

Domains and Kingdoms

Key Concept All organisms can be classified into three domains based on their shared derived characteristics.

What You Will Learn

- Classification systems change as greater numbers of different organisms are described.
- All prokaryotes are divided into one of two domains, domain Archaea or domain Bacteria.
- All eukaryotes are classified into the domain Eukarya, which is divided into four kingdoms.

Why It Matters

Learning about the characteristics of organisms in each domain and kingdom can help you recognize similarities and differences between organisms.

Vocabulary

- Archaea
- Bacteria
- Eukarya
- Protista
- Fungi
- Plantae
- Animalia

READING STRATEGY

Summarizing Read this section silently. In pairs, take turns summarizing the material. Stop to discuss ideas and words that seem confusing.

Archaea (ahr KEE uh) in a modern taxonomic system, a domain made up of prokaryotes that differ from other prokaryotes in the makeup of their cell walls and in their genetics



7.1.a Students know cells function similarly in all living organisms.

7.3.d Students know how to construct a simple branching diagram to classify living groups of organisms by shared derived characteristics and how to expand the diagram to include fossil organisms.

▶ For hundreds of years, all organisms were classified as either plants or animals. But over time, scientists discovered species that did not fit easily into these two kingdoms. For example, an organism of the genus *Euglena*, has characteristics of both plants and animals. How would you classify this organism?

Three Domains

Organisms are classified by their shared derived characteristics. *Euglena* are single-celled organisms that live in pond water. *Euglena* perform photosynthesis, move around, and can feed on other organisms. Therefore, *euglena* are neither plants nor animals. Scientists solved this classification problem by adding another kingdom, the kingdom Protista, for organisms such as *euglena*. However, scientists soon realized that new kingdoms could not solve some larger problems in classification.

As greater differences among organisms were discovered, scientists had to create a new level of classification, the level of domain. **Figure 1** shows the three domains in the eight-level classification system that is used today. Domains represent the largest differences among organisms. At each level of classification, organisms within a group are more like other organisms in the same group than organisms that belong to different groups. Therefore, organisms in each domain are more like each other than organisms in another domain. Domains are subdivided into kingdoms. Scientists are still working to describe the kingdoms in each of the three domains.

Standards Check What do scientists use to classify organisms today?



7.3.d

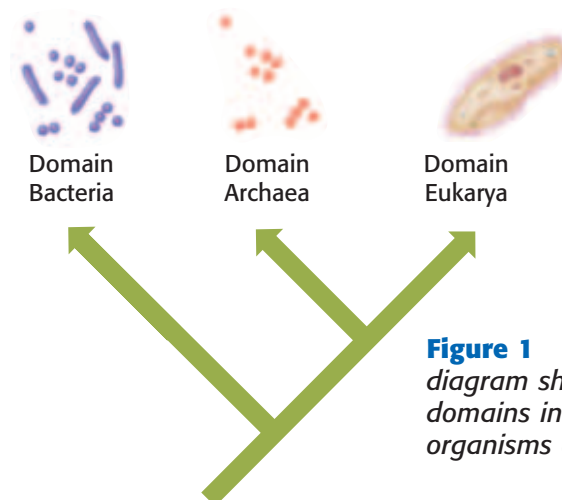


Figure 1 This branching diagram shows the three domains into which all organisms are classified.




Figure 2 *The Grand Prismatic Spring in Yellowstone National Park contains water that is about 90°C (194°F). The spring is home to archaea that thrive in its hot water.*

Domain Archaea

The domain **Archaea** is made up entirely of archaea. Archaea are one of two kinds of prokaryotes. *Prokaryotes* (proh KAR ee OHTS) are single-celled organisms that do not have a nucleus. Archaea were first discovered living in extreme environments, where other organisms could not survive. **Figure 2** shows a hot spring in Yellowstone National Park. The yellow and orange rings around the edge of the hot spring are made up of the billions of archaea that live there. Some archaea can also be found in more-moderate environments, such as the open ocean.

