



A S T R O B I O L O G Y

OSIRIS-REx AND THE SEARCH FOR LIFE

LESSON OBJECTIVES

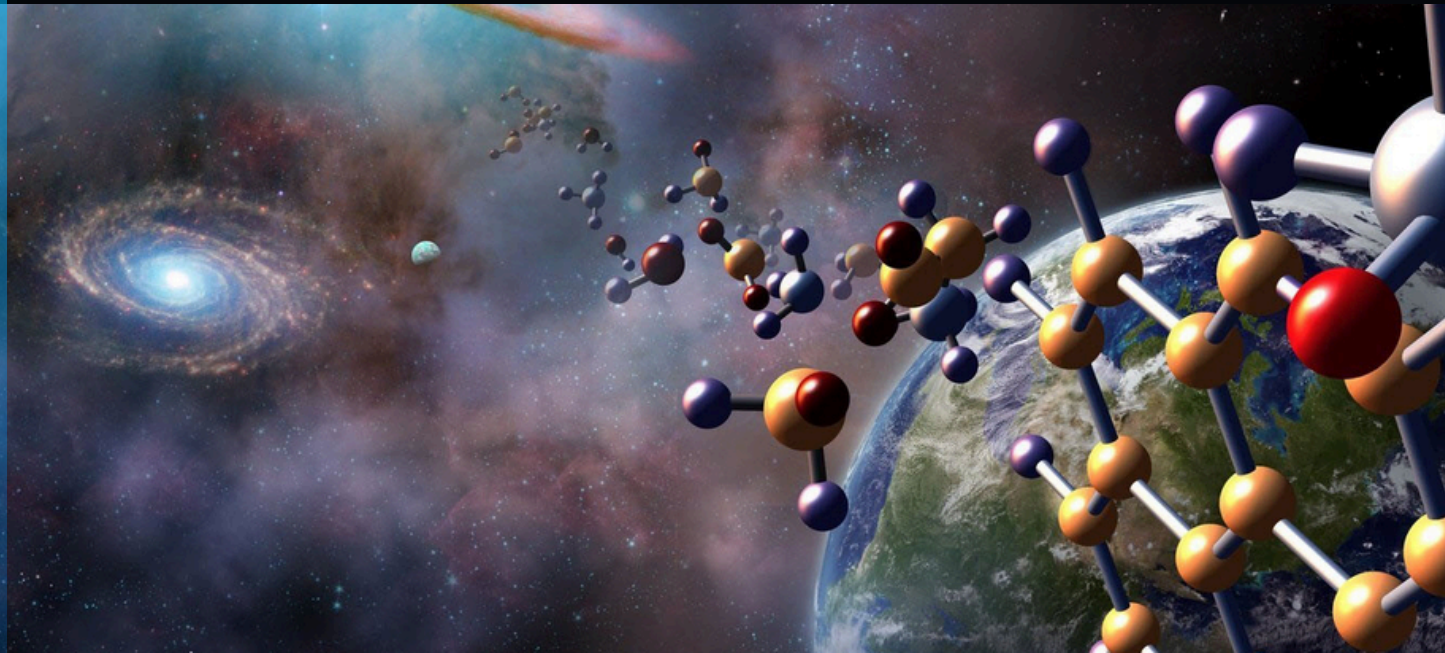
- Understand how Astrobiology can help humans understand the **origins of life** on Earth.
- Use data to select *where* and *why* we might and plan missions and explore astrobiology questions in space.
- Learn about the role of the NASA and **University of Arizona's OSIRIS-REx** asteroid sample return and its possible contributions to Astrobiology research.
- Learn how astrobiologists study **life beyond Earth**.



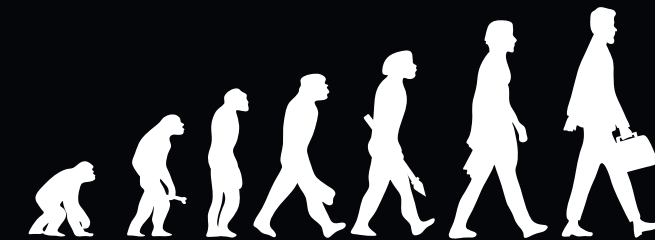
LESSON OUTLINE

1. **Looking at Earth:** What things does life *need* on Earth?
2. **Looking to Space:** What types of evidence or clues support Astrobiologists' search to understand life's origins and existence.
3. Determine where we should be searching for the clues and evidence about life in the universe.
4. Compare student findings with actual NASA missions.
5. Learn about OSIRIS-REx Sample Return Mission.

