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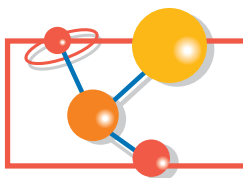
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Activity Two

Extreme Life Card Game

Purpose

To show that organisms living under extreme conditions on Earth can serve as analogs for extraterrestrial life

Overview

The teacher introduces today's games by playing *Concentration* with a special deck of 15 large-sized extremophile playing cards. Students make sets by matching three different kinds of cards—an *Organism* card, an *Earth Habitat* card, and a *Possible Extraterrestrial Habitat* card. A complete set illustrates the idea that if life can exist under extreme conditions on Earth, then it is conceivable that organisms might live under similar conditions on other worlds. Once they understand how to use the cards, students play *Go Fish* and *Concentration* with a similar deck of 48 cards.

Time: 100 minutes

Context

This activity explores some of the reasons for thinking that extraterrestrial life is possible. In doing so, it draws on concepts developed earlier in the course, such as understanding what life is, what it requires, and what makes a planet habitable. Students organized life-related factors into a concept map in Activity 1. In the next activity, students will estimate the amount of life in the universe, expanding their thinking about life elsewhere in the solar system.

Key Concepts

- Any search for extraterrestrial life must be based on what we know about life on Earth.
- Extremophiles live at the limits of what life's chemistry is able to tolerate.
- Places that mirror Earth's life-sustaining environments may harbor life.
- As we explore the solar system, we are finding evidence for habitable conditions.
- If extraterrestrial life is found in our solar system, it will most likely be microbial and inhabit environments considered extreme on Earth.

Key Skills

- *Drawing conclusions* and *making inferences* when creating sets
- *Using* extremophiles as analogs for extraterrestrial life
- *Conceptualizing* a plausible mission (optional)
- *Debating* the ethics of sending Earth life to another world (optional)

Materials

- Scissors (for teacher)
- Rubber bands (optional)
- Laminating materials (optional)
- BLM—*Game Cards*

Background

The assumption at work both in the search for extraterrestrial life and in this activity is that Earth's extremophiles can serve as models for life elsewhere. It is plausible to think that we may find evidence of life in any place that mirrors Earth's life-sustaining environments. In this activity, students play a card game. They match an extreme habitat on Earth with an extremophile that lives under those conditions. They then identify an extraterrestrial habitat similar to the Earth habitat. By grouping these three elements, students realize that promising extraterrestrial habitats, and maybe extraterrestrial life itself, may exist. Additionally, students ultimately grasp that if extraterrestrial life is found in our solar system, it will most likely resemble one of Earth's extremophile microbes.

Preparation

Make a copy of the *Game Cards* (BLM) for each team of 2-4 students.

- Cut out the cards.
- If possible, laminate the cards to make them reusable.
- Use rubber bands or other means to keep each set together.

Recommended Procedures

1. Introduce students to extremophiles
 - a. Have students look at the table in *What's the Story?* to become familiar with some of the chemical and physical extremes tolerated by life.
 - b. Conduct a brief class discussion to make sure students understand:
 - what extremophiles are
 - extremophiles require that the extreme conditions be ongoing. With extremophiles, we are talking about long-term conditions rather than short-term, one-time exposures.
 - the range of conditions that life can tolerate.
2. Introduce students to the *Game Cards*.
 - a. Have students read the directions in the Student Guide or demonstrate the games for the class.

- b. Make sure they understand:
 - what constitutes a set—the three cards in a set are linked by a particular environmental condition
 - that there are duplicates of the organism cards
 - that the habitats described on the *Possible Extraterrestrial Habitat* cards are speculations based on current data. Confirming the existence of most of the features described on these cards requires further exploration.
 - that, to date, no extraterrestrial life has been found. Matching specific Earth organisms to extraterrestrial habitats is an exercise in imagining how adaptations that help organisms succeed in harsh Earth environments might also help organisms survive harsh conditions on other worlds.
3. Have small groups of students play the games.
4. Conclude the activity.
 - a. Have students read *What's the Story? — Meet the Champions*.
 - b. Have students answer the *Think About It* questions on their own, in groups, as homework, or as a class.
 - c. Discuss the *Think About It* questions.

Think About It

1. How can life and conditions on Earth be used as a model for life on other worlds?

If a habitat on another world poses challenges similar to one found on Earth, and life has evolved to sustain itself in that Earth habitat, it follows that this extraterrestrial life will be similar to what we find on Earth.
2. If you could genetically engineer new extremophiles that combined the traits of two different kinds of extremophiles, which two traits would you merge if your extremophile were sent to live on Mars? On Europa? Explain why you chose the traits you did for each world.

*Be open to any possibility that makes sense and is explained well. Students should draw on the information presented in the *What's the Story?* and on the *Organism, Earth Habitat, and Possible Extraterrestrial Habitat* cards. For Mars and Europa, a student might want to combine a radiation-tolerant bacterium with a cold-tolerant bacterium, because the surface of both worlds have a high incidence of radiation and are extremely cold.*
3. Describe the kind of extraterrestrial life we are most likely to find in our solar system. Why do you think it is the most likely kind?

If we find life, it most likely will be microbial. Microbial life is diverse and simple enough to adapt to just about any environment. For example, microbes are the major inhabitants of Earth's extreme environments. Conditions on other worlds in our solar system can be similar to the extreme conditions found on Earth. Thus, it is possible that any life forms we find will be similar to those on Earth that have met similar challenges.

4. What would finding evidence of microbial life on another world suggest about life in general?

The simplest answer is that finding life on other worlds suggests that if conditions are right, life will evolve anywhere. If the life is similar to what we find on Earth, then life may be based on the same basic plan. The discovery of evidence of extraterrestrial microbial life might usher in new thinking about how life may travel from world to world.

5. Draw two pictures. One should show the kind of extraterrestrial life we might reasonably expect to find in our solar system. The other should show what you think most people imagine is out there. If the drawings are different, explain why you think they are different.

Students should be able to differentiate between what scientists believe are the most likely candidates for extraterrestrial life—prokaryotes—and the popular belief that life will be some kind of UFO-driving humanoid like those depicted on television or in movies.