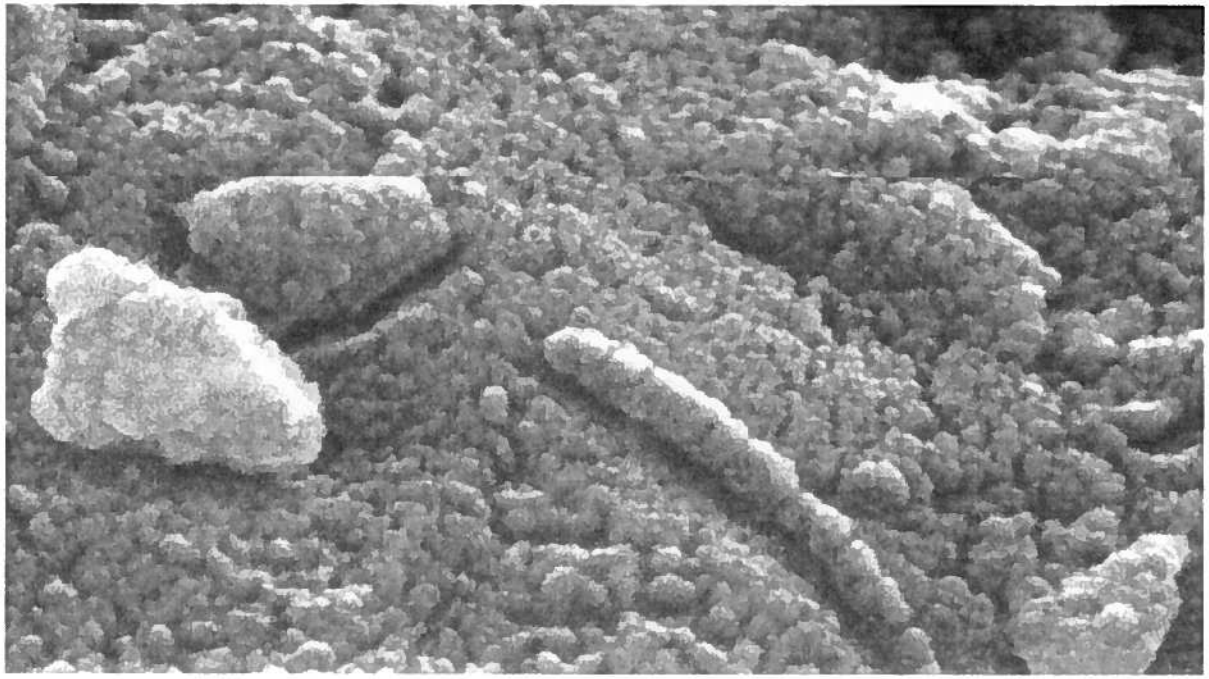


Is It Alive?