IMPORTANT VOCABULARY



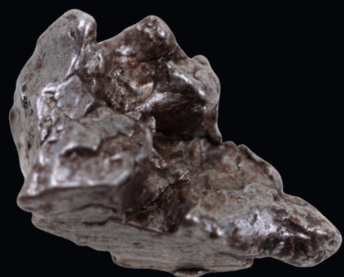
Astrobiology: the branch of biology concerned with the origins, nature, and evolution of life on Earth and in space.



Evolution: the process by which different kinds of living organisms are thought to have developed and diversified from earlier forms during the history of the Earth.



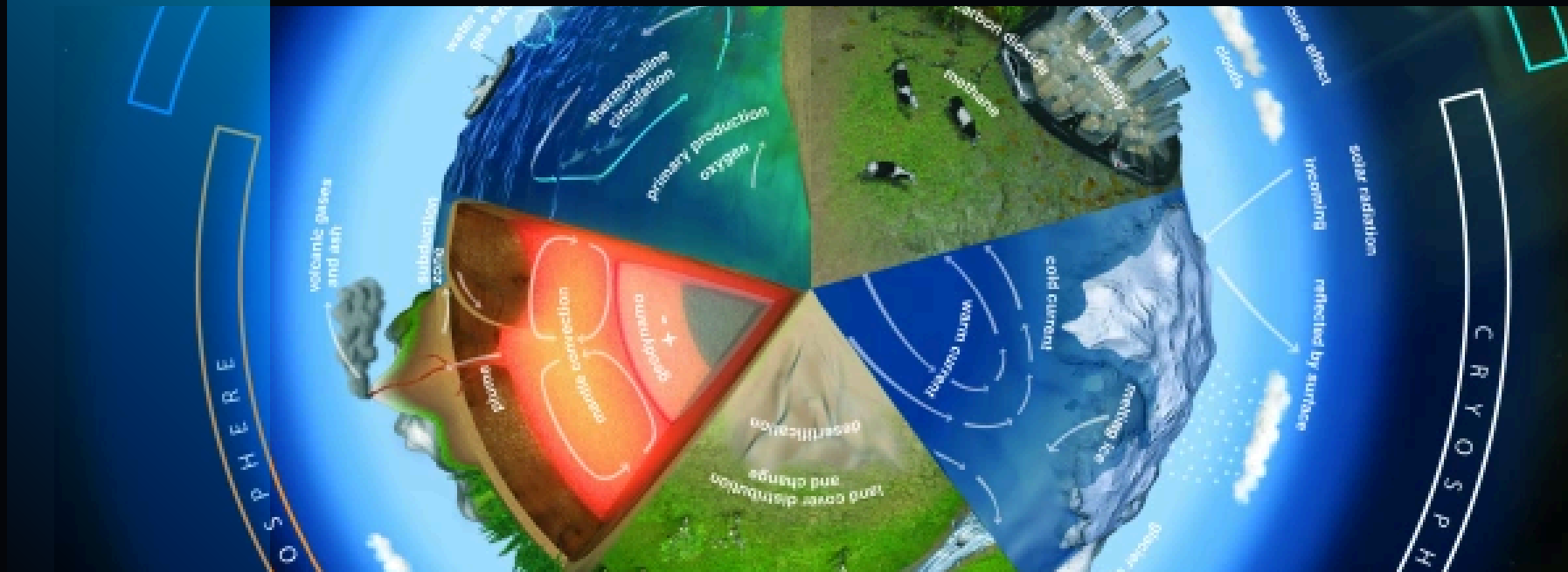
Asteroid: a small, rocky object that orbits the Sun, mostly found in the asteroid belt between Mars and Jupiter. They vary in size, from tiny particles to larger bodies, and are remnants from the early days of our solar system.



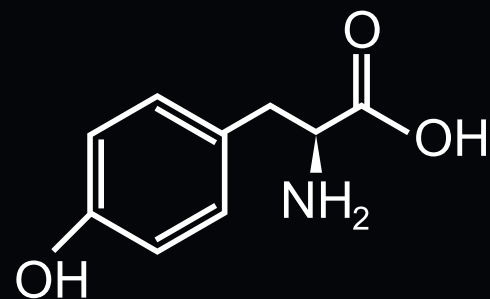
Meteorite: a piece of rock or metal that falls from space and lands on Earth's surface. It comes from asteroids or other celestial bodies and can vary in size from tiny fragments to larger masses.



IMPORTANT VOCABULARY (CONTINUED)



Biosphere: all the places in the Universe where life exists, including Earth and other planets, moons, or celestial bodies that may support living organisms.



