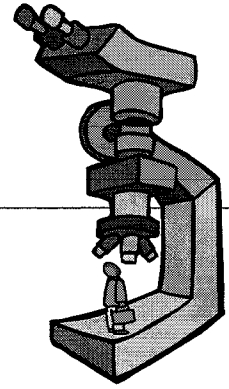


# Kingdom Classifications

## Section 15.1 The Six Kingdom System



### Pre-View 15.1

- **Six Kingdom System** – classification system that includes Animalia, Plantae, Fungi, Protista, Eubacteria, and Archaeobacteria
- **Archaeobacteria** – newest kingdom that includes organisms that look like bacteria but have different characteristics than “normal” bacteria
- **Eubacteria** – typical bacteria that were classified as Monera in the five kingdom system
- **Prokaryotic** – describes single-celled organisms that do not have a true nucleus
- **Eukaryotic** – describes cells that have a nucleus and other membrane-bound organelles
- **Autotrophic** – describes organisms that make their own food
- **Heterotrophic** – describes organisms that cannot make their own food

### The History of Kingdom Systems

When Aristotle first began to classify organisms, he divided them into two main kingdoms, plants and animals. You are probably most familiar with these two kingdoms. As scientists began using microscopes, they discovered microscopic organisms. They also discovered differences in cell structure between different organisms. They discovered that some organisms have characteristics that make it difficult to classify them as either plant or animal. Two kingdoms no longer worked, and eventually they decided on a **five kingdom system**: Animalia, Plantae, Fungi, Protista, and Monera.

### The Six Kingdom System

These five kingdoms were used for a while, and many people still think in terms of these five kingdoms. However, more recently, something else interesting happened. With the new technology that became available, scientists discovered that some bacteria have different gene sequences than any other organism living on earth. This discovery led to the formation of a new kingdom called the **archaeobacteria**, or “ancient bacteria.” In addition to having different gene sequences, these bacteria also have chemical specializations in their cell walls, and they live in the most extreme conditions. All other bacteria were placed in the kingdom **Eubacteria**. Today most scientists use a **six kingdom system** for classification: Animalia, Plantae, Fungi, Protista, Eubacteria, and Archaeobacteria. (Not to confuse the point, but some scientists classify the six kingdoms into three main “domains,” with a domain being a taxon above kingdom. As we continue to learn more and more, these classification systems may change again!)

### The Six Kingdoms

- **Archaeobacteria** (newest kingdom) – organisms that resemble bacteria but live in extreme conditions
- **Eubacteria** (known as the **Monera** kingdom in the five kingdom system) – typical bacteria
- **Protista** – examples are algae, protozoa, slime molds
- **Fungi** – examples are molds, mushrooms, yeasts
- **Plantae** – examples are mosses, ferns, grasses, vegetable plants, trees
- **Animalia** – examples are sponges, jellyfish, worms, snails, insects, fish, frogs, lizards, birds, kangaroos

## Section 15.1, continued

### The Six Kingdom System

Remember that a kingdom is the largest classification group. Organisms in each kingdom share many cellular characteristics. For example, are the organisms unicellular or multicellular? Are the organisms' cells **prokaryotic** (no membrane bound organelles) or **eukaryotic** (have membrane-bound organelles)? Do the cells have a cell wall? If so, what is it made of? Does the organism make its own food (**autotrophic**), or must it obtain food (**heterotrophic**)? Note that organisms that make their own food usually have chloroplasts in their cells, which enable them to carry out photosynthesis. Only a few types of organisms can make their own food without chloroplasts, and those are the ones that undergo chemosynthesis instead of photosynthesis. The chart below shows these main cellular characteristics for organisms in the six kingdoms.

Kingdom	Type of cells	Nucleus?	Cell Wall?	Makes Its Own Food?	Main Types of Reproduction
Archaeobacteria (or Archae)	Unicellular	No	Yes, but not made of peptidoglycan	Some do, mostly by chemosynthesis	binary fission, conjugation
Eubacteria (Monera)	Unicellular	No	Most do, usually made of peptidoglycan	Some do, mostly by photosynthesis	binary fission, conjugation
Protista	Unicellular or Multicellular	Yes	Some do, mostly made of cellulose	Some do by photosynthesis	binary fission, conjugation, mitosis, meiosis
Fungi	Unicellular or Multicellular	Yes	Yes, made of chitin and cellulose	No	fission, fragmentation, budding, spores (sexual and asexual)
Plantae	Multicellular	Yes	Yes, made of cellulose	Yes, by photosynthesis	vegetative propagation, sexual spores, pollination
Animalia	Multicellular	Yes	No	No	internal or external fertilization

### Practice 1

For each organism described, choose the **MOST** likely kingdom that the organism belongs to. Each kingdom will be used only once.

- |       |  |                    |
|-------|--|--------------------|
| _____ | 1. a prokaryotic, unicellular organism that may contain chloroplasts                                   | A. Archaeobacteria |
| _____ | 2. a eukaryotic, unicellular organism that may contain chloroplasts                                    | B. Eubacteria      |
| _____ | 3. a multicellular organism whose cells do not have a cell wall  | C. Protista        |
| _____ | 4. a multicellular organism that has a cell wall but does not make its own food                        | D. Fungi           |
| _____ | 5. a multicellular organism the makes its own food using photosynthesis                                | E. Plantae         |
| _____ | 6. a unicellular organism that lives in complete darkness deep on the ocean floor near a volcanic vent | F. Animalia        |

**Section 15.1, continued**  
**The Six Kingdom System**

**Practice 2**

Answer the following questions on the six kingdoms.

