students will analyze data, enabling them to discern strategic locations to direct origin-of-life research efforts. The OSIRIS-REx Asteroid Return Mission is highlighted as a NASA/University of Arizona mission with origins of life research as one of its scientific goals. Duration: 90 minutes
LEARNING OBJECTIVES	• Understand how Astrobiology can help humans understand the origins of life on Earth. • Learn how our current understanding of how life evolved on Earth influences how astrobiologists study possible life beyond Earth. • Use data to select where and why we might explore astrobiological questions in space and plan missions. • Learn about the role of the NASA and University of Arizona OSIRIS-Rex asteroid sample return mission and its possible contributions to Astrobiology research.
ARIZONA STANDARDS	8.L4U1.11 Develop and use a model to explain how natural selection may lead to increases and decreases of specific traits in populations over time. 8. L4U1.12 Gather and communicate evidence on how the process of natural selection provides an explanation of how new species can evolve.
NEXT GENERATION SCIENCE STANDARDS	MS-LS4-6 Use mathematical representations to support explanations of how natural selection may lead to increases and decreases of specific traits in populations over time. 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	• PPT slides for use during the lesson. • Data from missions about the environment of other planets or bodies in the Universe. Provided with the lesson. • Student structured note-taker sheets. • Computers and Internet connection for student use • Projector/computer for PPTs and video display
BACKGROUND KNOWLEDGE	Students should have basic knowledge of the following: • The mechanism of inheritance and heredity. • Natural selection can favor certain traits within a population. • Populations can evolve over time in response to their environment. • Basic knowledge of how to read data and graphs. • Background knowledge about why Earth has an environment that allows life to exist and some extreme forms of life that live on Earth.
VOCABULARY	• Astrobiology: The scientific study of life in the Universe. It explores questions about life's origin, evolution, and potential distribution on other planets, moons, and celestial bodies beyond Earth. • Evolution: The process by which different living organisms are thought to have developed and diversified from earlier forms during the history of the Earth. • Asteroid: A small rocky object that orbits the Sun, primarily found in the asteroid belt between Mars and Jupiter. They vary in size, from tiny particles to larger bodies, and are remnants from the early days of our solar system. • Meteorite: A piece of rock or metal that falls from space and lands on Earth's surface. It comes from asteroids or other celestial bodies and can vary in size from tiny fragments to larger masses. • Biosphere: Refers to all the places in the Universe where life exists, including Earth and any other planets, moons, or celestial bodies that may support living organisms. • Organic compounds: A type of molecule that contains carbon atoms bonded together, often combined with other elements like hydrogen, oxygen, nitrogen, or sulfur. Organic compounds are the building blocks of living things and play essential roles in many chemical processes. • Carbonaceous chondrites: Special rocks from space that contain carbon, a key ingredient for life. They are time capsules from the early solar system, helping scientists learn about how planets formed and how life might have started. • OSIRIS-REx mission: A NASA spacecraft mission led by the University of Arizona, which studied and collected a sample from an asteroid named Bennu. One of its main goals is to learn more about the origins of our solar system and the potential for life on other celestial bodies.
SET UP	Plan for digital access to lesson slideshows, structured notes, data sets, and video projection for OSIRIS-REx videos. Students can view and use the included structured note-takers that are included. These materials may also be printed. Student work can be completed on physical handouts or electronic notes.

LESSON PROCEDURE

Activity 1: Powerpoint (90 minutes)

1. **(Slides 1-5)** Following a short introductory bell work activity (at the teacher's discretion), students are provided an outline of the class period and the lesson objective and vocabulary list (included in structured notes. (Pg. 1 of structured notes)
2. **(Slides 6-7)** Review: Earth as a model. The teacher gives a short review about how environmental conditions on Earth relate to the needs and characteristics of life. These are the same kinds of conditions we might look for when searching for life beyond Earth. Students write notes in their structured notes during this time to use later. (Pg. 1 of structured notes).
3. **(Slides 8-9)** Group Brainstorm: What environmental factors on Earth influence life and natural selection on Earth?
 - a. Students are placed into groups of 3-4 and will use their previous knowledge of how Earth's environment makes it a suitable location for life.
 - b. Groups brainstorm what they already know about Earth's environment and what environmental factors might influence natural selection on Earth. (Pg. 1 of structured notes)
 - c. Groups will then use their knowledge of Earth's environment to predict what real Astrobiologists would use to decide where to look for origins of life information. (Pg. 1 of structured notes)
4. **(Slides 10-11)** Group Activity and Class Share—Looking to Space
 - o Small group discussion, students discuss and list in their notes what clues, i.e., environmental characteristics, Astrobiologists should be looking for and thinking about when they search for life!
5. **(Slides 12-15)** Be An Astrobiologist: Groups study data collected about various bodies in space. The goal is to choose mission targets that would be helpful to astrobiologists – to collect evidence about the origins of life on Earth and the nature/possibility of life beyond Earth. Each group uses the data provided in the structured notes on page 5 to complete this part of the activity.
 - a. Students should use the information they listed about Earth's environment to make decisions and discuss their ideas about space missions that would be beneficial for collecting information about the origins of life and potential suitability for finding signs of life as we know it. Students should also consider practical/logistical factors such as distance to these targets. (Pg. 2 of structured notes)
6. **Class share:** Following the analysis of data and the selection of possible targets for research, the group will discuss which targets they selected and why. (Pg. 4 of structured notes) The teacher asks each group about some of the targets they chose. Observe and point out trends in the selections.
 - a. Optional Projects: Group or individual project—Create a digital poster or poster board of their selected mission target. Include research questions related to astrobiology, the rationale for the choice of the target using data from the datasheet, a description of the mission, and images of the target.

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LESSON PROCEDURE

7. **(Slides 16-17)** Teacher Presentation: Lead the students through a quick explanation that many of the targets in the data table they picked have also been the subject of past, current, or planned missions. (see Astrobiology Missions – NASA:

<https://astrobiology.nasa.gov/missions/>

For southern Arizona classrooms, focusing on the OSIRIS-Rex mission is important as it ties the lesson to the University of Arizona and the students' local community (Pg. 4-5 of structured notes)

Suggested beginning of Part 2

(Slides 18-21) Discussion of Space missions with the example of the OSIRIS-REx Mission and its connection to Astrobiology and UA/Arizona.

Show videos:

- NASA Finds Ingredients of Life in Fragments of Lost World

<https://youtu.be/hwrV7X69ucl>

- OSIRIS-REx: NASA's First Mission to Deliver Asteroid Samples to Earth

<https://www.youtube.com/watch?v=cYi-WRBTPho>

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.

- Why did scientists, including astrobiologists, choose the Asteroid Bennu as a mission target?
- What could we learn about the origins of life on Earth and life in the Universe from Bennu?
- What are some factors or reasons you think should guide NASA and mission designers in choosing mission targets?

EXTENSIONS AND TAKE HOME ACTIVITIES

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

- Students create 1-2 questions that can be submitted to the OSIRIS-REx team for responses.
- Students can conduct research about University majors and educational programs related to Astrobiology and Space Exploration (Lesson: Careers in Astrobiology and Space Exploration)

This module was created by Alex Rutherford, an 8th Grade Science Teacher at Utterbach Middle School in Tucson, AZ, in collaboration with the Arizona Astrobiology Center. It is supported and distributed by the University of Arizona's Astrobiology Center with funding from the Marshall Foundation, Tucson, AZ. For more information, contact Lauren James at laurenjames@arizona.edu. Lesson kits are available for checkout from the Arizona Astrobiology Center – astrobiology.arizona.edu