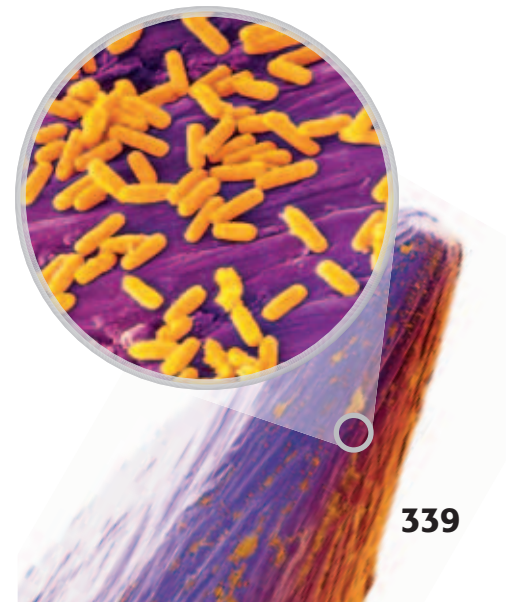
Domain Bacteria

All bacteria belong to the domain **Bacteria**. Bacteria are another kind of prokaryote. Bacteria can be found in the soil, in water, and even on and inside the human body! For example, *Escherichia coli* (ESH uh RIK ee uh KOH LIE), pictured in **Figure 3**, is present in large numbers in human intestines, where it produces vitamin K. One kind of bacterium converts milk into yogurt. Some bacteria cause diseases, such as pneumonia. Other bacteria make chemicals that help us fight disease-causing bacteria. Although bacteria and archaea are prokaryotes, differences in their characteristics allow them to live in very different kinds of environments.

Standards Check Describe one major difference between archaea and bacteria.  **7.1.a**

Bacteria (bak TIR ee uh) in a modern taxonomic system, a domain made up of prokaryotes that differ from other prokaryotes in the makeup of their cell walls and in their genetics

Figure 3 *Specimens of E. coli are shown on the point of a pin under a scanning electron microscope. These bacteria live in the intestines of animals and decompose undigested food.*



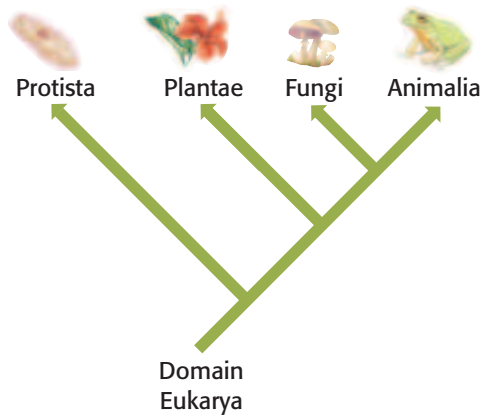


Figure 4 This branching diagram shows the four kingdoms in the domain Eukarya.


Eukarya (yoo KAR ee uh) in a modern taxonomic system, a domain made up of all eukaryotes

Figure 5 The slime mold on the left is a protist. The brightly colored fungus on the right is of the genus *Amanita* and is poisonous.



Domain Eukarya

All organisms whose cells have a nucleus and membrane-bound organelles are called *eukaryotes*. Eukaryotes belong to the domain **Eukarya**. The four kingdoms within the domain Eukarya are Protista, Fungi, Plantae, and Animalia, as **Figure 4** shows.

Standards Check Based on the branching diagram, what are the two kingdoms in Eukarya that evolved most recently?  7.3.d

Kingdom Protista

Members of the kingdom **Protista** commonly called *protists* (PROH tists), are single-celled or simple multicellular organisms. Scientists think that the first protists evolved from ancient bacteria about 2 billion years ago. Much later, ancient protists gave rise to fungi, plants, and animals. The kingdom Protista contains many kinds of organisms. Animal-like protists are called *protozoa*. Plantlike protists are called *algae*. Slime molds, such as the one shown in **Figure 5**, belong to the kingdom Protista.

Kingdom Fungi

Molds and mushrooms are examples of the complex, multicellular members of the kingdom **Fungi**. Unlike plants, fungi do not perform photosynthesis. Unlike animals, fungi do not eat food. Instead, fungi absorb nutrients from substances in their surroundings. They use digestive juices to break down the substances. **Figure 5** shows a very poisonous fungus. Never eat wild fungi.



Figure 6 Giant sequoias can be found in California. Giant sequoias can measure 30 m around at the base and can grow to more than 91.5 m tall.

MATH PRACTICE

Ring-Around-the-Sequoia

How many students would have to join hands to form a human chain around a giant sequoia that has a circumference of 30 m? Assume for this calculation that the average student can extend his or her arms about 1.3 m.