- (A) (B) (C) (D) 1. A unicellular organism that does not have a nucleus would belong in which kingdom?  
A. Eubacteria                  B. Fungi                  C. Plantae                  D. Protista
- (A) (B) (C) (D) 2. Steven observes cells from a multicellular organism. Each cell has a cell wall but does not contain chloroplasts. The organism MOST likely belongs to which kingdom?  
A. Archaeobacteria                  B. Fungi                  C. Plantae                  D. Animalia
- (A) (B) (C) (D) 3. Which of the following characteristics do plants and fungi have in common?  
A. They both have cell walls made of chitin.  
B. They both contain chloroplasts to make their own food.  
C. They both are made of cells containing nuclei.  
D. They can both be unicellular.
- (A) (B) (C) (D) 4. Which characteristic MOST clearly differentiates bacteria in the Eubacteria kingdom from unicellular protists?  
A. cell wall    C. ability to make their own food  
B. presence of a nucleus    D. ability to be seen with the naked eye
- (A) (B) (C) (D) 5. Which of the following characteristics BEST distinguishes animals from the other kingdoms?  
A. never have cell walls and never have the ability to make their own food  
B. have cells with a nucleus but never have chloroplasts  
C. are multicellular in structure and have cells with nuclei  
D. have cell walls made of cellulose and always have chloroplasts
- (A) (B) (C) (D) 6. The presence of which of the following is one main difference between plants and fungi?  
A. a cell wall    C. a multicellular organism  
B. a nucleus    D. chloroplasts
- (A) (B) (C) (D) 7. Single-celled organisms are found living in a volcanic hot spring where scientists did not expect to find any form of life at all. These organisms are MOST likely from which kingdom?  
A. Eubacteria                  B. Archaeobacteria                  C. Fungi                  D. Protista
- (A) (B) (C) (D) 8. Which kingdom contains organisms that ALWAYS make their own food?  
A. Eubacteria                  B. Protista                  C. Plantae                  D. Animalia
- (A) (B) (C) (D) 9. Jona observes cells under a microscope and determines that they must be either fungal cells or animal cells. How could he BEST determine their kingdom classification?  
A. the presence of a nucleus    C. the presence of cytoplasm  
B. the presence of chloroplasts    D. the presence of a cell wall
- (A) (B) (C) (D) 10. Hannah observes a single-celled organism under a microscope and notes that the cell does not have a cell wall. The organism is MOST likely which of the following?  
A. an animal                  B. a protist                  C. a fungus                  D. a plant

# Kingdom Classifications

## Section 15.2

### Kingdoms of Archaeobacteria and Eubacteria



#### Pre-View 15.2

- **Bacteria** – single-celled prokaryotic organisms
- **Prokaryote** – a single-celled organism that does not have a true nucleus
- **Archaeobacteria** – a type of bacteria that lives in extreme environments
- **Eubacteria** – common bacteria; single-celled, prokaryotic organisms
- **Monerans** – a generic term for all bacteria
- **Archae** – another name for archaeobacteria
- **Heterotroph (or consumer)** – an organism that cannot make its own food and must obtain food from another organism
- **Parasite** – an organism that gets food by feeding on another living organism
- **Autotroph (or producer)** – an organism that can make its own food
- **Saprotroph (or decomposer)** – an organism that feeds on dead or decaying organisms or organic wastes
- **Flagella** – a tail-like structure that is used by a cell for movement
- **Binary fission** – asexual reproduction used by bacteria
- **Conjugation** – a type of primitive sexual reproduction used by bacteria to exchange genetic information
- **Endospore** – a dormant stage formed by some bacteria to survive harsh environmental conditions

## Bacteria

Organisms that are single-celled **prokaryotes** are called **bacteria**. Remember that prokaryotes do not have a true nucleus or any other membrane-bound organelles. Bacteria are the most widespread and most numerous organisms on the earth.

Bacteria are split into two kingdoms, **Kingdom Archaeobacteria** and **Kingdom Eubacteria**. Before being split into two different kingdoms, all bacteria were called **monerans**, and they were classified into a Kingdom Monera. Both types of bacteria can be found growing in weird places, but *most* of the bacteria that grow in “extreme” environments are archaeobacteria. (Some eubacteria are also found in extreme environments.)

How are archaeobacteria and eubacteria different? Some argue that archaeobacteria are so different from eubacteria that they shouldn’t even be called bacteria. For that reason, they are sometimes referred to simply as **archae**. Both kingdoms of bacteria have a cell wall (at least most do), but the composition of their cell walls and plasma membranes are different. The genes found in archaeobacteria are also very different from those found in eubacteria. The genes are actually more similar to eukaryotes (cells with a nucleus). Let’s take a closer look at each of these kingdoms.

## Kingdom Archaeobacteria

Archaeobacteria live in harsh environments and in some strange places — hot sulfur springs, volcanic deep-sea vents on the ocean floor, the Great Salt Lake, and even the intestines of mammals. Some love heat, some love extreme pH levels (acidic or basic), and some love salt. Even though they live in a wide variety of habitats, their relationship to each other is shown in their ribosomal RNA sequencing. (The gene sequences are a major difference between archaeobacteria and eubacteria.)

## Section 15.2, continued

### Kingdoms of Archaeobacteria and Eubacteria

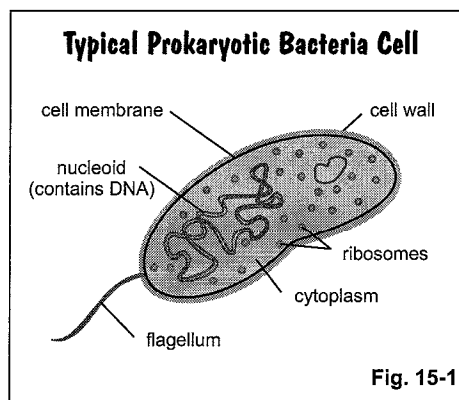
One type of archaeobacteria lives deep in the Pacific Ocean near cracks in the ocean floor. These are anaerobic **autotrophs** that are the first step in a very special food chain. (Autotrophs are also called **producers**; they make their own food, and they are food for other organisms.) Instead of using photosynthesis to make their own food, they use chemosynthesis. As you probably remember, **chemosynthesis** uses chemical energy instead of light energy to convert carbon dioxide to carbohydrates. All processes are anaerobic since there is very little oxygen available at those depths.

