

Is There Life Beyond Earth?

Objectives

After this lesson, students will be able to

J.3.6.1 List the conditions living things need to exist on Earth.

J.3.6.2 Recognize why scientists think Mars and Europa are good places to look for signs of life.

Target Reading Skill

Asking Questions Explain that changing a head into a question helps students anticipate the ideas, facts, and events they are about to read.

Answers

Possible questions and answers include the following:

What are the “Goldilocks” conditions? *The favorable conditions on Earth that allow life to exist.* **Is there life on Mars?** *Scientists have not yet found evidence for life on Mars.* **Why do scientists think Europa might have life?** *Europa has an ice crust that could have a liquid water ocean underneath.*

All in One Teaching Resources

- [Transparency J33](#)

Preteach

Build Background Knowledge

L2

Characteristics of Living Things

Show students a potted plant and a goldfish in a bowl. Ask: **What is the same about these two things?** (*Both are alive.*) **How do we know these things are alive?** (*They grow, reproduce, and excrete wastes.*) **What do these things both need to stay alive?** (*Water, space, and energy*)

Is There Life Beyond Earth?

Reading Preview

Key Concepts

- What conditions do living things need to exist on Earth?
- Why do scientists think Mars and Europa are good places to look for signs of life?

Key Term

- extraterrestrial life

Target Reading Skill

Asking Questions Before you read, preview the red headings. In a graphic organizer like the one below, ask a question for each heading. As you read, write the answers to your questions.

Is There Life Beyond Earth?

Question	Answer
What are the “Goldilocks” conditions?	The “Goldilocks” conditions are . . .

Lab Zone

Discover Activity

Is Yeast Alive or Not?

1. Open a package of yeast and pour it into a bowl.
2. Look at the yeast carefully. Make a list of your observations.
3. Fill the bowl about halfway with warm water (about 20°C). Add a spoonful of sugar. Stir the mixture with the spoon. Wait 5 minutes.
4. Now look at the yeast again and make a list of your observations.

Think It Over

Forming Operational Definitions Which of your observations suggest that yeast is not alive? Which observations suggest that yeast is alive? How can you tell if something is alive?

Most of Antarctica is covered with snow and ice. You would not expect to see rocks lying on top of the whiteness. But surprisingly, people have found rocks lying on Antarctica’s ice. When scientists examined the rocks, they found that many were meteorites. A few of these meteorites came from Mars. Astronomers think that meteoroids hitting the surface of Mars blasted chunks of rock into space. Some of these rocks eventually entered Earth’s atmosphere and landed on its surface.

In 1996, a team of scientists announced that a meteorite from Mars found in Antarctica has tiny shapes that look like fossils—the remains of ancient life preserved in rock—though much smaller. Most scientists doubt that the shapes really are fossils. But if they are, it would be a sign that microscopic life-forms similar to bacteria once existed on Mars. Life other than that on Earth would be called **extraterrestrial life**.