Kingdom Plantae

Although plants vary remarkably in size and form, most people easily recognize the members of the kingdom Plantae. **Plantae** consists of organisms that are eukaryotic, have cell walls, and make food through photosynthesis. For photosynthesis to occur, most plants need sunlight. Plants can therefore be found on land and in water that light can penetrate.

The food that plants make is important not only for the plants but also for all of the organisms that get nutrients from plants. Most life on Earth is dependent on plants. For example, some animals, fungi, protists, and bacteria consume plants. When these organisms digest the plant material, they get energy and nutrients made by the plants.

Plants also provide habitat for other organisms. The giant sequoias in **Figure 6** provide a home for birds, insects, and other animals.

Protista (proh TIST uh) a kingdom of mostly one-celled eukaryotic organisms that are different from plants, animals, bacteria, archaea, and fungi

Fungi (FUHN JIE) a kingdom made up of nongreen, eukaryotic organisms that have no means of movement, reproduce by using spores, and get food by breaking down substances in their surroundings and absorbing the nutrients

Plantae (PLAN tee) a kingdom made up of complex, multicellular organisms that are usually green, have cell walls made of cellulose, cannot move around, and use the sun's energy to make sugar by photosynthesis

Animalia (AN i MAY lee uh) a kingdom made up of complex, multicellular organisms that lack cell walls, can usually move around, and quickly respond to their environment

Kingdom Animalia

The kingdom **Animalia** contains complex, multicellular organisms that lack cell walls, are usually able to move around, and have specialized sense organs. These sense organs help most animals quickly respond to their environment. Organisms in the kingdom Animalia are commonly called *animals*. The bald eagle in **Figure 7** belongs to the kingdom Animalia.

Animals depend on the organisms from other kingdoms. For example, animals depend on plants for food. Animals also depend on bacteria and fungi to recycle the nutrients from dead organisms.

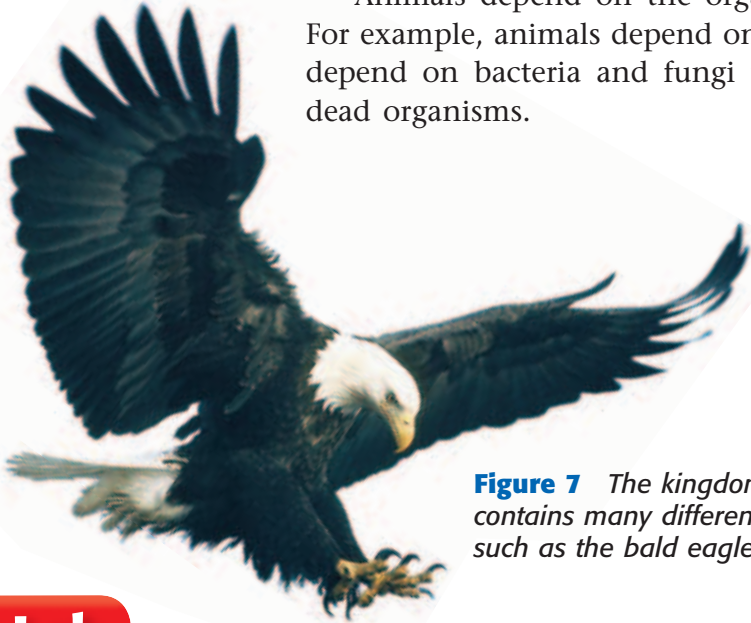


Figure 7 The kingdom *Animalia* contains many different organisms, such as the bald eagle.

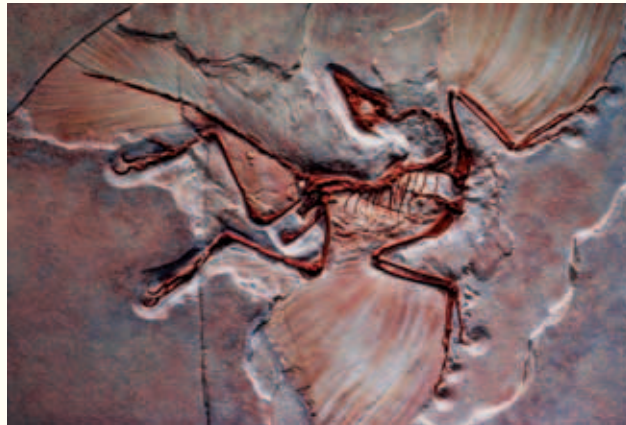
Quick Lab

Fossils and Branching Diagrams

Try this activity to learn how you can study a fossil and include it in a branching diagram with modern organisms.