Many of the archaeobacteria are autotrophic and use chemosynthesis to make their own food, but not all do. Some are autotrophic and use photosynthesis, and still others are heterotrophic and must obtain food instead of making it themselves.

### Kingdom Eubacteria

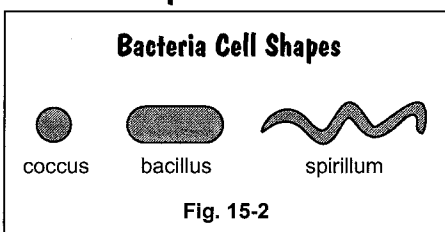
The bacteria that you are more familiar with are the **eubacteria**, which are usually classified according to shape and their reaction to a process called Gram staining. A typical bacteria cell is shown in figure 15-1.

Eubacteria are very diverse. They can be **heterotrophs** (consumers) that must eat other organisms as a food source. Some are **parasites** that get the nutrients they need by feeding on other living organisms. Others are **autotrophs**, which produce their own food. Some autotrophic eubacteria contain chloroplasts and use photosynthesis; others use chemosynthesis. (The archaeobacteria are not the only bacteria that use chemosynthesis.) And finally, some are **saprotrophs** and get nutrients by decomposing dead organisms or organic wastes. That's a lot of variety!



Many bacteria have one or more **flagella** that are used for locomotion. The bacterial flagellum works like a propeller on a motorboat. It rotates to propel the bacterium cell forward. About half of the known bacteria use flagella to move around. The other half are unable to propel themselves.

### Bacteria Shapes



Bacteria cells generally have one of three shapes: coccus, bacillus, or spirillum (figure 15-2). The prokaryotic cell shown in figure 15-1 is bacillus, or rod-shaped. Regardless of the shape, bacteria cells have the same prokaryotic characteristics. Bacteria are named depending on their shape and cell arrangement. For example, *Streptococcus pneumoniae*, the bacteria that causes pneumonia, has a coccus shape, and the cells arrange themselves in a straight line.

### Bacteria Reproduction

Both archaeobacteria and eubacteria have DNA in their cytoplasm, which may be a single loop. To reproduce, the bacteria cell will replicate its strand of DNA, double its cell size, and then divide in half. As you may remember, this type of asexual reproduction is called **binary fission**. Binary fission produces two genetically identical bacteria cells. Using this method of reproduction, bacteria can reproduce very quickly.

To increase genetic diversity, one bacterium can also exchange genetic material with another bacterium using a primitive form of sexual reproduction called **conjugation**. During conjugation, two bacteria create a hollow bridge between them. Genes can then move across the bridge from one bacterium to the other.

Some types of bacteria, when exposed to extreme conditions, will form **endospores**. Endospores are a dormant stage that can survive harsh conditions, such as high temperatures, toxic chemicals, and drought. When conditions become favorable, the bacterium will again emerge from the endospore.

## Section 15.2, continued

### Kingdoms of Archaeobacteria and Eubacteria

#### Bacteria Pros and Cons

When most people think about bacteria, they think about “germs” that cause disease and infection, but most bacteria are important and beneficial:

- **Nitrogen-fixing bacteria** are an important part of the nitrogen cycle. They live in the roots of certain plants, and they are an example of eubacteria that undergo chemosynthesis. These and other chemosynthetic autotrophs not only make organic molecules for food, but they also do so by breaking down inorganic compounds that contain nitrogen and sulfur.
- Some bacteria live in the soil and help to break down and recycle organic and inorganic materials. These important bacteria are called saprotrophs, or decomposers.
- **Cyanobacteria** are photosynthetic bacteria that live in the water. They produce a great deal of the oxygen that is released into the atmosphere.
- Many foods, such as pickles, yogurt, sauerkraut, and Swiss cheese, depend on bacteria for their distinctive odors and flavors.
- Certain kinds of bacteria are used to make **antibiotics**, such as neomycin and erythromycin, which are used to destroy other bacteria.
- Bacteria called **probiotics** are important for human health. They live in the intestines and produce certain vitamins, enhance the absorption of nutrients, and strengthen the immune system.

Of course, many bacteria do cause diseases. Some bacteria that form endospores can cause botulism or tetanus. Others cause Lyme disease, strep throat, and cavities in your teeth.

#### Practice 1

Match each of the following terms with its definition.

- |       |                    |  |
|-------|--------------------|--|
| _____ | 1. eubacteria      | A. organism that makes its own food                                    |
| _____ | 2. archaeobacteria | B. the type of asexual reproduction used by bacteria                   |
| _____ | 3. autotroph       | C. kingdom of bacteria that live in extreme environments               |
| _____ | 4. heterotroph     | D. organism that cannot make its own food                              |
| _____ | 5. saprotroph      | E. a primitive type of sexual reproduction used by some bacteria       |
| _____ | 6. flagellum       | F. a dormant stage formed by some bacteria to survive harsh conditions |
| _____ | 7. conjugation     | G. kingdom of “common” bacteria  |
| _____ | 8. binary fission  | H. a tail-like structure used by some bacteria for movement            |
| _____ | 9. parasite        | I. organism that feeds on another living organism                      |
| _____ | 10. endospore      | J. organism that decomposes dead organisms or organic wastes           |

**Section 15.2, continued**  
**Kingdoms of Archaeobacteria and Eubacteria**

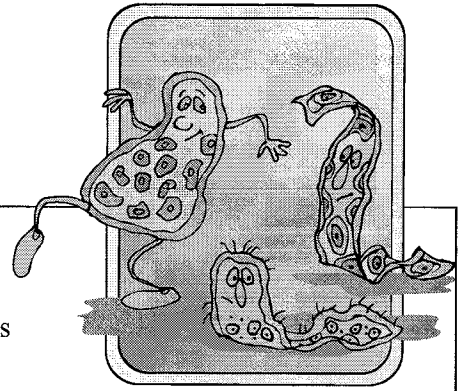
**Practice 2**

Answer the following questions about bacteria.

