Classification of Living Things

7

A lone giraffe strolls past grazing zebras on a lazy afternoon in Kenya. Trees, surrounded by a carpet of green grass, stretch for the sky. Somewhere nearby, an ant zigzags across the dirt, a bird watches from a branch, and insects buzz. Suppose you had to organize all of this life into groups. Would trees and giraffes go together, since both are tall? Would insects and birds go together since both have wings? In this chapter, you will learn how biologists classify living things—from those on the grasslands of Kenya to those in a city park.

Guide for Reading

Key words: taxonomy, genus, kingdom, binomial nomenclature, species

Questions to think about:

How are biologists able to classify organisms?

How is the theory of evolution the basis for modern taxonomy?

What are the major characteristics of each of the five kingdoms?

7-1 Classification

Section Objectives:

- *Explain* the function of classification systems.
- *Describe* the naming system used in modern biology.
- *Explain* how the theory of evolution has affected taxonomy.
- *Describe* the types of evidence now used to determine relationships between groups of organisms.

About 1.5 million kinds of living organisms are known today, and each year thousands more are identified. Some experts believe there are as many as 10 million different kinds. They vary in form and size from microscopic bacteria to giant redwood trees.

To deal with this huge number of organisms, biologists name and group, or classify, the organisms according to an established international system. This makes it easier for scientists to discuss the types and characteristics of living things. The branch of biology that deals with the classification and naming of living things is called **taxonomy** (tak SAHN uh mee).

▲ **Figure 7–1**

Diversity of Life. A great diversity of plant and animal species is found in the rain forests.

Classification Systems

You face many everyday situations in which you need to find objects or information. If the objects or information have been organized or classified into groups, you should be able to find what you are looking for without checking every item in a large group. To

Figure 7–2
Organization in a Supermarket. Think of how long you might search for a single item if products in a supermarket were not arranged according to some system. ▶

help you understand what is involved in classification, consider the arrangement of goods in a supermarket.

A large supermarket, like the one shown in Figure 7–2, carries 7000 to 10 000 items. If these items were placed on the shelves randomly, shopping for the week's groceries might take an entire day or even longer. However, the basis for any classification system is the grouping of things according to similarities. You can find the items you need fairly quickly because related items are arranged in groups. First, items are grouped into broad categories—frozen foods, meat, produce, cleaning supplies, paper goods, and dairy products. Each of these departments is subdivided into a series of smaller, related categories. For example, the frozen food department has separate sections for vegetables, juices, cakes, fish, TV dinners, and ice cream. Each of these sections is further subdivided. The ice cream section is divided into half-gallons, quarts, pints, and cups. Within each size range, the ice cream may be grouped by flavor or brand name.

Once you are familiar with the organization of the supermarket, it is easy to find an item. If the market manager gets a new kind of frozen cake, it is a simple matter to place it with the other frozen cakes. In a similar manner, the classification system used in modern biology allows biologists to identify an organism and place it in the correct group with related organisms.

Early Classification Schemes

In early attempts at classification, living things were separated into two major groups—the plant kingdom and the animal kingdom. These two groups were then subdivided in various ways. In early historical documents, for example, plants were divided into grasses, herbs, and trees, while animals were classified as fish, creeping creatures, fowl, beasts, and cattle.

In the fourth century B.C., the Greek philosopher Aristotle made a study of animals; another philosopher, Theophrastus, studied plants. Aristotle grouped animals according to the kind of environment in which they lived. Thus, there were air-dwellers, land-dwellers, and water-dwellers. Theophrastus grouped plants according to stem structure. Thus, there were herbs (soft stems), shrubs (several woody stems), and trees (a single woody stem). Using these crude subdivisions, Aristotle and Theophrastus classified more than 500 kinds of plants and 500 kinds of animals.

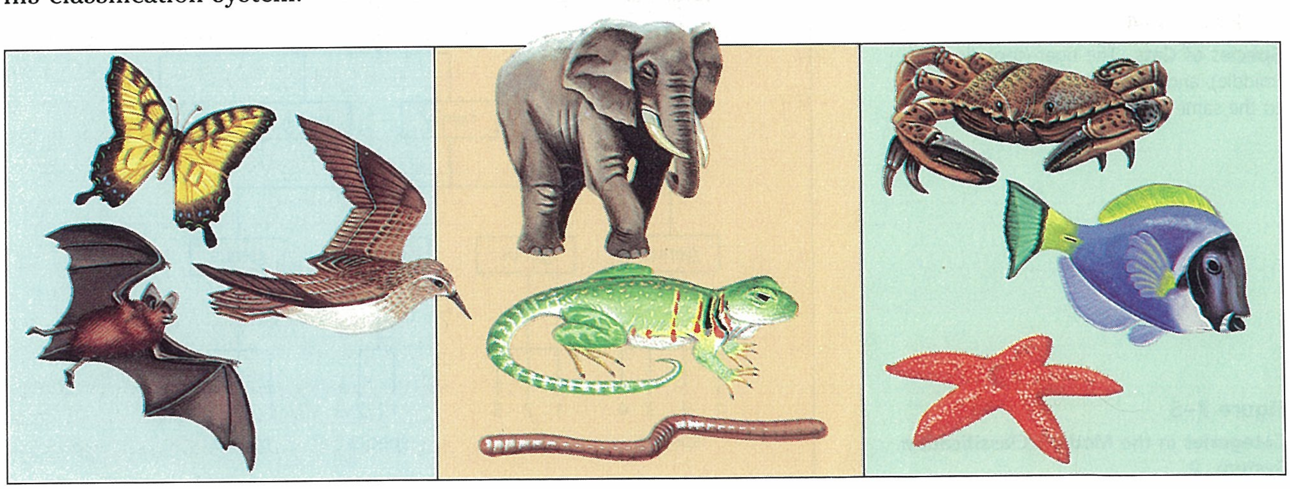
The classification systems of Aristotle and Theophrastus worked well for the small number of organisms that were familiar to the people of Europe and the Mediterranean region at the time. However, during the 1400s and 1500s, European explorers returned home from their travels with many new types of organisms. The development of the microscope in the 1600s also led to the discovery of many microorganisms not previously known to exist. As the number of known organisms increased, the need for a more effective classification system became clear.