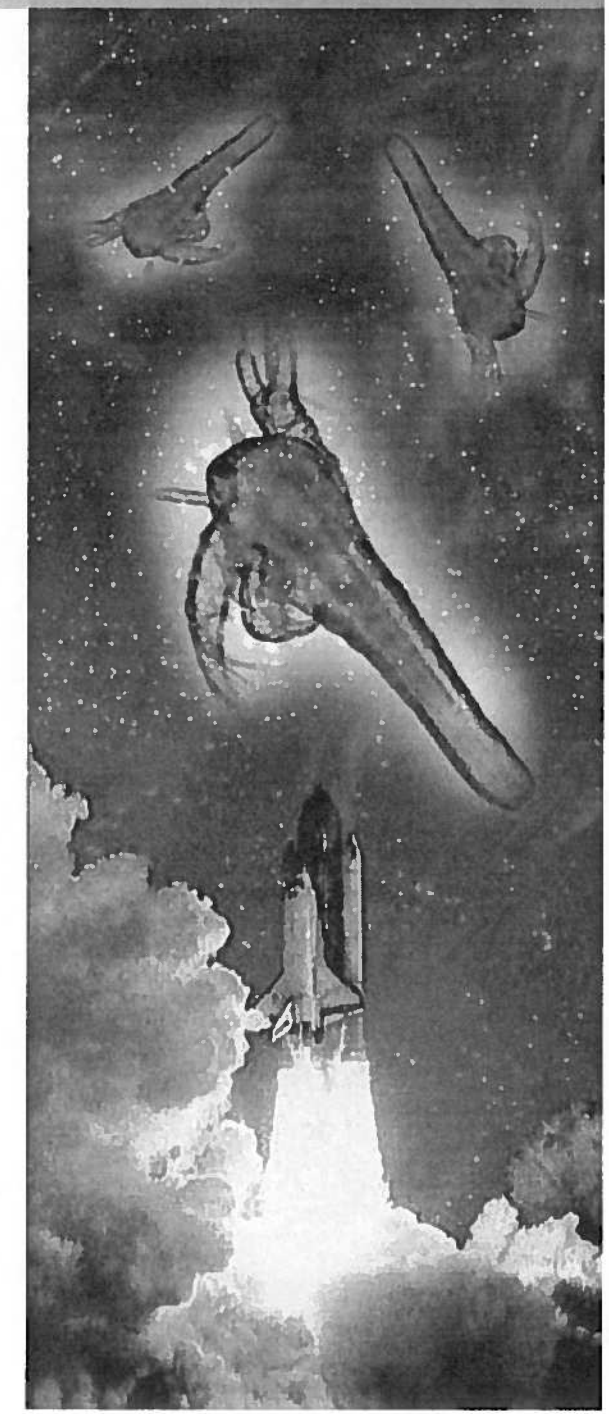
Chapter 2

Living Things

Imagine adding water to a packet of powder and ending up with a tank full of swimming creatures. This may seem like science fiction, but it's true. Brine shrimp are small relatives of crabs and lobsters. Brine shrimp eggs can live for many years in tiny hard cases. When you add water and set up a proper environment for the eggs, the brine shrimp hatch and thrive! A class of seventh graders from Pennsylvania designed an experiment to see if space travel would affect brine shrimp eggs. They sent a packet of the tiny eggs on the space shuttle Discovery in 1998 with U.S. Senator John Glenn. You can find articles about the results of the experiment on the Internet using the search phrase "brine shrimp in space." In this chapter you will learn how to tell if something is living or not, and you will see how the incredible variety of life on Earth is described, categorized, and named.

Key Questions

1. ***Is a cloud in the sky a living thing?***
2. ***How do sweating and shivering keep you alive?***
3. ***How is life on Earth classified?***



2.1 Is It Alive?

Do you know how bread is made? One of the most important ingredients is yeast. Open a packet of yeast and you'll see a bunch of tiny, dried specks. If you drop those specks into a cup of warm water with a little sugar, they'll start to bubble and froth. If you look at the mixture under a microscope (Figure 2.1), you will see individual clumps of yeast growing and even multiplying! Is yeast a living organism? In this section, you'll learn what it means to be alive.

What does it mean to be alive?

What is an organism?

An **organism** is an individual form of life. A tree is an organism and so is yeast. So are you. What makes something alive? As with many questions in science, the answer is not easy and is still argued among scientists. If you've ever had a cold or the flu, you're familiar with the effects of viruses. Viruses are very tiny things that have some of the characteristics of living things, but are not considered alive by many scientists.

The characteristics of living things

So what makes something alive? Having a set of rules is a good way to get closer to the answer. Biologists often use five basic rules to classify something as living or nonliving.

Five Characteristics of Living Things

1. Living things **respond** to their surroundings.
2. Living things **grow** and **develop**.
3. Living things are able to **reproduce**.
4. Living things **use energy**.
5. Living things are made of smaller building blocks called **cells**.