- (A) (B) (C) (D) 1. If a bacterium cell can move around in its environment, it probably has which structure?
- A. many cilia  
B. a true nucleus  
C. one or more flagella  
D. chloroplasts
- (A) (B) (C) (D) 2. A single-celled organism is observed under the microscope. One flagellum can be clearly seen. Which characteristic would help confirm that the cell is a bacterial cell?
- A. ribosomes found in the cytoplasm  
B. presence of a cell membrane  
C. presence of a cell wall  
D. DNA found in the cytoplasm
- (A) (B) (C) (D) 3. Which of the following is a true statement about bacteria?
- A. Some bacteria are parasitic, but all others are saprotrophs.  
B. All bacteria can make their own food, but some also feed on other organisms.  
C. No bacteria can make their own food.  
D. Some bacteria can make their own food, and others cannot.
- (A) (B) (C) (D) 4. Bacteria are found near volcanic vents deep on the ocean floor where there is little oxygen and no light. Which of the following is MOST likely true about this bacteria?
- A. They are archaeobacteria that produce food by chemosynthesis.  
B. They are archaeobacteria that produce food by photosynthesis.  
C. They are eubacteria that are parasitic.  
D. They are eubacteria that are saprotrophs.
- (A) (B) (C) (D) 5. Which of these bacteria are NOT autotrophs?
- A. cyanobacteria  
B. nitrogen-fixing bacteria  
C. parasitic eubacteria  
D. chemosynthetic archaeobacteria
- (A) (B) (C) (D) 6. Which of the following is a benefit of bacteria?
- A. They break down and recycle inorganic materials.  
B. They form endospores that cause botulism.  
C. They are parasitic organisms.  
D. They have no true nucleus.
- (A) (B) (C) (D) 7. Which of the following is NOT a disease caused by harmful bacteria?
- A. botulism  
B. influenza  
C. tetanus  
D. Lyme disease
- (A) (B) (C) (D) 8. Which of the following characteristics cause bacteria to be split into two kingdoms?
- A. Archaeobacteria and eubacteria live in very different environments.  
B. Archaeobacteria and eubacteria have different cell walls and genes.  
C. Archaeobacteria and eubacteria obtain or create food in different ways.  
D. Archaeobacteria and eubacteria have different shapes.
- (A) (B) (C) (D) 9. By which process can bacteria exchange genetic information?
- A. photosynthesis  
B. endospore formation  
C. conjugation  
D. binary fission

# Kingdom Classifications

## Section 15.3 Kingdom Protista



### Pre-View 15.3

- **Protist** – eukaryotic organisms that don't fit into any of the other kingdoms; can be unicellular or multicellular, autotrophs or heterotrophs
- **Eukaryote** – an organism with cells that contain a nucleus or other membrane-enclosed organelles
- **Protozoa** – single-celled animal-like protists; examples: paramecium and amoeba
- **Algae** – a plantlike protist that contains chlorophyll and undergoes photosynthesis
- **Euglena** – a single-celled algae that lives in fresh water
- **Diatom** – a single-celled algae that has a glasslike outer shell

**Kingdom Protista** is sometimes called the “catch-all kingdom” because it contains so many organisms that don't fit into the other kingdoms. Protists are a very diverse group; there is no such thing as a typical protist! They can be unicellular or multicellular. They can be microscopic or large enough to be seen with the naked eye. Some are autotrophs, and some are heterotrophs. They are alike in that all of them are **eukaryotes**; they have cells that contain a nucleus and other membrane-bound organelles.

### Animal-Like Protists

Many protists are somewhat animal-like. They are called **protozoans** and are single-celled. All animal-like protists are heterotrophs. They eat bacteria, algae, and smaller protists.

These animal-like protists are further classified according to how they move.

- The **ciliates** have hairlike projections called cilia that act like oars to help them move. The **paramecium** is a common ciliate that lives in freshwater ponds. See figure 15-3.
- **Flagellates** have one or more flagella to help them move. Several flagellates are parasites that cause disease in humans.
- **Amoebas** are irregularly shaped “blobs” that move by changing the shape of their cell to form **pseudopods**. Amoebas can be found living in fresh water, salt water, wet soil, and even in animals. See figure 15-4. Some also cause disease in humans.
- **Sporozoans** are parasitic protists that live in a host organism. Sporozoans cannot move on their own for most of their life cycle.

Some protozoans and other protists have an organelle called a **contractile vacuole** that pumps excess water out of the cell. This contractile vacuole is important because single-celled organisms, such as paramecia, live in fresh water, which is hypotonic to the cell. Water enters the cell by **osmosis**, and the contractile vacuole pumps the water back out so that the cell does not swell and burst. (Review Section 7.3 on osmosis if needed.)