The next major advance in classification was made in the mid-1600s by the English naturalist John Ray. In his travels through England and Europe, Ray identified and classified more than 18 000 different types of plants. He also classified the members of several different animal groups. Ray was the first to use the term *species* (SPEE sheez) for each different kind of organism. Ray defined a species as a group of organisms that were structurally similar and that passed these similarities to their offspring. Closely related species were included in a broader group called a **genus** (JEE nus) (plural, genera). See Figure 7–4. Related genera were arranged in still broader groups.

The Swedish botanist Carolus Linnaeus (luh NEE us), considered the founder of modern taxonomy, improved upon the work of earlier taxonomists. Linnaeus established methods for classifying and naming organisms that are still used. In his system, plants and animals were arranged in such a way that they could be identified easily. Like Ray, Linnaeus used structural similarities as a basis for his classification system.

Figure 7–3

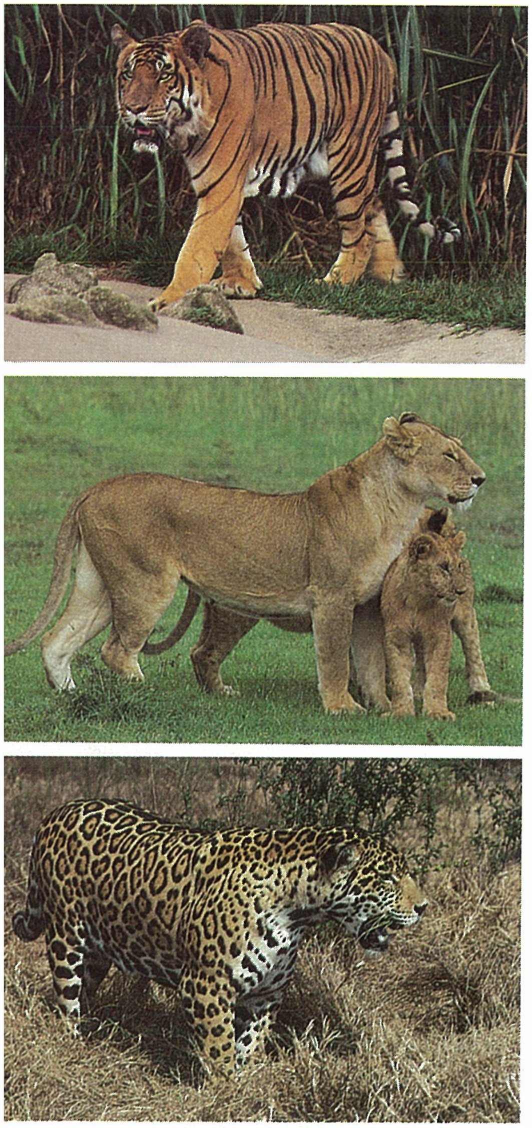
An Early Classification System. Aristotle grouped organisms as air-dwellers, land-dwellers, and water-dwellers. ▼



Classification Categories

Since the time of Linnaeus, taxonomists have added several categories to the classification system. The broadest category is the *kingdom.* The narrowest category is the species. In classifying living things, biologists generally use the following categories: **kingdom, phylum** (FY lum) (plural, phyla), **class, order, family, genus,** and **species.** In plant taxonomy, the term *division* is used in place of phylum.

As shown in Figure 7–4, related species are grouped in a *genus;* related genera are grouped in a *family;* related families are grouped in an *order;* related orders are grouped in a *class;* related classes are grouped in a *phylum;* and related phyla are grouped in a *kingdom.* Each species—that is, each type of organism—belongs to one kingdom, one phylum, one class, one order, one family, and one genus. Figure 7–6 shows the complete classification for several different species.



▲ **Figure 7–4**
Species of Cats. The tiger (top), lion (middle), and jaguar (bottom) all belong to the same genus, *Panthera.*