Organic Compound: type of molecule that contains carbon atoms bonded together, often combined with other elements. They are the building blocks of living things and play essential roles in many chemical processes.

Carbonaceous chondrites: special rocks from space that contain carbon, which is a key ingredient for life. They help 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. A sample of the asteroid, Bennu, was collected for scientists to study so that they can learn more about the origins of our solar system and the potential for life beyond Earth.



EARTH AS A MODEL



*What can Earth tell us about the conditions needed
for life beyond Earth?*

EVOLUTION & NATURAL SELECTION

- The environment causes life to evolve over time!
- Living organisms need certain environmental conditions to survive and reproduce.
- Earth has an environment that has allowed life to evolve to its current state.





GROUP ACTIVITY

- With your partners, brainstorm ideas about what things are needed on Earth for life to exist!
- As you complete this activity, think about the following:
 - What things do you already know about Earth's environment?
 - Which environmental factors might be influencing natural selection and the evolution of life?
- Each group will share at least 2 ideas.

WHAT DOES EARTH HAVE THAT HELPS LIFE EXIST?



Liquid Water



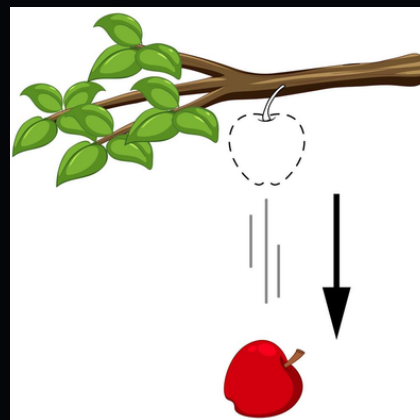
Oxygen



The Perfect
Temperatures



The Right Air
Pressure



Not Too Much
Gravity



Sunlight and Other
Energy

LOOKING TO SPACE



What should astrobiologists be looking for?