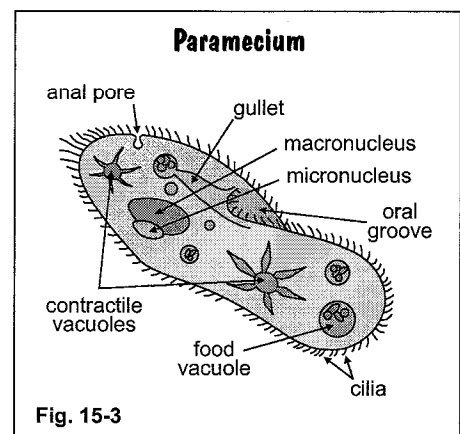


Fig. 15-3

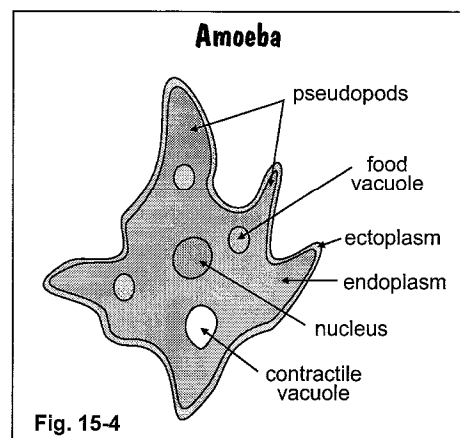


Fig. 15-4



## Section 15.3, continued

### Kingdom Protista

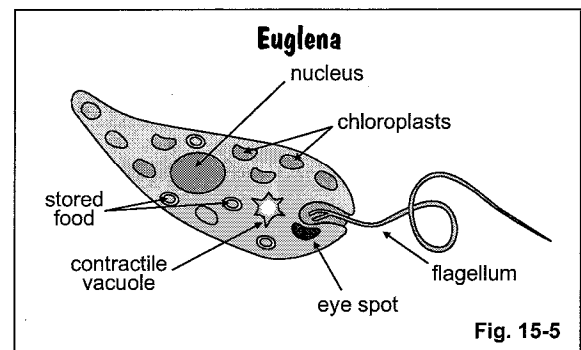
Protozoans can reproduce in a variety of ways:

- Most reproduce asexually by binary fission. Amoebas and most flagellates, for example, reproduce by binary fission.
- Some protozoans can also divide into multiple, identical protozoan cells by a process sometimes called multiple fission.
- Ciliates, such as the paramecium, can often reproduce sexually by conjugation. The process of conjugation is a little more complex than conjugation in bacteria, but the result is the same — an exchange of genetic material between two organisms.
- Still other protozoans, especially parasitic sporozoans, reproduce both asexually and sexually during their lifetimes, and some have complex reproductive cycles. For example in one host, a sporozoan may reproduce asexually by binary fission, and in the next host, it may use the process of meiosis to produce gametes similar to egg and sperm. These gametes will fuse when the life cycle is repeated.

### Plantlike Protists

Other protists are much more plantlike. They are autotrophs and contain chlorophyll, so they can carry out photosynthesis. These protists are called **algae** (singular is alga). Algae do not have roots, stems, leaves, or flowers like plants. Because many types of algae contain pigments other than chlorophyll, they may appear red, brown, or even a golden color. Algae are classified according to their color and structure. They range in size from microscopic, single-celled organisms to multicellular organisms measuring meters long. Types of algae include euglenoids, golden algae, green algae, brown algae, and red algae.

- **Euglena** are unicellular algae that live in fresh water and can move around by using a single flagellum. Euglena contain chloroplasts. If light is present, they make their own food by photosynthesis. If they do not have light, they will eat bacteria and smaller protists. Figure 15-5 shows a diagram of a euglena with its organelles labeled.
- **Diatoms** are unicellular algae that have glasslike outer shells. When the diatom dies, the glasslike material collects at the bottom of the ocean and is called **diatomaceous earth**.



Unicellular plantlike protists usually reproduce by binary fission. Some also reproduce asexually by forming spores that move using a flagellum. These spores are called zoospores. One exception are the diatoms. Diatoms reproduce asexually for several generations, but then they undergo a sexual stage in which they form gametes by meiosis. The gametes fuse to form a zygote, and the life cycle begins again.

Multicellular plantlike protists, such as several types of brown, green, and red algae, often reproduce both asexually and sexually. Many have life cycles that use alternation of generations. One stage of life will reproduce asexually, and the next stage will reproduce sexually.

### Funguslike Protists

The remaining group of protists are similar to fungi. The funguslike protists decompose dead organisms. They are able to move from place to place for at least part of their life cycle. These protists include the slime molds, downy mildews, and water molds. Many are very colorful. Funguslike protists reproduce in complex life cycles that often include both asexual and sexual stages.

Don't confuse funguslike protists with the next kingdom we will review, Kingdom Fungi, which contains bread molds, yeasts, and mushrooms, which are immobile.

## Section 15.3, continued

### Kingdom Protista

#### Pros and Cons of Protists

As with most organisms, some protists are beneficial and others are harmful. The plantlike protists tend to be beneficial.

- Algae, the plantlike protists, are important food sources for many types of animals. They are also important in producing much of the world's atmospheric oxygen.
- Algae or substances that are made from algae are found all around the home. Items, such as brownie and cake mix, ice cream, pudding, mayonnaise, toothpaste, salad dressing, cosmetics, vitamins, and paint, may contain algae ingredients.
- Diatomaceous earth, which is left behind by a type of algae, is used as an abrasive in toothpaste and cleaners and also as a filtering agent for liquids. It is even used as a non-toxic insecticide.

Several animal-like protists cause disease.

- The protist *Giardia* is an animal-like flagellate that causes intestinal illness in humans.
- Sporozoans are parasites. The sporozoan *Plasmodium vivax* causes malaria and is transmitted by the female mosquito of a certain species.

#### Practice 1

Match each definition with the term it BEST describes. Each term will be used only once.