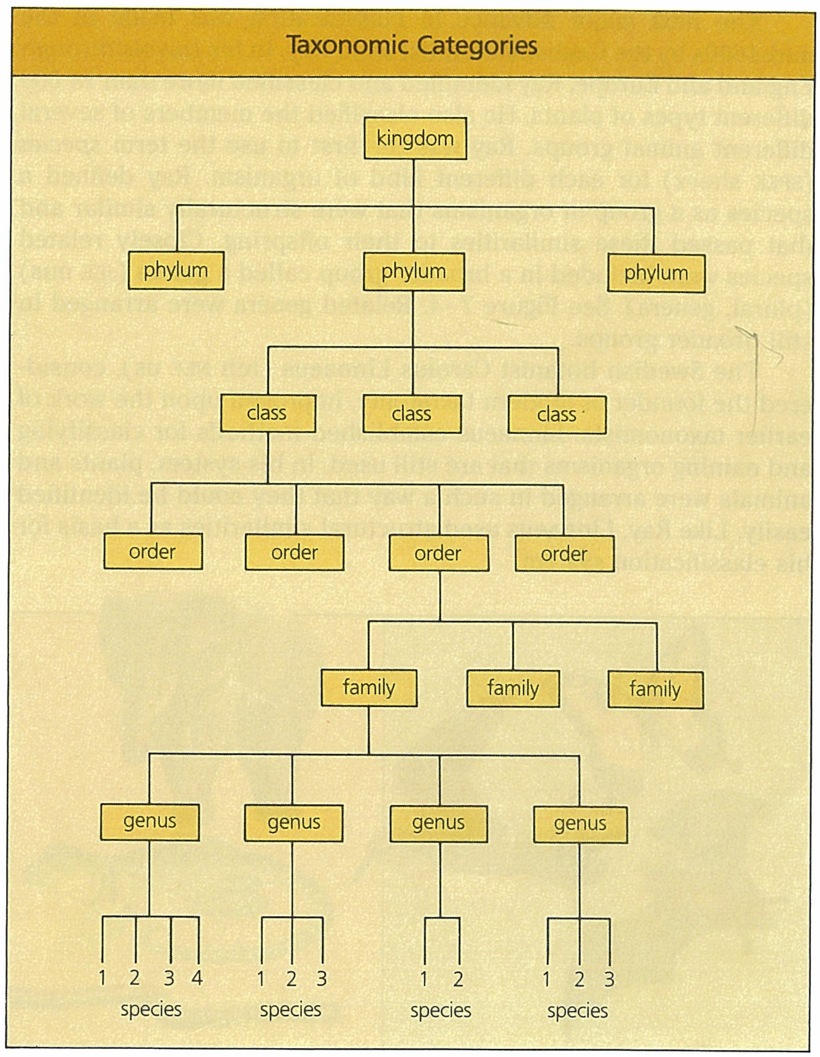


Figure 7–5
Categories in the Modern Classification System. ▶

Classification of Some Familiar Organisms				
Category	Human	Chimpanzee	Housefly	Dandelion
Kingdom	Animalia	Animalia	Animalia	Plantae
Phylum	Chordata	Chordata	Arthropoda	Tracheophyta
Class	Mammalia	Mammalia	Insecta	Angiospermae
Order	Primates	Primates	Diptera	Asterales
Family	Hominidae	Pongidae	Muscidae	Asteraceae
Genus	*Homo*	*Pan*	*Musca*	*Taraxacum*
Species	*Homo sapiens*	*Pan troglodytes*	*Musca domestica*	*Taraxacum officinale*

▲ **Figure 7–6**
Classification of Some Familiar Organisms.

Naming Organisms

A system for naming things is called **nomenclature** (NOH men klay chur). Before Linnaeus, each species was identified by its genus name followed by a string of Latin words that described the species. In some cases, 8 or 10 words followed the genus name. As you can imagine, using such long descriptions as a way of naming organisms was inefficient and inconvenient. In his descriptions of organisms, Linnaeus named each species with a genus name followed by a single descriptive word. Both words were in Latin, which was the language scholars used. Within each genus, no two species could be described by the same word.

This two-word system of identifying each kind of organism, which is still used, is known as **binomial** (by NOH mee ul) ("two names") **nomenclature.** It is equivalent to the system of using two names to identify a person—a family name and a given (or first) name. The genus name is like a person's family (or last) name, while the specific name is like a person's first name.

In modern biology, each kind of organism has a two-word Latin name—its scientific name. The first word is its genus name, the second identifies the species within the genus. Both names together make up the species name. The Latin terms are not chosen randomly. Usually, they point out some aspect of the organism, such as where it lives, its size, or one of its features. For example, *Hystrix indica* is the Indian porcupine and *Carnegiea gigantea* is the giant saguaro cactus. A fragrant species of water lily is *Nymphaea ordorata.*

It is common to abbreviate a genus name with its first letter. This usually is done when the names of species within the same genus appear over and over in a written document. For example, in a scientific article about oak trees, genus *Quercus,* species names such as *Quercus rubra* and *Quercus alba,* would appear as *Q. rubra* and *Q. alba.*

Most large plants and animals also have common names. However, common names are often confusing and inexact. A starfish, for example, is not a fish. Also, one species may have several different common names. The blue jay, *Cyanocitta christata,* is also known as the blue coat, the corn thief, and the nest robber. In other cases, the same common name is used for two or more different species. More than a dozen different species of plants are commonly known as raspberries. Finally, common names vary from language to language. An English "dog" is a Spanish "perro" and a Japanese "inu." However, the scientific name for dog, *Canis familiaris,* is understood by biologists everywhere.

Modern Taxonomy

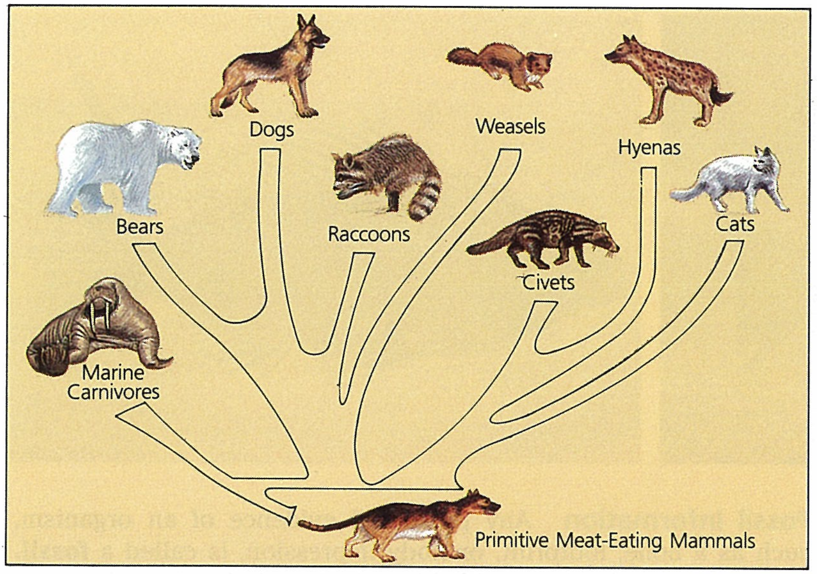
Until the mid-1800s, most scientists viewed each species as constant and unchanging. Every species was thought to be independent and unrelated to other species, no matter how many characteristics they had in common. The groupings in which taxonomists placed organisms merely indicated different degrees of similarity in structure or appearance.