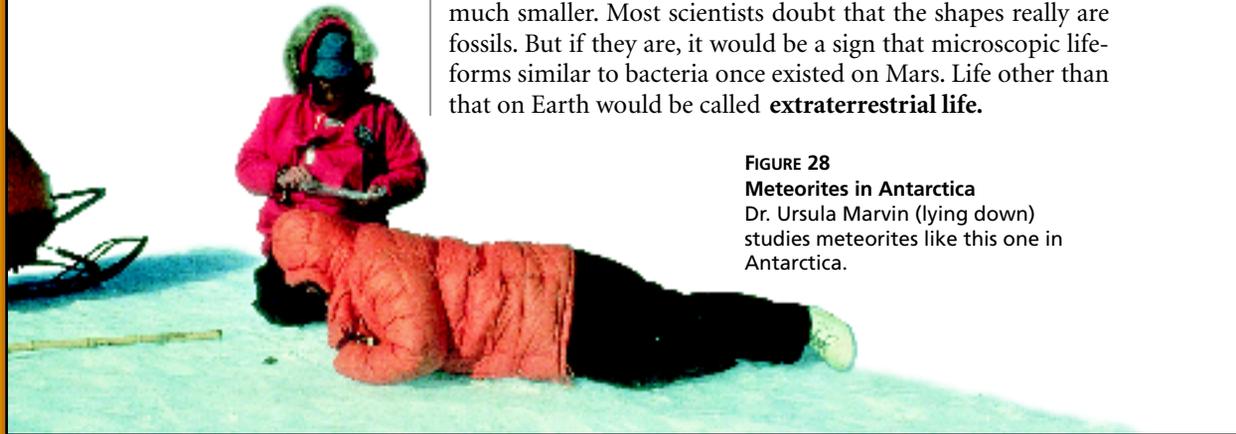


FIGURE 28
Meteorites in Antarctica
Dr. Ursula Marvin (lying down) studies meteorites like this one in Antarctica.

Lab Zone

Discover Activity

Skills Focus forming operational definitions

Materials yeast, warm water, bowl, thermometer, spoon, sugar, clock

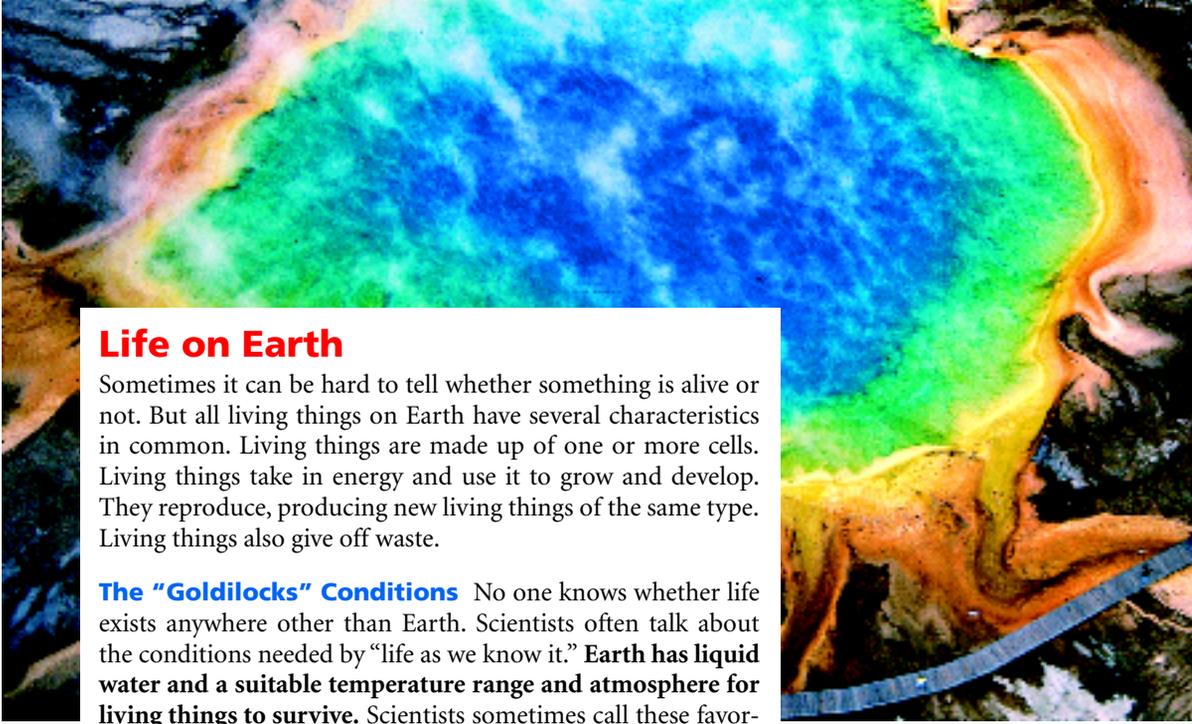
Time 15 minutes

Tips You may wish to buy yeast in bulk rather than in packets. A packet of yeast contains about one tablespoon.

L2

Expected Outcome Before adding water, the yeast will appear dry, brown, grainy, and immobile. After adding water, the yeast will bubble and give off a distinct odor.

Think It Over The first set of observations suggests that yeast is not alive. The second set of observations suggests that yeast is alive. Something is alive if it eats, breathes, or grows.