- |       |  |                        |
|-------|--|------------------------|
| _____ | 1. a temporary projection used by protists like the amoeba for movement                  | A. protists            |
| _____ | 2. an irregularly shaped protozoan that is found in many environments                    | B. protozoans          |
| _____ | 3. eukaryotic organisms that don't fit into any other kingdom                            | C. ciliates            |
| _____ | 4. term for all plantlike protists   | D. pseudopod           |
| _____ | 5. term for all animal-like protists   | E. paramecium          |
| _____ | 6. a type of parasitic protozoan   | F. amoeba              |
| _____ | 7. a type of algae that is unicellular and moves by using a flagellum                    | G. sporozoan           |
| _____ | 8. a type of algae that is unicellular and has a glasslike outer shell                   | H. contractile vacuole |
| _____ | 9. an organelle found in some protists that pumps out extra water                        | I. algae               |
| _____ | 10. a type of funguslike protist   | J. euglena             |
| _____ | 11. a general term for animal-like protists that move by using tiny hairlike projections | K. diatom              |
| _____ | 12. a common type of ciliate that lives in freshwater ponds                              | L. slime mold          |

**Section 15.3, continued**  
**Kingdom Protista**

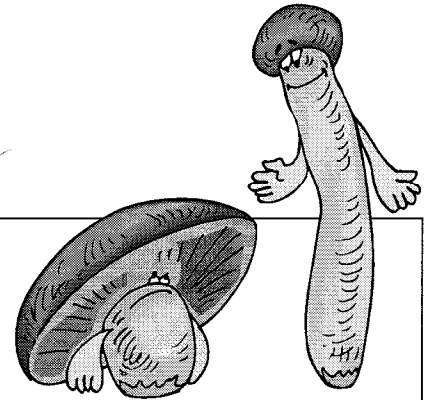
**Practice 2**

Answer the following questions on the Kingdom Protista.

- (A) (B) (C) (D) 1. What one characteristic do all members of the Kingdom Protista share?
- A. All reproduce sexually.
  - B. All are multicellular.
  - C. All are made of eukaryotic cells.
  - D. All are heterotrophs.
- (A) (B) (C) (D) 2. Which of the following protists use pseudopods to move?
- A. euglena
  - B. amoeba
  - C. paramecium
  - D. *Plasmodium vivax*
- (A) (B) (C) (D) 3. How do funguslike protists differ from true fungi?
- A. Funguslike protists make their own food.
  - B. Funguslike protists do not contain chlorophyll.
  - C. Funguslike protists decompose dead organisms.
  - D. Funguslike protists can move about from place to place.
- (A) (B) (C) (D) 4. *Euglena* is a single-celled plantlike protist that has contractile vacuoles. What would likely happen if the *Euglena* did not have the contractile vacuoles?
- A. It would expand with water and burst.
  - B. It would lose water and shrink.
  - C. It would starve from lack of food.
  - D. It would have no mode of transportation.
- (A) (B) (C) (D) 5. Which of the following would NOT be found in the Kingdom Protista?
- A. amoeba
  - B. diatoms
  - C. algae
  - D. bread mold
- (A) (B) (C) (D) 6. Which of the following structures do paramecium use to move?
- A. flagella
  - B. cilia
  - C. pseudopods
  - D. roots
- (A) (B) (C) (D) 7. Green algae have a complex life cycle that includes both haploid and diploid forms of the organism. Green algae is an example of which type of reproduction?
- A. alternation of generations
  - B. conjugation
  - C. binary fission
  - D. fragmentation
- (A) (B) (C) (D) 8. *Spirogyra*, a type of green algae, can break into small pieces. Each small piece can then grow into a new organism. What type of reproduction does *Spirogyra* undergo in this situation?
- A. alternation of generations
  - B. conjugation
  - C. binary fission
  - D. fragmentation

# Kingdom Classifications

## Section 15.4 Kingdom Fungi



### Pre-View 15.4

- **Fungus** – a eukaryotic organism that has a cell wall usually made of chitin, is usually multicellular, and is always a consumer (heterotroph) or a decomposer (saprotroph)
- **Consumer** – an organism that must obtain food from another organism; a heterotroph
- **Chitin** – a complex carbohydrate that makes up the cell walls of most fungi cells
- **Hyphae** – threadlike structures used by fungi to break down and absorb food
- **Basidiospores** – mushroom spores formed by meiosis
- **Sporangium** – a specialized type of hypha used by certain molds that produce spores asexually
- **Zygospor** – a spore formed by sexual reproduction in certain molds
- **Saprotroph** – an organism that feeds on dead or decaying organisms; a decomposer
- **Lichen** – an “organism” made up of a fungus and an alga living together in a mutualistic relationship
- **Rusts and smuts** – types of fungi that cause plant diseases

If you look hard enough, you can find fungi just about everywhere. Fungi like to grow anywhere that has moisture — on the walls of basements and bathrooms, in yards and gardens, and even on people’s feet. Most fungi are multicellular although there are a few single-celled fungi, such as yeasts.

### The Roles of Fungi

Fungi used to be classified as plants, but they do not contain chlorophyll, and therefore, they can’t undergo photosynthesis. Plants are called **producers** (autotrophs) because they make their own food and provide food for other organisms. Fungi, on the other hand, are either **consumers** (heterotrophs) or decomposers (saprotrophs). Either way, they obtain their food from another organism. A fungus gets nutrients by something called *extracellular digestion*. They are heterotrophs that send out threadlike structures called **hyphae** into their source of food. The hyphae release enzymes that break down the large food molecules into molecules small enough to diffuse directly into the hyphae. Unlike plants, which have cell walls made of cellulose, most fungi have cell walls made out of a complex carbohydrate called **chitin**.

### Fungi Reproduction

Some fungi reproduce sexually, some asexually, and some both sexually and asexually. Examples of fungi reproduction are given below:

- Yeasts reproduce asexually by budding or by fission. In **budding**, a new yeast organism grows from a parent organism and eventually breaks off to form a new yeast cell. In **fission**, the yeast splits in half to form two yeast cells.
- Most mushrooms reproduce sexually by forming spores called **basidiospores**. These spores are produced in the cap of the mushroom. The spores, produced by meiosis, are haploid, and two compatible spores must germinate and fuse in order to produce a new mushroom.

## Section 15.4, continued

### Kingdom Fungi

- Bread molds and many other fungi can produce sexually or asexually. Bread molds can produce asexual spores in a specialized hypha called a **sporangium**. The sporangium releases the spores, and the spores can germinate and grow hyphae and additional sporangia. Bread molds can also reproduce sexually when environmental conditions become unfavorable. Two compatible mating strains of hyphae fuse together to form a **zygospore**. The zygospore has a thick wall and can remain dormant until conditions are favorable for germination.