This view of the biological world as static began to change as evidence grew that species gradually change, or evolve, over time. According to this theory of gradual change, which is known as the **theory of evolution,** new species arise, or evolve, over long periods of time from preexisting species. As new species evolve, older species may become extinct. Unit 6 discusses the mechanisms that most scientists believe are involved in evolution.

Today, the definition of a species has been further refined. Now, a **species** is a natural group, or *population,* of similar organisms that interbreed in nature. If the members of a species become separated into groups that breed independently for long periods of time, each group will evolve differently. Their evolution will depend on the opportunities and demands of the particular environment. Eventually, the separated groups may become so different that they must be classified as different species.

The theory of evolution serves as the basis of modern taxonomy. The number and kinds of similarities between different species are used to estimate the hereditary relationship between species. Species sharing many of the same characteristics are believed to share a common ancestral species. Many scientists believe that the more similarities between organisms in any two groups, the more recently in evolutionary history the species evolved from a common ancestor. Similarly, the fewer shared characteristics, the further back in evolutionary time the species evolved. This kind of information often is represented in the form of a branched diagram called a *phylogenetic tree.* **Phylogeny** is the evolutionary history of a species or a group of organisms. A phylogenetic tree indicates when related groups of organisms have evolved from common ancestors and, in some cases, how much they have diverged from each other. Figure 7-7 is an example of a phylogenetic tree.

But what information about an organism do taxonomists use when they classify? Taxonomists use structural, biochemical, cytological, embryological, behavioral, and fossil information. Usually, the more kinds of information used, the more likely the classification will reflect true evolutionary relationships.



◀ **Figure 7–7**

Phylogenetic Tree. The evolutionary relationship among the different types of meat-eating animals is shown in this phylogenetic tree.

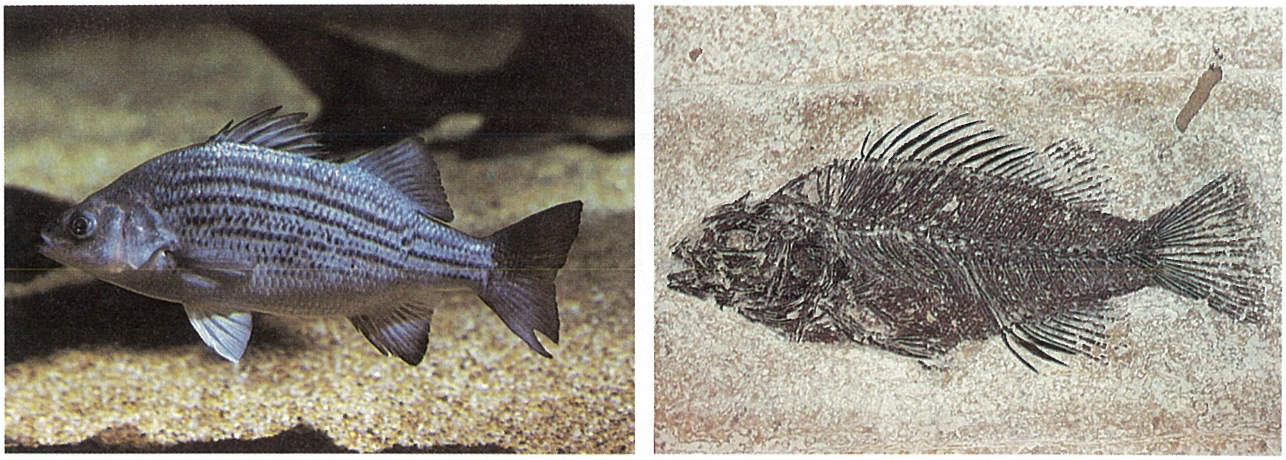
Structural Information Structural similarities, such as those in skeletal structure or leaf anatomy, are the primary basis for grouping organisms. There are instances, however, in which additional information may be needed to make a classification judgment. Furthermore, it is always desirable to pair structural information with other kinds of available information.

Biochemical Information Today, taxonomists frequently use biochemical data when classifying organisms. Information about the DNA, RNA, and proteins of different species can be compared to establish relationships. This kind of information was used recently to show that the giant panda of Asia probably is closely related to bears.

Cytological Information Details about the cellular structure of organisms can also offer clues to evolutionary relationships. Many single-celled organisms, for example, have been classified on the basis of their similarities in cellular structure, which can be seen with the electron microscope. Another source of cytological information that taxonomists have used is information on numbers of chromosomes in a species. Many plant species have been classified, in part, according to their chromosome numbers.

Embryological Information The term *embryo* refers to any multicellular organism in its early stages of development. While the adult forms of different animal species may look very different, the embryos can look very similar. Taxonomists use embryological data to establish taxonomic relationships that otherwise might be overlooked.

Behavioral Information Sometimes, behavior may be the only basis for distinguishing one species from another. For example, some species of crickets can be distinguished only on the basis of their mating calls.



▲ **Figure 7–8**
Modern and Fossil Fish. A modern-day fish (left) shows striking similarity to the fossil of an ancient fish (right).

Fossil Information Any preserved evidence of an organism, such as a bone, footprint, or body impression, is called a **fossil.** Fossils are useful in establishing likely relationships between modern-day species and species that lived thousands or even millions of years ago.

Taxonomy in Perspective

Although taxonomy has come a long way since Aristotle, not all classification problems have been solved. In fact, taxonomists constantly reexamine and refine previous classifications. A good part of taxonomy is subjective. While taxonomists follow general, established principles, their decisions are judgment calls that often vary from one taxonomist to another. Taxonomists may disagree over whether a species belongs in one genus or another or whether several species should be considered one species. Add to this process the task of classifying and naming newly discovered organisms and you realize taxonomy is a dynamic and important field of biology.