STUDY SKILLS

Make a list of all of the vocabulary terms in this section. For each term:

1. Write its definition, in your own words.
2. Use the term in a sentence.

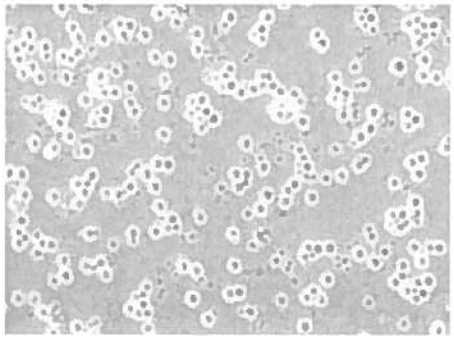


Figure 2.1: *Yeast magnified 100 times. Yeast is a living organism. Each tiny sphere is an individual organism.*

VOCABULARY

organism - an individual form of life.

Response and stimulus Have you ever gone from a dark room out into the sunshine? You respond by squinting your eyes. The brightness of the sun is called a **stimulus** and your reaction to it is called a **response**. All living things respond to a stimulus.

Growth You may think of growth as an increase in size. You have increased in size since you were born. **Growth** also refers to an increase in mass and to an increase in number of cells.

Reproduction The process of making more of the same kind of organism is called reproduction. Because all living things eventually die, reproduction allows life to continue.

Energy All living things take materials from their surroundings such as food, water, and gases. They use these materials to get energy. This energy is needed to carry out all of the life functions.

Cells A **cell** the smallest unit of a living thing. It is the simplest structure that can carry out all of the functions described above. You'll learn more about cells in Unit 2.

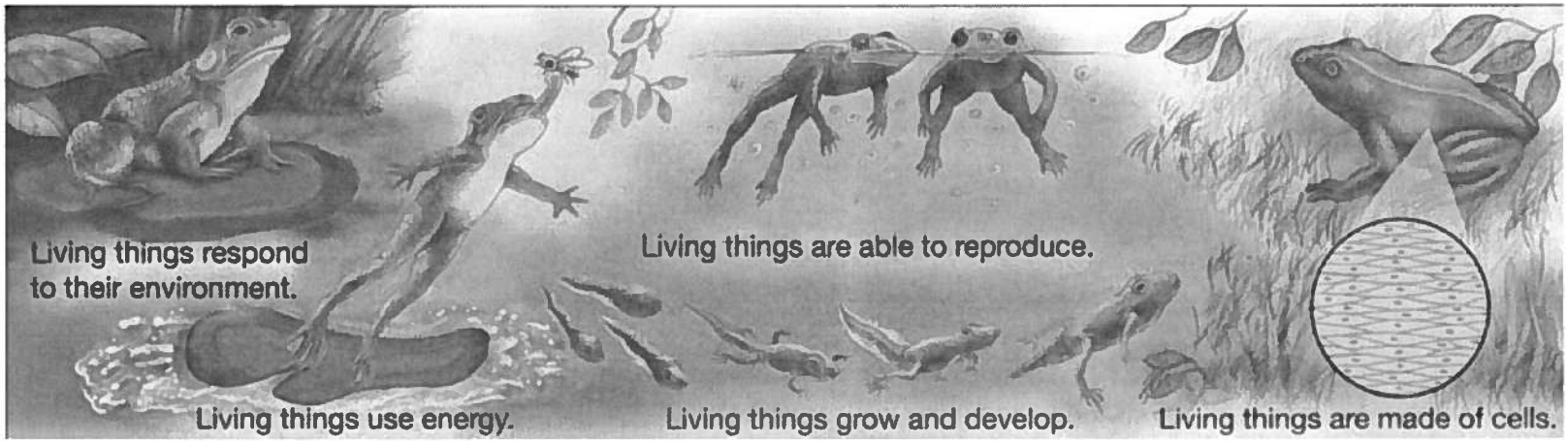
VOCABULARY

stimulus - something that causes a response.

response - how an organism reacts to a stimulus.

growth - an increase in mass.

cell - the smallest unit of a living thing.



Is a barnacle alive?

A trip to the beach

One day at the beach, Zeke picked up one of many rocks that were covered in white bumps (Figure 2.2). He thought the rock would look nice in his marine aquarium so he brought it home and dropped it into his tank. One day, while watching the fish in his tank, Zeke got a surprise. The white bumps on the rock had sprouted tiny legs and were waving back and forth in the water. The rock was alive! (Actually, the white bumps were alive.)