### Pros and Cons of Fungi

Many fungi are beneficial.

- Some fungi, such as mushrooms, are **saprotrophs**, which means they feed on dead organic matter. In the environment, fungi play an important role as **decomposers**, organisms that break down dead organisms and waste material.
- Many people like to eat mushrooms (although some mushrooms are poisonous).
- Yeast cells are added to bread dough to make it rise.
- A certain species of the *Penicillium* mold is used to make the antibiotic penicillin.
- Still other molds are used in making cheeses.
- The **lichens** that you see growing on rocks and trees are actually two organisms made up of a fungus and usually a green alga that have formed a mutualistic relationship so that both organisms benefit by living closely together. Lichens are important to the environment because they break down rocks into soil so that plants can grow. They also enrich the soil with nutrients when they themselves die and decompose.

Other fungi are harmful.

- Fungi that cause plant diseases are called **rusts** and **smuts**. They destroy large amounts of timber and crops each year.
- Some fungi produce spores that can be fatal if inhaled by humans.
- Others fungi, like the ones that cause ringworm and athlete's foot in humans, are parasites and absorb nutrients directly from the cells of the host organism on which they live.

### Practice 1

Match each definition with the term it BEST describes.

- |       |   |                 |
|-------|---|-----------------|
| _____ | 1. threadlike structures used by fungi to break down and absorb food    | A. fungus       |
| _____ | 2. a spore formed by sexual reproduction                                | B. chitin       |
| _____ | 3. a complex carbohydrate that makes up fungi cell walls                | C. hyphae       |
| _____ | 4. a symbiotic organism made up of a fungus and an alga                 | D. basidiospore |
| _____ | 5. a type of hypha that produces asexual spores                         | E. sporangium   |
| _____ | 6. mushroom spores formed by meiosis                                    | F. zygospore    |
| _____ | 7. an organism that feeds on dead or decaying organic matter            | G. saprotroph   |
| _____ | 8. eukaryotic organism that has a cell wall and is always heterotrophic | H. lichen       |

**Section 15.4, continued**  
**Kingdom Fungi**

**Practice 2**

Answer the following questions on Kingdom Fungi.

- (A) (B) (C) (D) 1. Which of the following is NOT a type of fungus?  
A. rusts                                      B. algae                                      C. mushrooms                                      D. yeast
- (A) (B) (C) (D) 2. Fungi have filaments that absorb nutrients. What are these filaments called?  
A. rust                                      B. spores                                      C. hyphae                                      D. enzymes
- (A) (B) (C) (D) 3. The process used by fungi to break down food is called what?  
A. absorption                                      C. intracellular digestion  
B. extraction                                      D. extracellular digestion
- (A) (B) (C) (D) 4. Lichens are formed by a relationship between a fungus and which other type of organism?  
A. a protozoan                                      C. an alga  
B. an archaebacterium                                      D. another fungus
- (A) (B) (C) (D) 5. Which of these is NOT a way that some fungi obtain nutrients?  
A. They make their own food through photosynthesis.  
B. They decompose dead organisms or waste materials.  
C. They live as parasites on a host organism.  
D. They form a mutualistic relationship with green algae.
- (A) (B) (C) (D) 6. When does bread mold form sexual spores?  
A. when moisture is present                                      C. when conditions become favorable  
B. when conditions become unfavorable                                      D. never
- (A) (B) (C) (D) 7. Which of the following correctly describes the sexual spores produced by mushrooms?  
A. haploid                                      B. bipolar                                      C. diploid                                      D. sporangia
- (A) (B) (C) (D) 8. In what specialized structure do fungi such as bread molds form asexual spores?  
A. basidia                                      B. zygosporangium                                      C. sporangium                                      D. saprotroph
- (A) (B) (C) (D) 9. Which of the following is a characteristic that makes fungi different from plants?  
A. Fungi do not have chlorophyll.                                      C. Fungi cannot grow in soil.  
B. Fungi do not have cell walls.                                      D. Fungi are multicellular.
- (A) (B) (C) (D) 10. Yeast and green algae are both unicellular organisms. Which of the following characteristics would both organisms have in common?  
A. Both have cell walls made of chitin.  
B. Both make their own food through the process of photosynthesis.  
C. Both can move around with the use of cilia.  
D. Both have a nucleus.

# Kingdom Classifications

## Section 15 Review

Answer the following questions on kingdom classifications.

The characteristics of four different organisms are listed in the table below.

Organism	Cell Type	Contains Chlorophyll?	Reproduction	Mode of Movement
1	prokaryotic, unicellular	no	binary fission, conjugation	one flagella
2	eukaryotic, multicellular	no	sexual and asexual: produces spores	none
3	eukaryotic, unicellular	yes	binary fission, conjugation	two flagella
4	eukaryotic, multicellular	yes	sexual: pollination	none

1. Based on the characteristics given, organism 1 should be classified in which kingdom?

- A Eubacteria
- B Protista
- C Fungi
- D Animalia

(A) (B) (C) (D)

3. Based on the characteristics given, organism 3 should be classified in which kingdom?

- A Archaeobacteria
- B Protista
- C Fungi
- D Plantae

(A) (B) (C) (D)

2. Based on the characteristics given, organism 2 should be classified in which kingdom?

- F Eubacteria
- G Protista
- H Fungi
- J Animalia

(F) (G) (H) (J)

4. Based on the characteristics given, organism 4 should be classified in which kingdom?

- F Eubacteria
- G Protista
- H Fungi
- J Plantae

(F) (G) (H) (J)

**Section 15 Review, continued**

**5. An organism that can make its own food and that has cells with cell walls made of cellulose would be in which kingdom?**

- A** Eubacteria
- B** Fungi
- C** Plantae
- D** Animalia

(A) (B) (C) (D)

**9. Which characteristic most clearly differentiates bacteria from a unicellular protist like an amoeba?**

- A** the ability to carry out photosynthesis
- B** the absence of a nucleus
- C** the composition of the cytoplasm
- D** the ability to move

(A) (B) (C) (D)

**6. A heterotroph with a cell wall made of chitin would be in which kingdom?**

- F** Archaeobacteria
- G** Protista
- H** Fungi
- J** Plantae

(F) (G) (H) (J)

**10. Why are bacteria sometimes called nature's recyclers?**

- F** They undergo conjugation.
- G** They break down nutrients in dead matter.
- H** They can switch between respiration and fermentation.
- J** They carry out photosynthesis.