7-1 Section Review

1. Describe the system of binomial nomenclature used by biologists.
2. How has the theory of evolution affected the science of taxonomy?
3. What is the modern definition of a species?
4. What kinds of information are used by taxonomists to determine relationships between groups of organisms?

Critical Thinking

5. Explain the relationship between a class and an order. (*Relating Parts and Wholes*)

7-2 Major Taxonomic Groups

Section Objectives:

- *Name* the five kingdoms and describe the characteristics of each.
- *Explain* the advantages of the five-kingdom system.

Laboratory Investigation: *Classify* some organisms by means of a taxonomic key (p. 140).

In all early classification schemes, living things were divided into two kingdoms—plants and animals. This system works with large organisms. Trees, grass, and flowers are plants, while frogs, fish, insects, birds, and cats are animals. However, some organisms have both plant and animal characteristics. An organism called euglena (yoo GLEEN uh), for example, is a unicellular organism that carries on photosynthesis like a plant yet moves like an animal.

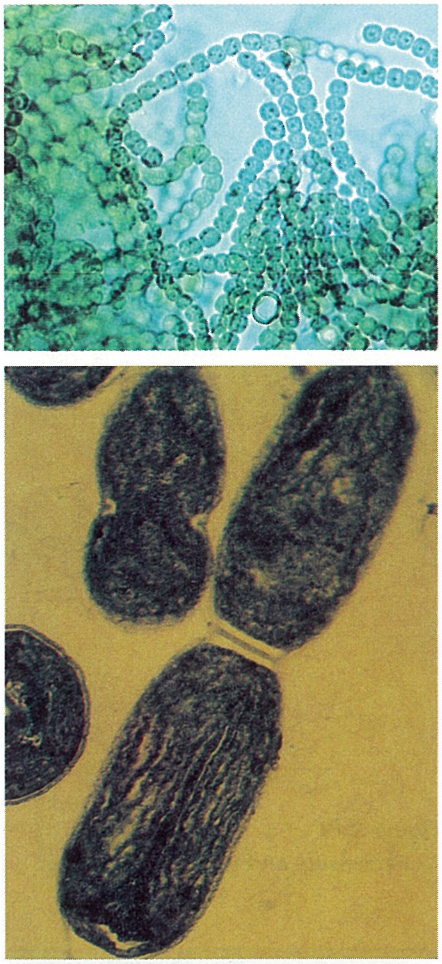
To solve the problem of classifying organisms that are not obviously animals or plants, taxonomists have added new kingdoms to the classification system. However, there is no universal agreement about how many kingdoms are needed and which organisms should be placed in them. Each possible arrangement has some advantages and some disadvantages.

Most taxonomists use a five-kingdom system of classification. This is the system used in this text. The five kingdoms are Monera, Protista, Fungi, Plantae, and Animalia. The five-kingdom system emphasizes certain basic differences among large groups of organisms. The general characteristics of the five kingdoms are described briefly in the following sections and in Figure 7-9.

Figure 7–9
Characteristics of the Five Kingdoms.

Characteristics of the Five Kingdoms

CHARACTERISTIC	KINGDOM				
	Monera	Protista	Fungi	Plantae	Animalia
cell type	prokaryotic	eukaryotic	eukaryotic	eukaryotic	eukaryotic
body form	most unicellular; some colonial	most unicellular; some simple multicellular	most multicellular	multicellular	multicellular; organs, and organ systems
cell wall composition	polysaccharides and amino acids	present in some composition varies	usually chitin	cellulose	no cell wall
mode of nutrition	photosynthesis, chemosynthesis, absorption	photosynthesis, ingestion, or absorption	absorption	photosynthesis	ingestion
nervous system	absent	absent	absent	absent	present
locomotion	present in some	present in some	absent	absent	present



▲ **Figure 7–10**
Examples from the Kingdom Monera. A colonial (filamentous) blue-green bacterium (top) and a blue-green bacterium at higher magnification are examples of monerans. (Magnification 99 900X)

Kingdom Monera

The kingdom **Monera** (muh NER uh) includes all prokaryotic organisms. These organisms, known as *monerans,* or bacteria, are mostly unicellular, although some form chains, clusters, or colonies of connected cells. As you know from Chapter 5, prokaryotic cells do not have an organized nucleus with a nuclear membrane. They also lack most of the organelles, such as mitochondria, lysosomes, and Golgi bodies, found in eukaryotic cells. Although prokaryotic cells have cell walls, the cell walls are chemically different from the cell walls of other organisms.

Most bacteria do not carry on photosynthesis. They must absorb nutrients from the environment. However, blue-green bacteria (once called blue-green algae) and a few other types of bacteria contain chlorophyll and carry on photosynthesis. See Figure 7–10. Chloroplasts are not present in these bacteria. Rather, chlorophyll is contained in layers of membranes that lie within the bacterial cell.

Kingdom Protista

Members of the kingdom **Protista** (proh TIST ah) are mostly unicellular, although there are colonial and simple, multicellular forms. The cells of *protists* are eukaryotic. That is, like the cells of multicellular organisms, each contains a membrane-bound nucleus and other organelles. Some protists are motile and feed upon bacteria and bits of organic matter. These animal-like protists are called *protozoa.* Other protists carry out photosynthesis. These plantlike protists are members of a group of organisms called algae.