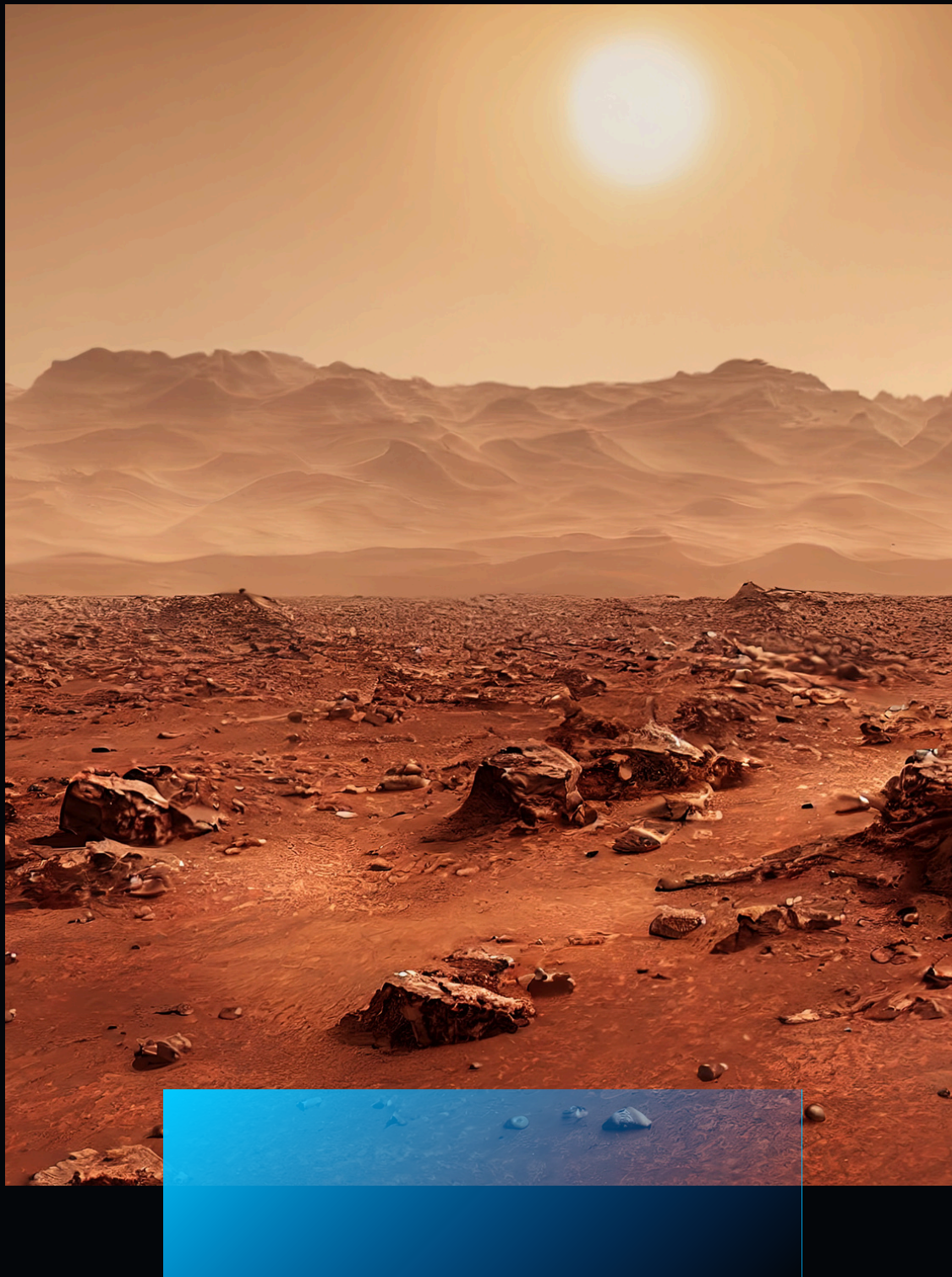
GROUP ACTIVITY

- With your group, decide what astrobiologists should be looking for when they search for life!
- Keep in mind the things that we know help life on Earth.
- You should also consider the fact that missions cost money and time.
- You will use the things you come up with in the next part of the lesson.

BE AN ASTROBIOLOGIST!



Use real NASA data and decide where to look!



BE AN ASTROBIOLOGIST

- With your group, analyze real data from NASA.
- Out of the possible targets in the data, your group will select which ones make the most sense to study.
- Remember, missions to these targets are expensive and take a lot of work, so choose wisely!

Be an Astrobiologist! Group Activity

Instructions: With your group, analyze the data provided. Out of the 11 possible targets, choose the 3 you would propose as mission targets for searching for signs of life or clues about the origins of life on earth. Use the information from the previous part of the lesson to help you think about what to look for!

Target	Object Type	Possible Water	Habitable zone?	Oxygen	Temperature*	Gravity**	Estimate Travel Time***
Mercury	Planet	Yes (frozen at the poles)	No	Yes	800 F to -230 F	38%	6.5 years
Venus	Planet	No	No	No	900 F	91%	100-200 days
Mars	Planet	No	Yes	Yes (trace)	70 to -225	38%	6-9 months
Ceres	Dwarf Planet	Yes	No	No	-100 to -225	3%	3-4 years
Europa	Moon	Yes	No	Yes	-225	1.30%	5-7 years
Ganymede	Moon	Yes	No	Yes	-171 to -297	2.50%	5-7 years
Enceladus	Moon	Yes	No	No	-330	1%	7-12 years
Pluto	Dwarf Planet	Yes (frozen in mantle)	No	No	-387	16%	9.5 years
Bennu	Asteroid	No	No	No	240 to -100	>1%	2.25 years
Saturn	Planet	No	No	No	-288	9500%	6-7 years
Kepler 186f	Exo-Planet	Yes (possibly on surface)	Yes	Possible	-121 °F	? (could be similar to Earth)	~771,000 years****

YOUR RESULTS!

- What targets did you pick and why?
- What makes a target more likely to have life or evidence of life?
- What factors do you think NASA uses to decide where to send missions?



NASA SPACE MISSIONS



How does your analysis compare to current and past NASA missions?