Barnacles

Zeke's rock was covered with tiny organisms called *barnacles* (Figure 2.3). These creatures live in tide pools along the seacoast where waves crash and tides cause water to flow in and out. Inside its shell the barnacle can hold seawater to survive the many hours of drought at low tide. At high tide the shell opens and the barnacle begins to feed. Its long, comb-like legs sweep back and forth to catch tiny organisms called plankton.

Is a barnacle alive? Let's use the five criteria to decide.

1. Barnacles **respond** to their environment by closing their shells at low tide, and opening them at high tide.
2. Barnacles **grow** and **develop**. They begin life as free-swimming creatures. Once they find a good spot, they "glue" themselves to a rock and form a shell.
3. Barnacles **reproduce**. After fertilization from a male barnacle, females hold the eggs in their shells until they hatch.
4. By waving their legs, barnacles capture food. They **use energy** from the food to move their legs, open and close their shells, and carry out all life processes.
5. If you examined the legs of a barnacle with a microscope you would see that they are made of individual **cells**.

Figure 2.2: *What are the white bumps covering this rock?*

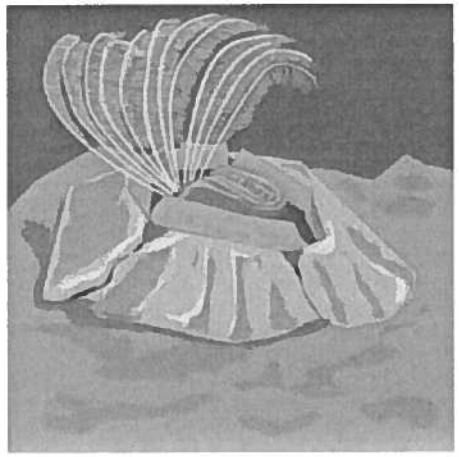


Figure 2.3: *Each bump is an individual barnacle. Barnacles feed by waving their legs back and forth.*

2.2 What is a Living System?

You have learned that a *system* is a group of factors that are related in some way. You can think of an individual organism as a *living system*. What variables affect *you* as a system? An obvious answer is the temperature around you (Figure 2.5). The type of food you eat is another variable. Your body responds to different variables in different ways. In this section, you will learn about how living systems are organized and the variables that affect them.

The organization of living systems

Living systems are organized Is your room disorganized? Even if it is, *you* are not! As a living system, your body is organized to use matter and energy to move, grow, and survive. Living systems—like you—contain many levels of organization. These are described on the next few pages.

Molecules A *molecule* is a basic unit of matter. Living systems are made of many different molecules. Each type of molecule has an important function. Your body contains molecules that store energy, control life functions, and even hold all of the information needed to make another you! You'll learn more about molecules in Chapter 4.

Cells **A cell is the basic unit of a living system.** Each cell is made up of different types of molecules including proteins, carbohydrates, and others. Your body contains trillions of cells, each one a living system on its own. Some organisms are made up of only one cell. Figure 2.6 shows what a one-celled organism called a *euglena* looks like. Organisms that are made of more than one cell are called *multicellular* organisms. You'll learn much more about cells in Chapters 4, 5, and 6.

A cell is the basic unit of a living system.

Figure 2.5: *A living system is affected by outside variables. What are the variables affecting the girl in the picture?*