Life on Earth

Sometimes it can be hard to tell whether something is alive or not. But all living things on Earth have several characteristics in common. Living things are made up of one or more cells. Living things take in energy and use it to grow and develop. They reproduce, producing new living things of the same type. Living things also give off waste.

The “Goldilocks” Conditions No one knows whether life exists anywhere other than Earth. Scientists often talk about the conditions needed by “life as we know it.” **Earth has liquid water and a suitable temperature range and atmosphere for living things to survive.** Scientists sometimes call these favorable conditions the “Goldilocks” conditions. That is, the temperature is not too hot and not too cold. It is just right. If Earth were much hotter, water would always be a gas—water vapor. If Earth were much colder, water would always be solid ice.

Are these the conditions necessary for life? Or are they just the conditions that Earth’s living things happen to need? Scientists have only one example to study: life on Earth. Unless scientists find evidence of life somewhere else, there is no way to answer these questions for certain.

Extreme Conditions Recently, scientists have discovered living things in places where it was once believed that life could not exist. Giant tubeworms have been found under the extremely high pressures at the bottom of the ocean. Single-celled organisms have been found in the near-boiling temperatures of hot springs. Tiny life-forms have been discovered deep inside solid rock. Scientists have even found animals that do not require the energy of sunlight, but instead get their energy from chemicals.

These astounding discoveries show that the range of conditions in which life can exist is much greater than scientists once thought. Could there be life-forms in the solar system that do not need the “Goldilocks” conditions?



What are some characteristics of all living things?

FIGURE 29
Hot Spring

Bacteria that thrive in near-boiling water help to produce the striking colors of Grand Prismatic Spring in Wyoming. **Inferring** How does studying unusual organisms on Earth help scientists predict what extraterrestrial life might be like?

Lab zone Skills Activity

Communicating You are writing a letter to a friend who lives on another planet. Your friend has never been to Earth and has no idea what the planet is like. Explain in your letter why the conditions on Earth make it an ideal place for living things.

Lab zone Skills Activity

Skills Focus communicating

Materials none

Time 15 minutes

Tips Have pairs of students critique each other’s letters. Then have each student write a final draft of his or her letter.

L1 Expected Outcome Letters should note that Earth has liquid water and a suitable temperature range and atmosphere for living things.

Extend Challenge students to present the information in a chart listing the three “Goldilocks” conditions and how Earth satisfies each of these conditions. **learning modality: verbal**

Instruct

Life on Earth

Teach Key Concepts L2

Conditions for Life

Focus Review the conditions necessary for life on Earth.

Teach Ask: **How would you describe Earth to a visitor from another solar system?** (Earth has liquid water and temperature and an atmosphere suitable for life.)

Apply Tell students that scientists have launched spacecraft carrying messages from Earth to potential extraterrestrial civilizations. Have students research and discuss the content of these messages.

learning modality: verbal

Independent Practice L2

All in One Teaching Resources

- [Guided Reading and Study Worksheet: Is There Life Beyond Earth?](#)



Student Edition on Audio CD

Address Misconceptions L2

Extraterrestrial Life

Focus Some students may think that extraterrestrial life is limited only to intelligent life forms.

Teach Ask students to give examples of various life forms on Earth. (Possible answers: Bacteria, worms, plants) Stress that extraterrestrial life would include any organism living elsewhere in the universe.

Apply Ask: **Why would scientists want to discover single-celled life on other planets?** (It would prove that life has arisen elsewhere.) **learning modality: logical/mathematical**

Monitor Progress L2

Drawing Have students create diagrams of the characteristics of living things.

Answers

Figure 29 Scientists learn more about the wide range of conditions in which life on other planets might exist.



They consist of one or more cells, take in energy, develop, reproduce, and give off waste.

Life Elsewhere in the Solar System?

Teach Key Concepts

L2

Viking Missions

Focus Remind students that both *Viking* landers were programmed to search for signs of life on Mars.

Teach Ask: **What hypothesis were scientists testing when they sent the *Viking* spacecraft to Mars?** (One hypothesis was that Mars may once have had life.) **What kinds of samples did the *Viking* examine?** (Air and soil)

Apply Ask: **How were these samples useful to scientists?** (Scientists found no evidence of life on Mars.) **learning modality: logical/mathematical**

Lab zone **Build Inquiry**

L2

Making Judgments

Materials none

Time 30 minutes

Focus Point out that some topics in science are hotly debated. One such topic is the possibility of life on Mars.

