Section 2

Classifying Organisms

Reading Preview

Key Concepts

- Why do biologists organize living things into groups?
- What do the levels of classification indicate about the relationship between organisms?
- What characteristics are used to classify organisms into domains and kingdoms?

Key Terms

- classification
- taxonomy
- binomial nomenclature
- genus
- species
- prokaryote
- nucleus
- eukaryote

Target Reading Skill

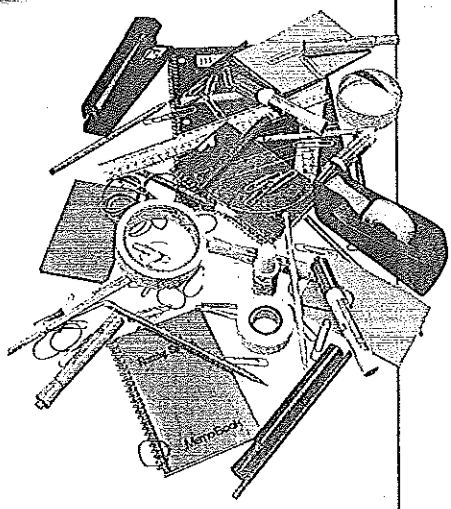
Asking Questions Before you read, preview the red headings. In a graphic organizer like the one below, ask a *what*, *why*, or *how* question for each heading. As you read, write the answers to your questions.

Classifying Organisms

Question	Answer
Why do scientists classify?	Scientists classify because . . .

Lab zone Discover Activity

Can You Organize a Junk Drawer?



1. Your teacher will give you some items that you might find in the junk drawer of a desk. Your job is to organize the items.
2. Examine the objects and decide on three groups into which you can sort them.
3. Place each object into one of the groups, based on how the item's features match the characteristics of the group.
4. Compare your grouping system with those of your classmates.

Think It Over

Classifying Which of your classmates' grouping systems seemed most useful? Why?

Suppose you had only ten minutes to run into a supermarket to get what you needed—milk and tomatoes. Could you do it? In most supermarkets this would be an easy task. You'd probably find out where the dairy and produce sections are, and head straight to those areas. Now imagine if you had to shop for these same items in a market where things were randomly placed throughout the store. Where would you begin? You'd have to search through a lot of things before you found what you needed. You could be there for a long time!

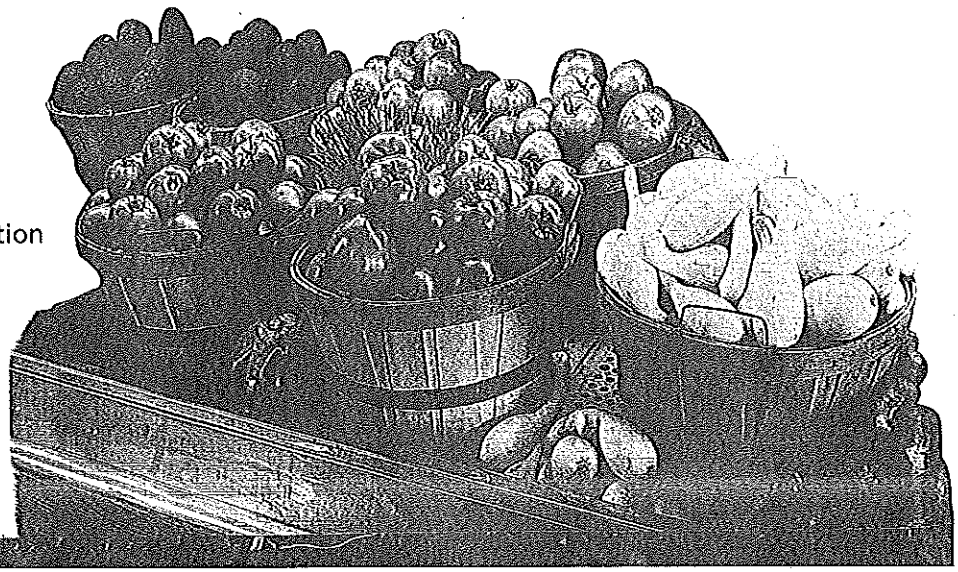


FIGURE 6
Classifying Vegetables
Vegetables in the produce section of a supermarket are neatly organized.