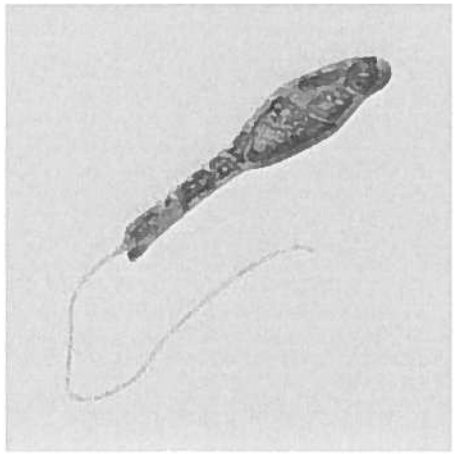


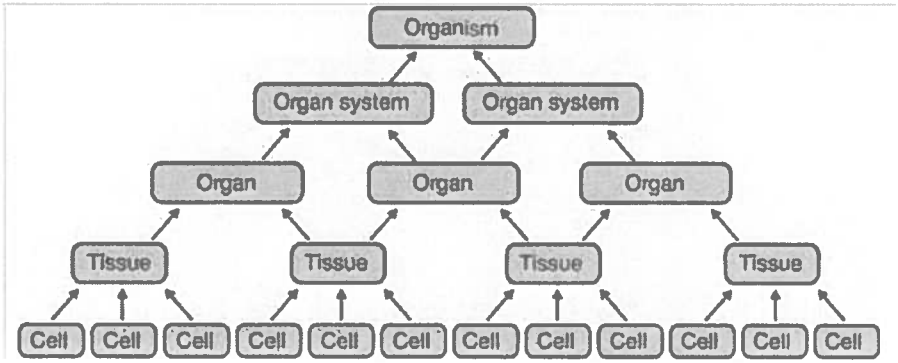
Figure 2.6: *A euglena is a one-celled organism.*

Tissues Your body is made up of many different types of cells. You have skin cells, muscle cells, liver cells, nerve cells, and blood cells, to name just a few. A group of specialized cells that performs a particular function is called a **tissue**. For example, muscle tissue is a tissue that is able to contract. Figure 2.7 shows what your muscle tissue looks like under a microscope.

Organs Tissues combine to form organs, the next level of organization. An **organ** is a group of tissues that works together to carry out a set of functions. For example, your stomach is an organ that contains several types of tissue. Muscle tissue in your stomach contracts to mix food. Another type of tissue makes a chemical that breaks down the food.

Organ systems A group of organs that works together to perform a set of functions is called an **organ system**. For example, your digestive system consists of many organs including the esophagus, stomach, small intestine, and large intestine. Each organ in the system performs a different function that is part of the digestive process.

Organism In multicellular organisms like you, different body parts and organ systems take on different functions. The network of organ systems works together to keep the organism alive. **An organism is an independently functioning living thing.**



VOCABULARY

tissue - a group of specialized cells that performs a particular function.

organ - a group of tissues that works together to carry out a set of functions.

organ system - a group of organs that works together to perform a set of functions.

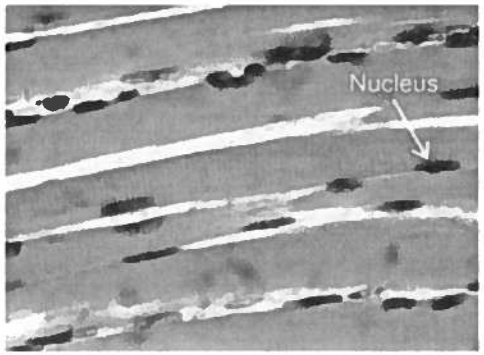


Figure 2.7: *Muscle tissue is made of individual muscle cells. Each individual cell has a dark spot called a nucleus.*

Variables and living systems

Homeostasis

Living things can respond to changes in their surroundings to maintain a steady internal environment. The process of maintaining a life-supporting system is called homeostasis. Homeostasis happens at all levels of organization, including the cellular level, and is a characteristic of all living things.

Variables that affect life

All sorts of variables affect an organism's ability to stay alive. These include temperature, food, water, and the level of oxygen (Figure 2.8). All organisms have built-in processes to help them survive when variables change. Organisms can survive within a range of values for each variable. If a change in a variable is too severe, the organism may not be able to maintain homeostasis and could die.

Why do we sweat and shiver?

You experience homeostasis every day, as you'll see in the following story. It was a hot day so Sarah decided to go for a swim in the neighborhood pool. She packed a towel and headed out on her bicycle. As Sarah climbed up a hill, she began to drip with sweat. She couldn't wait to jump into the pool! When she started to swim though, the water was so cold she couldn't stay in very long. Once Sarah got out of the water, she started shivering. The shivering stopped once she felt warm again.