Teach Divide the class into two teams. Have one team make a list of arguments against the existence of life on Mars. Have the other team make a list of arguments supporting the existence of life on Mars.

Apply Have the pro and con teams present their arguments to each other and discuss the evidence on both sides. **learning modality: verbal**

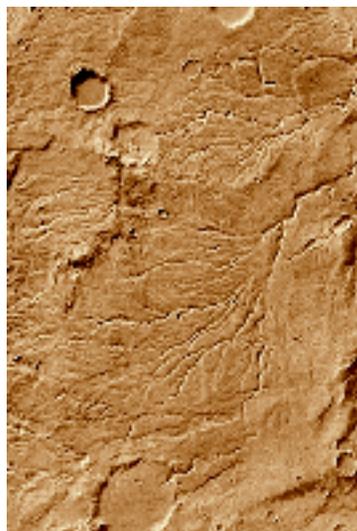


FIGURE 30
Liquid Water on Mars
 The river-like patterns on the surface of Mars indicate that liquid water once flowed there.

Applying Concepts Why does this evidence make it more likely that there may once have been life on Mars?

Life Elsewhere in the Solar System?

Recall that Mars is the planet most similar to Earth. That makes Mars the most obvious place to look for living things.

Life on Mars? Spacecraft have found regions on the surface of Mars that look like streambeds with crisscrossing paths of water. Shapes like those shown in the left photo of Figure 30 were almost certainly formed by flowing water. **Since life as we know it requires water, scientists hypothesize that Mars may have once had the conditions needed for life to exist.**

In 1976 twin *Viking* spacecraft reached Mars. Each of the *Viking* landers carried a small laboratory meant to search for life forms. These laboratories tested Mars's air and soil for signs of life. None of these tests showed evidence of life.

More recently, the *Spirit* and *Opportunity* rovers found rocks and other surface features on Mars that were certainly formed by liquid water. However, the rovers were not equipped to search for past or present life.

Interest in life on Mars was increased by a report in 1996 about a meteorite from Mars that may contain fossils. The scientists' report started a huge debate. What were the tube-shaped things in the meteorite? Some scientists have suggested that the tiny shapes found in the meteorite are too small to be the remains of life forms. The shapes may have come from natural processes on Mars.

The most effective way to answer these questions is to send more probes to Mars. Future Mars missions should be able to bring samples of rocks and soil back to Earth for detailed analysis. Scientists may not yet have evidence of life on Mars, but hope is growing that we can soon learn the truth.

Reading Checkpoint What did the *Spirit* and *Opportunity* rovers discover on Mars?

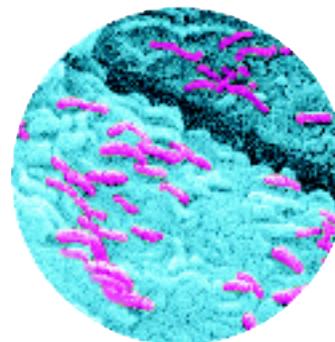
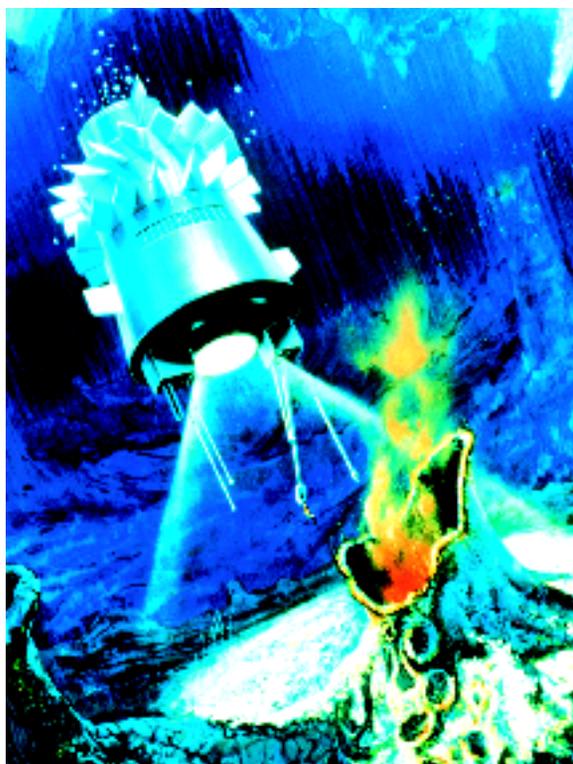


FIGURE 31
Martian Fossils?
 This false-color electron microscope image shows tiny fossil-like shapes found in a meteorite from Mars. These structures are less than one-hundredth the width of a human hair.