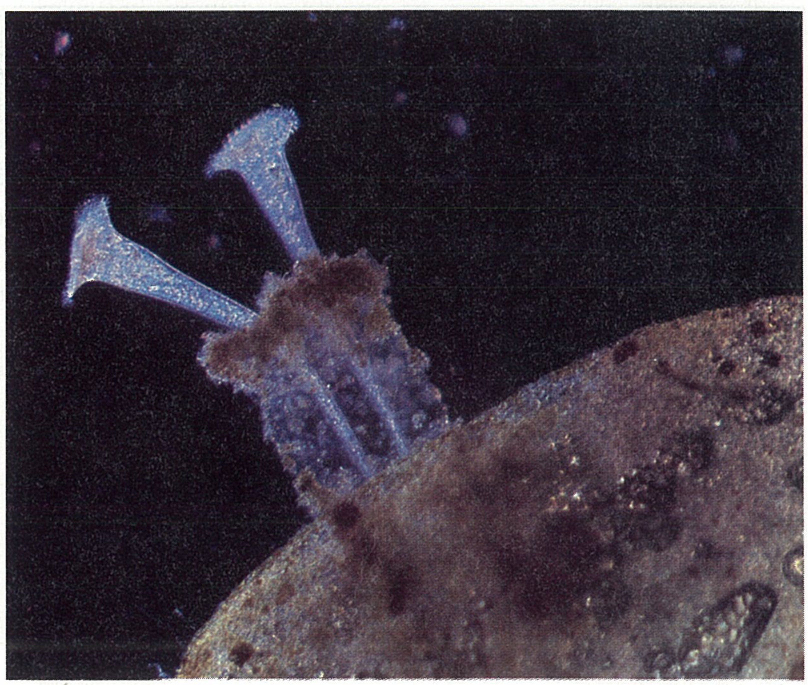
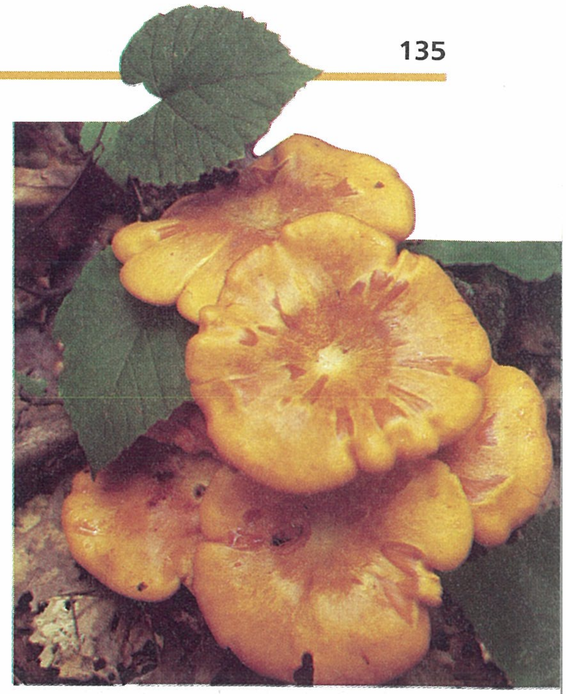


Figure 7–11
An Example from the Kingdom Protista. This colonial species of *Stentor* is a type of protozoan. (Magnification 52X) ▶

Algae is the term used for all eukaryotic, unicellular and simple multicellular, organisms that carry out photosynthesis and live in water. The different groups of algae are not thought to be directly related to each other.

Kingdom Fungi

The kingdom **Fungi** (FUN jy) includes molds, yeasts, mushrooms, rusts, and smuts. *Fungi* (singular, fungus) live either as parasites on other living things or as decomposers of dead matter. Some fungi are unicellular, but most are multicellular. Fungi are eukaryotic. That is, they have cell organelles and distinct nuclei surrounded by nuclear membranes. Although fungi have cell walls, the walls are chemically different from those of other organisms. In the past, members of the kingdom Fungi were placed in the plant kingdom because they resemble plants more than animals. See Figure 7–12. The differences between fungi and plants are so great, however, that biologists have placed fungi in their own kingdom. Unlike plants, fungi contain no chlorophyll and cannot synthesize food. Instead, they secrete enzymes that digest food material outside the organism. The fungi then absorb the nutrients.



▲ Figure 7–12
An Example from the Kingdom Fungi. Mushrooms, like the poisonous one shown here, are just one of many types of fungi.

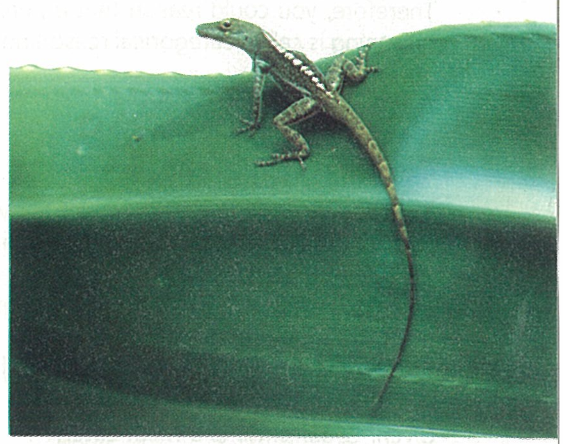
Kingdom Plantae

The *plants,* members of the kingdom **Plantae** (PLAN tee), include mosses, liverworts, ferns, and seed plants. See Figure 7–13. The cells of plants have cell walls. Members of the plant kingdom show a true tissue and organ organization. Plants cannot move from place to place on their own. Nearly all plants carry on photosynthesis and most live on land. Within plant cells, chlorophyll is found in chloroplasts.

Kingdom Animalia

There are more species in kingdom **Animalia** (an uh MAL ee ah) than in any other kingdom. Members of the animal kingdom are multicellular and usually show an organ and organ system level of organization. During some part of their life cycle, most animals can move from place to place on their own. Since animals cannot carry on photosynthesis, they must obtain food from their environment. Most animals actively search for food, relying upon highly specialized sensory systems, brains, and nerve-muscle systems to do so. These same systems permit other complex types of behavior. Animals such as sponges, worms, and insects have no backbone and are called *invertebrates.* Animals with backbones, such as fish, snakes, and humans, are called *vertebrates.* Sexual reproduction is more common in animals than asexual reproduction. In some species, there is specialized courtship behavior, and there may be extensive parental care of the young.