Sweating and shivering are examples of homeostasis

Sweating and shivering are good examples of how your body responds to maintain a steady temperature. Normal human body temperature is 37°C (98.6°F). At this temperature, your cells can perform their functions. When it's too hot and your body temperature begins to rise, glands in your skin produce sweat to cool the temperature back down. When it's too cold and your body temperature begins to lower, shivering is a response that warms your body temperature back up (Figure 2.9).

VOCABULARY

homeostasis - the process of maintaining a life-supporting internal environment.

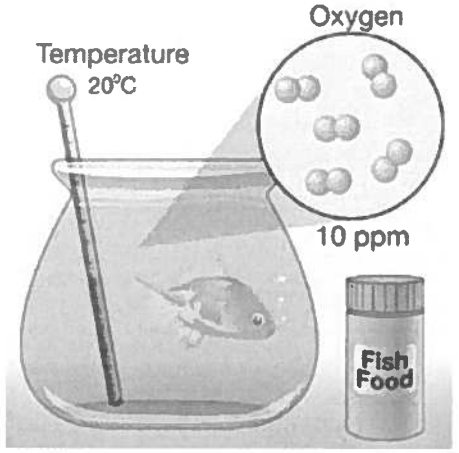


Figure 2.8: *A few of the variables that affect an organism's ability to stay alive.*

Figure 2.9: *Your normal body temperature is 37°C. Sweating and shivering are your body's way of maintaining that temperature.*

ASTRONOMY CONNECTION

Is There Proof of Life on Mars?

Do you think there is life on other planets? Not long ago, most people would have said "no." The search for life on other planets switched from science fiction to real science during the last century. The search for life elsewhere has followed on the heels of our greater understanding of the universe itself.

We now know that the universe is huge. It contains billions of galaxies. Because the universe is so big, the chances of life existing beyond Earth are very good.

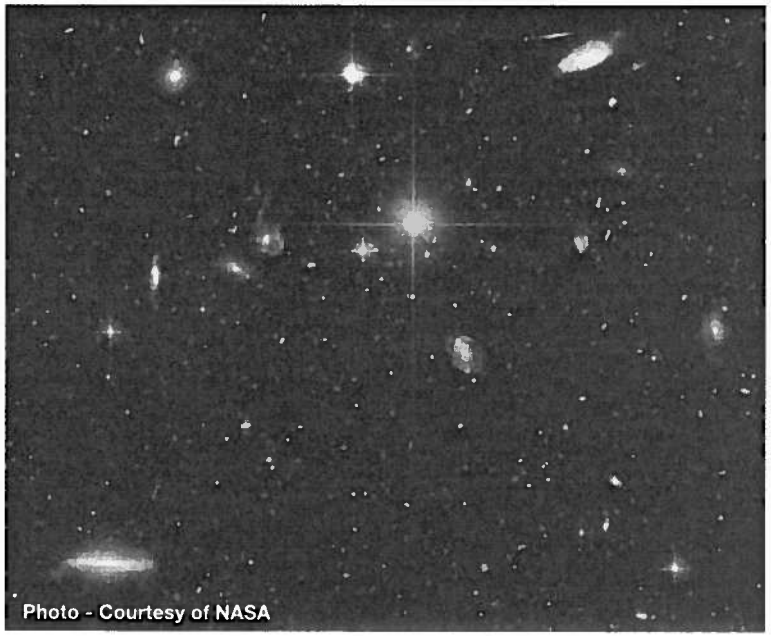


Photo - Courtesy of NASA

What do we mean by life when we talk about other parts of the universe? Definitions vary. We know that all living things on Earth are made of carbon compounds. We also know that all living things on Earth need water. Some scientists believe that if we find life elsewhere, it will have to be carbon-based. Other scientists think the universe is too vast to know this for sure. Our search for life beyond Earth starts with the search for evidence of water. If we find evidence of water, this suggests the existence of life.

Journeys to Mars

Our "near" neighbor Mars is the fourth planet from our sun. Mars is a little like our planet. It has long been the focus of our search for life beyond the Earth.