▶ Try It!

1. The image on the right is a photo of a fossil of an organism called an archaeopteryx.
2. Create a simple list of characteristics that describe the archaeopteryx.
3. Construct a branching diagram of the animal kingdom. Include fish, amphibians, reptiles, birds, and apes in the branching diagram. (Hint: Among these organisms, fish evolved earliest. Amphibians formed the next group, and they were followed by reptiles and then birds. Among these organisms, apes are the most recent group.)
4. Consider the characteristics of each group of organisms. Decide where the archaeopteryx would fit in your branching diagram, and add it to your diagram.



7.3.d
7.7.d

▶ Think About It!

5. Using your branching diagram, how can you tell that the archaeopteryx is extinct?
6. Which kinds of organisms are more recent than the archaeopteryx? Which kinds of organisms evolved before the archaeopteryx?



15 min

Strange Organisms

Classifying organisms is often not easy. Like an animal, some plants can eat other organisms to obtain nutrition. Some protists can use photosynthesis as plants do and move around as animals do. The animal kingdom also includes some members that might surprise you, such as corals.

The red cup sponge in **Figure 8** is also an animal. Sponges are usually considered the simplest animals. They lack sense organs, and most of them cannot move. Scientists used to classify sponges as plants. But sponges cannot make their own food. They must eat other organisms to get nutrients, which is one reason that sponges are classified as animals.

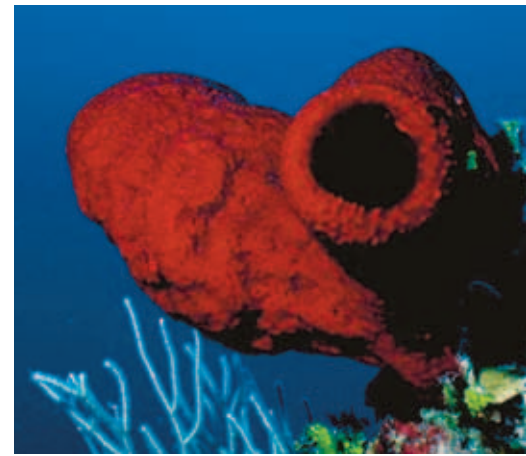


Figure 8 This red cup sponge is a simple animal.

SECTION Review



7.1.a, 7.3.d

Summary

- Most biologists recognize three domains: Archaea, Bacteria, and Eukarya.
- As scientists discover new organisms, classification systems are changed to include the characteristics of those new organisms.
- Archaea can live in extreme environments. Bacteria live almost everywhere else. All prokaryotes are members of the domain Archaea or the domain Bacteria.
- Domain Eukarya is made up of four kingdoms: Protista, Fungi, Plantae, and Animalia. All members of Eukarya are eukaryotes.

Using Vocabulary

- 1 Write an original definition for *Archaea* and *Bacteria*.

Understanding Concepts

- 2 **Identifying** Describe one characteristic of the domain Eukarya and one characteristic of each kingdom in the domain Eukarya.

Critical Thinking

- 3 **Applying Concepts** What do all of the organisms from the three domains have in common?
- 4 **Making Inferences** A branching diagram shows an unusual group of organisms on a branch between birds and mammals. What could you tell about when this unusual group of organisms evolved?
- 5 **Applying Concepts** You have discovered a new prokaryote. It lives deep within the crust of Earth, which is an extreme environment that has little air or food. Into which domain would you classify this organism? Explain.

Math Skills

- 6 **Making Calculations** If a certain bacterium divides every 30 min, when will there be more than 1,000 bacteria?

Challenge

- 7 **Identifying Relationships** Very hot water gushes out of formations on the sea floor called black smokers. Scientists have discovered many new kinds of organisms around black smokers. Why are scientists using a classification system to group these organisms?
- 8 **Applying Concepts** To get nutrients, the Venus' flytrap uses photosynthesis and traps and digests insects. Its cells have cell walls. Into which kingdom would you place this organism? What makes this organism unusual in this kingdom?

Internet Resources

For a variety of links related to this chapter, go to www.scilinks.org
Topic: **Kingdoms**
SciLinks code: **HY71397**