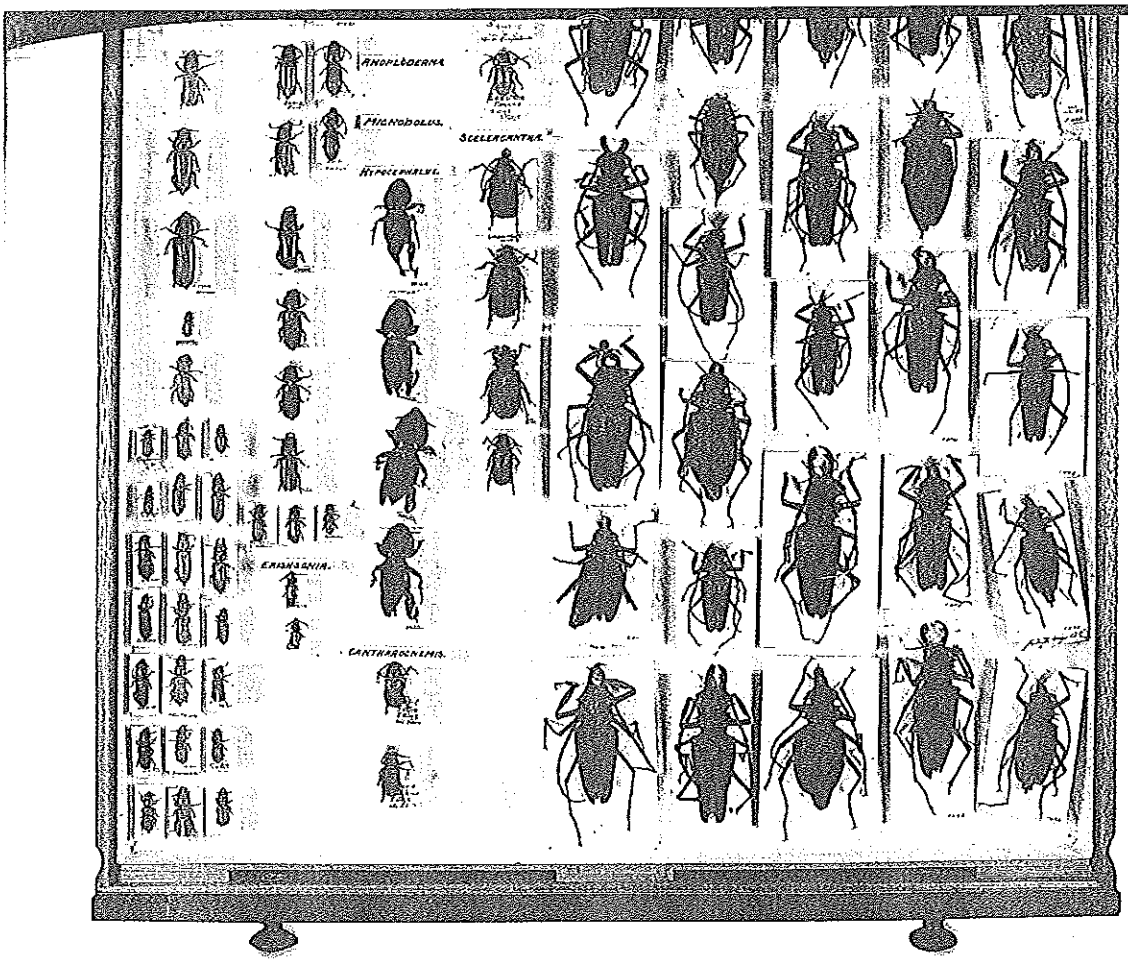


FIGURE 7
Classifying Beetles
These beetles belong to a large insect collection in a natural history museum. They have been classified according to characteristics they share. Observing *What characteristics may have been used to group these beetles?*

Why Do Scientists Classify?