In the 1880s, better telescopes showed what seemed to be canals on Mars. Some even believed that people lived on Mars. These ideas lasted until the 1960s. At that point, improved techniques gave us a closer look at Mars. The "canals" were an optical illusion.

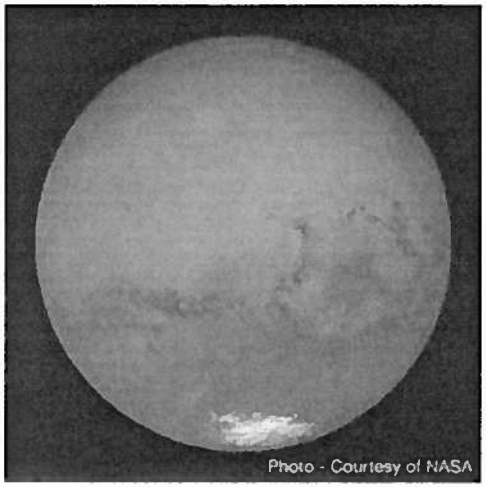


Photo - Courtesy of NASA

In 1976, the Viking mission landed on Mars. It found a thin atmosphere made mostly of carbon dioxide. Soil samples were tested. Viking found no signs of life or liquid water. Photos sent back revealed Mars as a barren place. Yet these images showed landforms that suggested liquid water might have existed on Mars long ago. Since then, scientists have tried to find out if Mars had water in the ancient past.

Proof from Earth?

In 1996, some scientists made a startling claim. They said that they had evidence suggesting that life existed on Mars more than 3 billion years ago. Perhaps most amazing of all, they found the evidence on Earth!

The evidence was found in a meteorite in Antarctica. You might wonder how can we know the meteorite came from Mars? Scientist discovered that the gases trapped in the meteorite match those found on Mars by Viking.

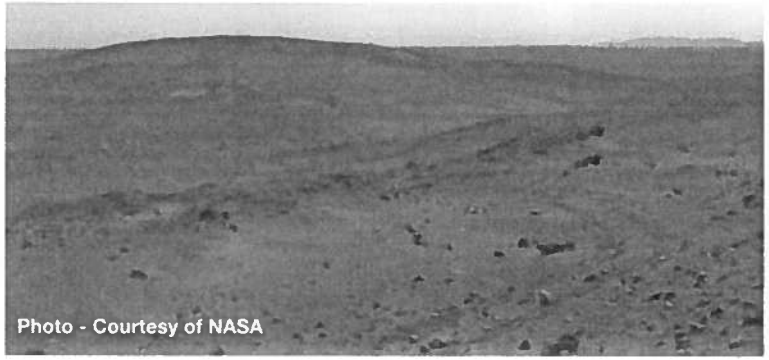
Here is what some scientists think may have happened. The rock was originally beneath the surface of Mars. About 3.6 billion years ago, meteorites hit Mars. The meteor impact cracked the rock. A liquid seeped into the cracks leaving mineral deposits behind. The deposits included carbon and iron compounds. These compounds are associated with some bacteria on Earth.

Then, about sixteen million years ago, an asteroid hit Mars. The rock was blasted into space. It finally fell to Earth in Antarctica about 13,000 years ago.

Scientists have studied the meteorite and found what might be fossils of ancient bacteria. Similar tiny bacteria have been found on Earth. These discoveries suggest that water once existed on Mars. This is just one conclusion from the evidence.

Other evidence

More evidence needs to be collected. Recent missions to Mars are looking for water. In 2003, the NASA rovers Spirit and Opportunity landed on Mars. They have sent back many amazing photographs.



Close-up images from Mars show textures that geologists recognize. Inside of some rocks, crystals form in salty water. Later the crystals dissolve. They leave marks on the rocks. Geologists see this on Earth. If the same process caused the textures on Mars, it would indicate the presents of water.

So far, we are not sure if water ever existed on Mars, much less if there are living things there now. Each new piece of evidence takes us a step closer to an answer.

Questions:

1. How likely is it that life exists in other parts of the universe? Why?
2. What possible evidence of liquid water on Mars did Viking find?
3. What evidence of possible life on Mars was found on the Earth? Explain.