Life on Europa? Many scientists think that Europa, one of Jupiter’s moons, may have the conditions necessary for life to develop. Europa has a smooth, icy crust with giant cracks. Close-up views from the *Galileo* space probe show that Europa’s ice has broken up and reformed, resulting in large twisted blocks of ice. Similar patterns occur in the ice crust over Earth’s Arctic Ocean. Scientists hypothesize that there is a liquid ocean under Europa’s ice. The water in the ocean could be kept liquid by heat coming from inside Europa. **If there is liquid water on Europa, there might also be life.**

How could scientists study conditions under Europa’s ice sheet? Perhaps a future space probe might be able to use radar to “see” through Europa’s icy crust. After that, robotic probes could be sent to drill through the ice to search for life in the water below.

FIGURE 32
Exploring Europa
Scientists have discussed sending a robotic probe to search for life in the ocean below Europa’s icy crust.



Use Visuals: Figure 32

L2

Life Under the Ice

Focus Point out that a variety of organisms live under Earth’s Arctic ice.

Teach Encourage students to speculate on what kinds of life forms could exist beneath Europa’s icy crust. Ask: **What sort of adaptations might these life-forms need?** (Sample answers: *Blubber to keep warm, ability to swim or float*)

Apply Have students design and sketch a life-form that has adapted to living on Europa. **learning modality: visual**

Monitor Progress

L2

Answers

Figure 30 Because life as we know it requires water, evidence of liquid water flowing on Mars makes it more likely that there may once have been life there.



The two rovers found rocks and other surface features on Mars that were formed by liquid water.

Section 6 Assessment

Target Reading Skills Asking Questions Use the answers to the questions you wrote about the section headings to help answer the questions.

Reviewing Key Concepts

- Relating Cause and Effect** What conditions does life on Earth need to survive?
 - Summarizing** Why is Earth said to have the “Goldilocks” conditions?
 - Applying Concepts** Do you think there could be life as we know it on Neptune? Explain. (*Hint:* Review Section 4.)
- Explaining** Why do astronomers think there could be life on Europa?
 - Identifying** Scientists think that in the past Mars may have had the conditions needed for life to exist. What are these conditions? Do they still exist?

- Making Generalizations** What characteristic do Mars and Europa share with Earth that makes them candidates to support extraterrestrial life?

Lab zone At-Home Activity

Making a Message Imagine that scientists have found intelligent extraterrestrial life. With family members, make up a message to send to the extraterrestrials. Remember that they will not understand English, so you should use only symbols and drawings in your message.

Lab zone At-Home Activity

Making a Message **L1** Encourage students to consider what information about Earth and its inhabitants would be most important for extraterrestrials to know. Suggest that students ask each family member to contribute one piece of the message. Have students include a key to the symbols used in their message.

Assess

Reviewing Key Concepts

- Liquid water, suitable temperature range and atmosphere, and source of energy
 - Earth’s water, temperature, and atmosphere are just right for living things to survive.
 - No; Neptune is extremely cold and there is no liquid water.
- Europa is covered by a layer of ice like Earth’s Arctic Ocean; there may be liquid water beneath the ice.
 - Flowing water; no
 - They once had or may now have liquid water.

Reteach

L1

Have students list the evidence for life on Mars and Europa and what other conditions need to exist.

Performance Assessment

L2

Writing Have students explain which of the planets and their moons in our solar system would be good places to search for signs of life and which would not.

All in One Teaching Resources

- [Section Summary: Is There Life Beyond Earth?](#)
- [Review and Reinforce: Is There Life Beyond Earth?](#)
- [Enrich: Is There Life Beyond Earth?](#)