SOME SPACE MISSIONS



Venus Life Finder
Mission



Perseverance Mars
Mission



Ceres Dawn Mission



Europa Clipper
Mission



Ganymede JUICE
Mission

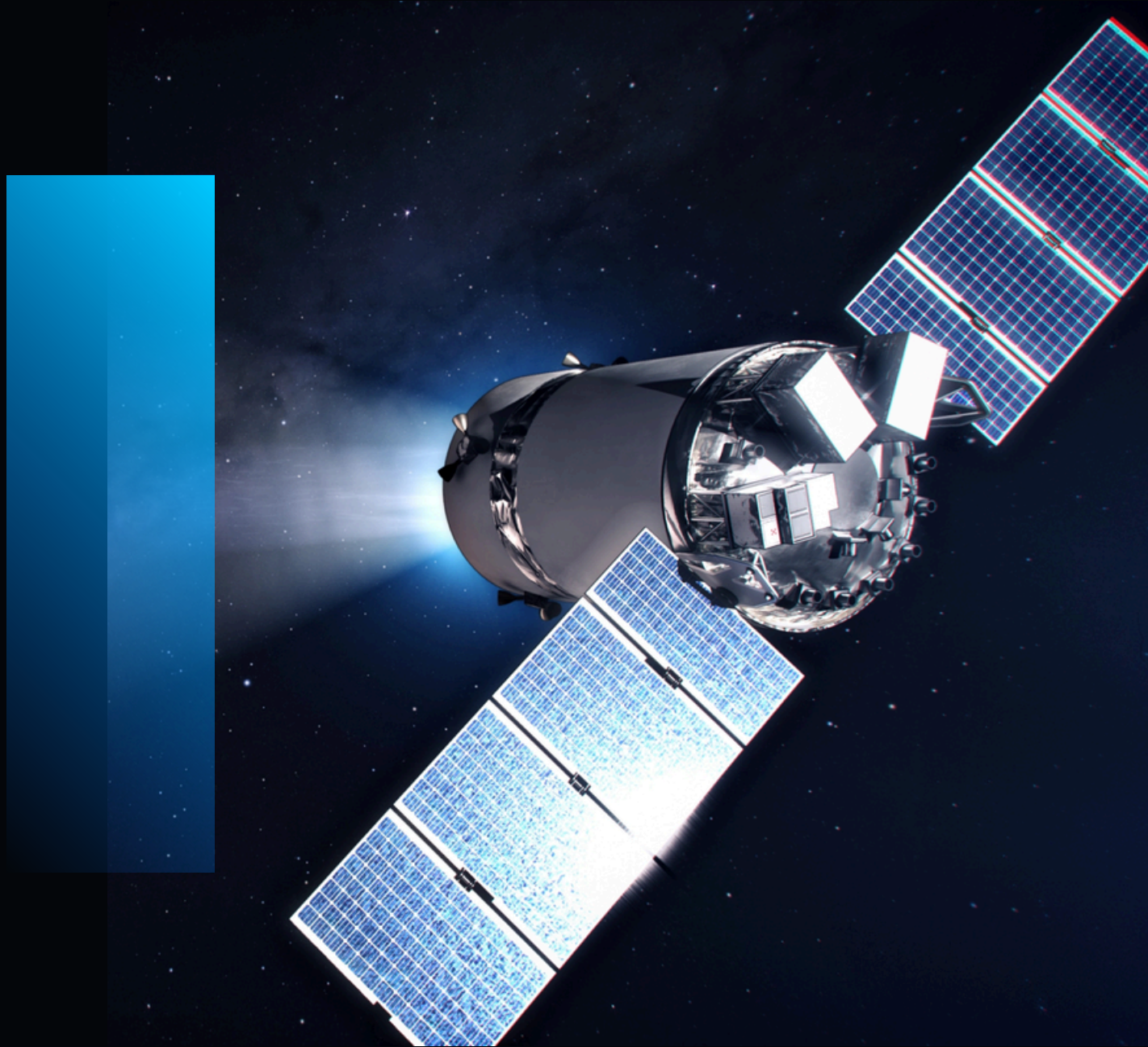


OSIRIS-REx Mission



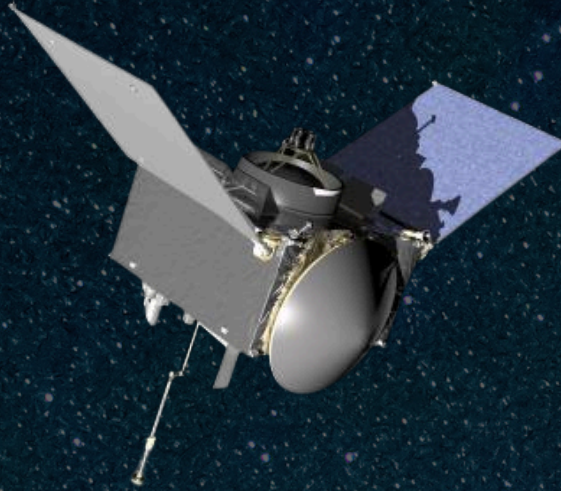
OSIRIS-APEX Mission

Sunlight and Other
Energy



SPACE MISSIONS

- Many actual missions to research the origins of life have happened or been planned for the same places you selected!
- You can see how astrobiologists have decided where to focus their research.
- The same skills you and your group members used are the same as real life astrobiologists.



THE OSIRIS-REX MISSION

- NASA mission launched in 2016 led by scientists at the University of Arizona and returned samples of asteroid Bennu on September 24th, 2023.
- OSIRIS-REx was the first U.S. mission to collect and return an asteroid sample to Earth. Some was returned to Tucson and is being studied at the University of Arizona.
- 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>



DISCUSSION QUESTIONS

- 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 factors or reasons do you think should guide NASA and mission designers in choosing mission targets?