(F) (G) (H) (J)

**7. A heterotrophic, unicellular organism moves by using cilia. The organism contains several organelles including a nucleus. Which of the following organisms fit the description given above?**

- A** paramecium
- B** alga
- C** bacterium
- D** yeast

(A) (B) (C) (D)

**11. How are eubacteria and archaeobacteria different?**

- A** the presence of a nucleus
- B** the composition of their cell walls
- C** their difference in size
- D** the presence of a cell wall

(A) (B) (C) (D)

**8. What is one way that fungi resemble plants?**

- F** They both always have stems.
- G** They always grow from the ground.
- H** They are always multicellular.
- J** They always have cell walls.

(F) (G) (H) (J)

**12. Which of the following characteristics do ALL protists have in common?**

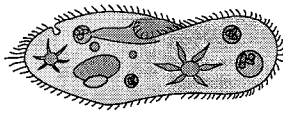
- F** They are all eukaryotic.
- G** They are all unicellular.
- H** They are all multicellular.
- J** They are all autotrophs.

(F) (G) (H) (J)



**Section 15 Review, continued**

13. Study the picture below.



Which part of this paramecium enables it to move?

- A flagella
- B contractile vacuole
- C pseudopods
- D cilia

(A) (B) (C) (D)

16. Trey and Clay became interested in archaeobacteria after studying about them in their biology class. They decided to collect samples of pond water from Trey's farm and use the microscope to examine the water for archaeobacteria. Why are they unlikely to find archaeobacteria in the pond water?

- F Archaeobacteria do not live in water.
- G Archaeobacteria are too small to be seen with a microscope.
- H Archaeobacteria usually prefer more extreme living conditions than a farm pond.
- J Archaeobacteria are found only in salt water.

(F) (G) (H) (J)

14. Algae can use the energy from sunlight because they contain which of the following?

- F cilium and fucoxanthin
- G chlorophyll and other pigments
- H phycobilin and flagellum
- J oogonium and antheridium

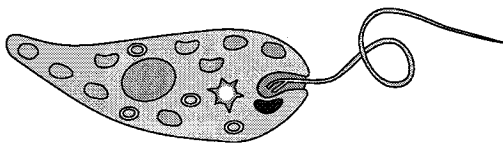
(F) (G) (H) (J)

17. Which organelle prevents a protist from bursting when it is placed in a hypotonic solution?

- A food vacuole
- B oral groove
- C flagellum
- D contractile vacuole

(A) (B) (C) (D)

15. Study the picture below.



The unicellular organism shown above contains a nucleus, a contractile vacuole, and chloroplasts. To which kingdom does this organism MOST likely belong?

- A Archaeobacteria
- B Eubacteria
- C Protista
- D Fungi

(A) (B) (C) (D)

18. When Shawn was a little boy, his grandmother would scold him for playing outside in the dirt. She would say that he would get ringworm because the ringworm eggs were in the dirt. After learning about ringworm in biology class, Shawn knew that his grandmother's warning was an "old wives' tale" and was not true. What did Shawn learn in biology class?

- F Ringworm is a type of protist, and protists do not lay eggs.
- G Ringworm is a type of fungus, and fungi do not produce eggs.
- H Ringworm is caused by a bacterium and not by eggs in the soil.
- J Ringworm is caused by a water mold that doesn't live in dirt.

(F) (G) (H) (J)

**Section 15 Review, continued**

**19.** Miss Robinson gave her class water samples that contained different types of protists. She asked the class to make slides of the water and to determine if the protists observed were autotrophs, heterotrophs, or saprotrophs. Westyn knew that his protist was autotrophic as soon as he focused the microscope. What did Westyn see?

- A a single flagellum
- B cilia around the edges of the protist
- C a contractile vacuole
- D the pigment chlorophyll

(A) (B) (C) (D)

**23.** Dwayne and Harold observed some cells under the microscope. In their lab report they noted that the cells had crystal-like glass shells in many beautiful shapes. Based on this observation, what kind of cells were they viewing?

- A diatoms
- B eubacteria
- C archaebacteria
- D yeast

(A) (B) (C) (D)

**20.** How do funguslike protists get nutrients?

- F by photosynthesis
- G by living as an animal parasite
- H by absorbing them from dead or decaying matter
- J by a mutualistic relationship with algae

(F) (G) (H) (J)

**24.** What are lichens?

- F a type of plantlike protist
- G a type of fungi
- H a type of archaebacteria
- J a dual organism made of a fungus and an alga

(F) (G) (H) (J)

**21.** Under which of the following conditions would molds **MOST LIKELY** produce sexual spores?

- A lack of sunlight
- B lack of moisture
- C lack of soil
- D lack of wind

(A) (B) (C) (D)

**25.** Why are lichens important to the environment?

- A They provide food for bacteria.
- B They break down rocks into soil.
- C They decompose dead organisms.
- D They kill viruses.

(A) (B) (C) (D)

**22.** Which of the following describes the sexual spores formed by mushrooms?

- F haploid
- G diploid
- H photosynthetic
- J parasitic

(F) (G) (H) (J)

**26.** How are fungi important to ecosystems?

- F They carry out photosynthesis.
- G They break down dead organisms.
- H They make alcohol.
- J They kill bacteria.

(F) (G) (H) (J)