A more complete list of all the taxonomic groups is found in Appendix F at the back of this book.



▲ Figure 7–13
Examples from the Plant and Animal Kingdoms. The leaf is part of a plant, while the lizard is a member of the animal kingdom.

The Taxonomic Key

What questions would you ask if you were playing a game in which you had to identify a famous person of whom another player was thinking? You might begin by asking: Is the person male or female? If female, is she American, or non-American? If non-American, is she European or non-European? By continuing with questions that became more and more specific, you could identify the person.

Biologists use a similar procedure to identify an organism. The procedure they use is a series of instructions called a taxonomic key. A **taxonomic key** is a tool used to identify organisms already classified by taxonomists. Most keys are dichotomous. That is, they consist of a series of paired statements that describe alternative possible characteristics of the organism. These paired statements usually describe the presence or absence of certain characteristics or structures that are easily seen. For example, an animal may or may not have a spinal column. If it has a spinal column, it may or may not have gills. If gills are absent, its body may or may not be covered with scales, and so on. Each set of choices must be arranged in such a way that each step produces a smaller grouping. Figure 7–14 shows a sample taxonomic key that is used for identifying vertebrates.

Critical Thinking in Biology

Reasoning Categorically

Something that is true about a group or a *category* will be true for every member of the group or category. For example, you know that all fish can swim. You also know that a perch is a fish. Therefore, you could reason that a perch can swim. This type of reasoning is called categorical reasoning. The argument can be set up formally:

Premise: All fish can swim.
Given: A perch is a fish.
Conclusion: A perch can swim.

1. Using the categorical argument above as a model, construct a categorical argument to show that a bird is a vertebrate.
2. The cells shown at right are from a multicellular organism. Construct a categorical argument to determine whether they are plant or animal cells.
3. What is wrong with this categorical argument?
Premise: All cats are meat-eaters.
Given: Organism B is a meat-eater.
Conclusion: Therefore, Organism B is a cat.
4. Think About It Explain your thought processes as you answered Question 1.

Key for Identifying Vertebrates	
1	1A. spinal column present . . . go to 2. 1B. spinal column absent . . . Invertebrate.
2	2A. fins and gills present . . . Fish. 2B. fins and gills absent . . . go to 3.
3	3A. scales present . . . Reptile. 3B. scales absent . . . go to 4.
4	4A. feathers present . . . Bird. 4B. feathers absent . . . go to 5.
5	5A. hair or fur present . . . Mammal. 5B. hair or fur absent . . . Amphibian.

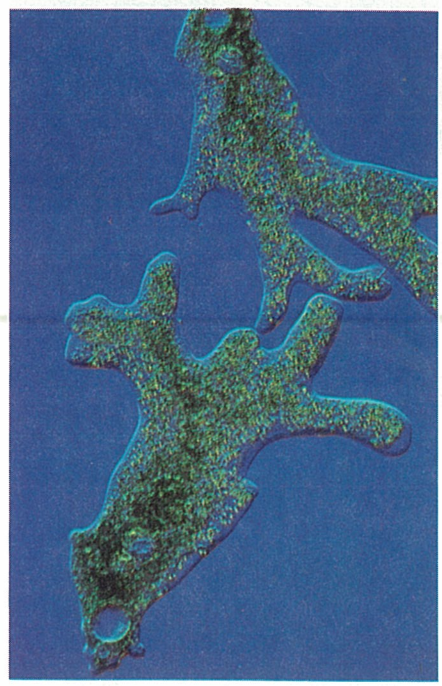
◀ **Figure 7–14**
A Sample Taxonomic Key For Identifying Vertebrates.

Representative Organisms

As you learned in Chapter 1, all living things carry on certain processes such as nutrition, respiration, transport, excretion, and regulation. Size greatly influences how an organism performs these processes. The cells of single-celled and small multicellular organisms are in close contact with the external environment. Because they are small, they can carry on their life processes in a simple fashion. However, as animals become larger, most of their cells are not in contact with the environment. In these animals, the life functions are carried out by groups of organs arranged in systems.

In Unit 2, you will study how certain organisms solve the problems of life. Since you cannot consider every organism, you will study six representative organisms in order of increasing complexity. Two of these organisms, the ameba and the paramecium, are unicellular and are classified as protists. The others are animals: the hydra, the earthworm, the grasshopper, and the human. All these organisms are **heterotrophs** (HET uh ruh trohfs) —organisms that obtain their food from the environment. In contrast, plants and certain other organisms make their own food. These organisms are called **autotrophs.**

Ameba and Paramecium The ameba and paramecium are common inhabitants of ponds and streams. As protists, they carry out their life processes within a single cell. Although they are small, they can be seen without a microscope. Under the microscope, the ameba, shown in Figure 7-15, appears as a transparent mass that constantly changes shape. It has cytoplasm with a cell membrane and a nucleus. It creeps along through the flowing of cytoplasm into temporary structures called *pseudopods,* or false feet.



▲ **Figure 7–15**
Ameba. The ameba is just one of many types of protozoan. Organelles and other particles are evident in the cytoplasm of these ameba. (Magnification 108X)

The paramecium, shown in Figure 7-16, is easy to recognize because of its slipperlike shape. It contains two nuclei. The larger macronucleus controls general cell activities. The smaller micronucleus is involved in reproduction. A stiffened cell membrane with

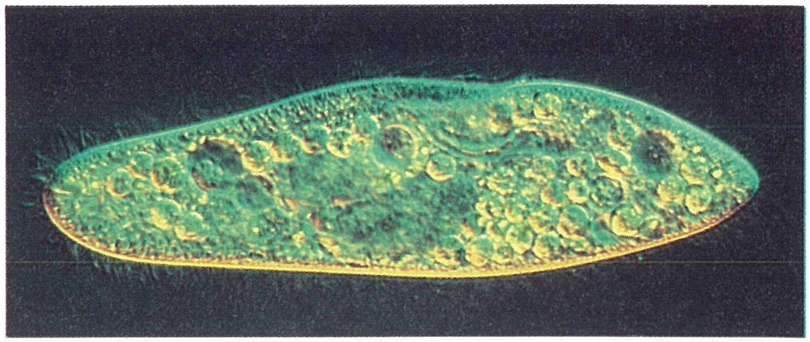
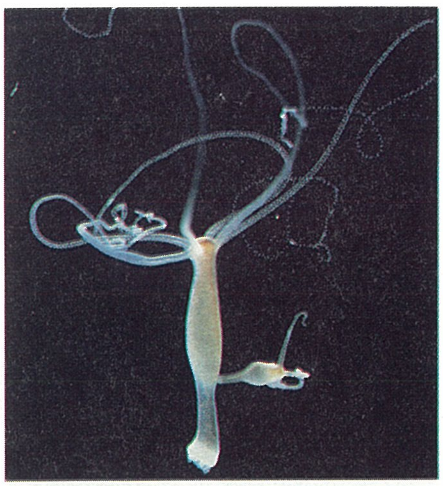


Figure 7–16
Paramecium. The paramecium is another type of protozoan. The cilia that cover the surface of a paramecium can be seen along the edge of this specimen. (Magnification 325X) ▶

numerous, hairlike cilia surrounds the paramecium. The cilia allow the paramecium to swim. On one side of the paramecium is a depression, known as the oral groove, that leads into a tubular gullet. Both the oral groove and the gullet are involved in nutrition.



▲ **Figure 7–17**
Hydra. The hydra represents a simple, multicellular organism. This hydra is reproducing by budding a new hydra.

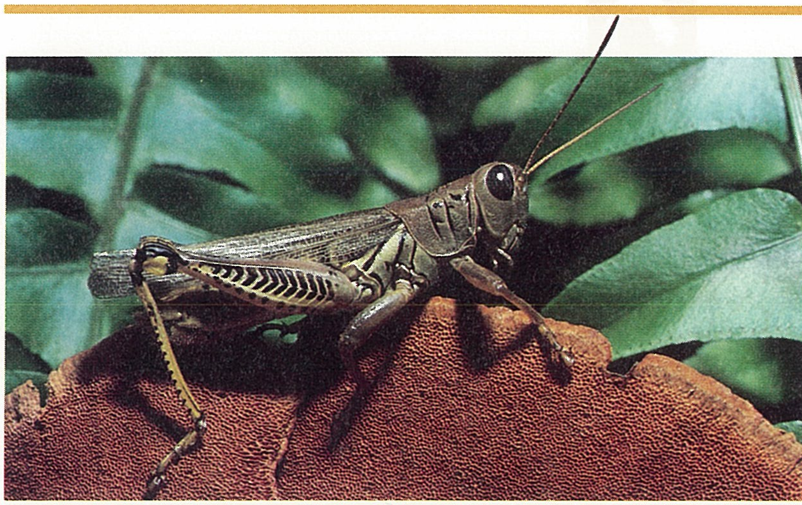
Hydra The hydra, shown in Figure 7–17, belongs to the phylum **Coelenterata.** In its structure and function, the hydra is a simple animal. It is about five millimeters long and lives in fresh water. Usually it attaches itself to an underwater plant or some other solid object. The hydra has a tubelike body with only one opening, a mouth. The mouth, which leads into an internal cavity, is surrounded by tentacles. The body wall is made of only two cell layers.

Earthworm The earthworm, shown in Figure 7–18, belongs to the phylum **Annelida.** Its long, round body is composed of many segments. The earthworm has a well-developed digestive system, a circulatory system, excretory organs, and a well-defined nervous system.

Grasshopper The grasshopper, shown in Figure 7–19, belongs to the class *Insecta* of the phylum **Arthropoda.** The grasshopper has a well-developed digestive system, a circulatory system, a respiratory system, excretory organs, and a nervous system.

Human Humans belong to the class *Mammalia* of the subphylum *Vertebrata* of the phylum **Chordata.** Mammals nourish their young with milk. Their bodies are covered with hair or fur. Many have well-developed brains.

Figure 7–18
Earthworm. Earthworms have a more complex body organization than hydra. ▶



◄ **Figure 7–19**

Grasshopper. The grasshopper shows a level of complexity in its body structure that is greater than that in the earthworm.

Evolution: A Unifying Theme

As you have read, the modern taxonomy system attempts to classify organisms into groups that reflect their hereditary and, therefore, evolutionary relationships. To classify an organism, taxonomists must gather whatever is known about the organism's structure, chemistry, embryological development, and behavior and try to reconstruct, based on the modern theory of evolution, a reasonable picture of the organism and its relationship to other organisms.

When scientists observe striking similarities between some species, they are led to conclude that similar species have evolved from a common ancestor. Scientists may note, for example, that while a bird's wing and a seal's flippers look very different and have very different functions, their internal structure as well as their embryological development is quite similar. Using these similarities as clues to a common ancestor, scientists have some basis for classifying the bird and the seal.

As a unifying theme in biology, evolution explains why there is such a diversity of life on earth today as well as how various groups of organisms are related. It also explains how the organisms of today are related to organisms of the past.

7-2 Section Review

1. Name the five kingdoms.
2. In what fundamental way are members of the Monera different from organisms in the other kingdoms?
3. What are protozoa?
4. To what phylum and class do humans belong?

Critical Thinking

5. Why do scientists prefer the five-kingdom system of classification over a three- or four-kingdom system? (*Identifying Reasons*)