Just as shopping can be a problem in a disorganized store, finding information about a specific organism can also be a problem. So far, scientists have identified more than one million kinds of organisms on Earth. That's a large number, and it is continually growing as scientists discover new organisms. Imagine how difficult it would be to find information about one particular organism if you had no idea even where to begin. It would be a lot easier if similar organisms were placed into groups.

Organizing living things into groups is exactly what biologists have done. Biologists group organisms based on similarities, just as grocers group milk with dairy products and tomatoes with produce. **Classification** is the process of grouping things based on their similarities.

Biologists use classification to organize living things into groups so that the organisms are easier to study. The scientific study of how living things are classified is called **taxonomy** (tak SAHN uh mee). Taxonomy is useful because once an organism is classified, a scientist knows a lot about that organism. For example, if you know that a crow is classified as a bird, then you know that a crow has wings, feathers, and a beak.

Reading Checkpoint **What is the scientific study of how living things are classified called?**

The Naming System of Linnaeus

Taxonomy also involves naming organisms. In the 1750s, the Swedish naturalist Carolus Linnaeus devised a system of naming organisms that is still used today. Linnaeus placed organisms in groups based on their observable features. Based on his observations, Linnaeus gave each organism a unique, two-part scientific name. This naming system Linnaeus used is called **binomial nomenclature** (by NOH mee ul NOH men klay chur). The word *binomial* means "two names."

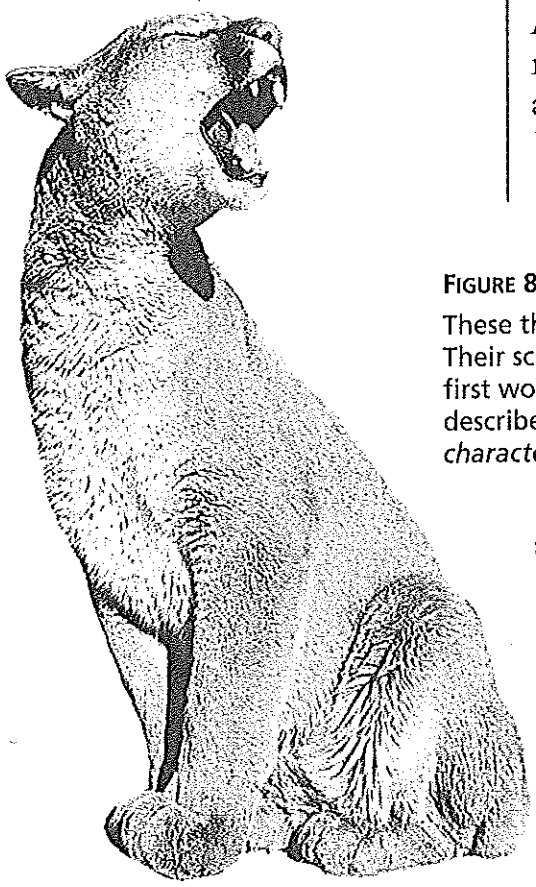
Genus and Species The first word in an organism's scientific name is its genus. A **genus** (JEE nus) (plural *genera*) is a classification grouping that contains similar, closely related organisms. For example, pumas, marbled cats, and house cats are all classified in the genus *Felis*. Organisms that are classified in the genus *Felis* share characteristics such as sharp, retractable claws and behaviors such as hunting other animals.

The second word in a scientific name often describes a distinctive feature of an organism, such as where it lives or its appearance. Together, the two words indicate a unique species. A **species** (SPEE sheez) is a group of similar organisms that can mate with each other and produce offspring that can also mate and reproduce.

Reading Checkpoint **What kind of name did Linnaeus give each organism?**

FIGURE 8 Binomial Nomenclature

These three species of cats belong to the same genus. Their scientific names, written in Latin, share the same first word, *Felis*. The second word of their names describes a feature of the animal. Classifying *What characteristics do these species share?*



Felis concolor (Puma)
Concolor means "the same color." Notice that this animal's coat is mostly the same color.

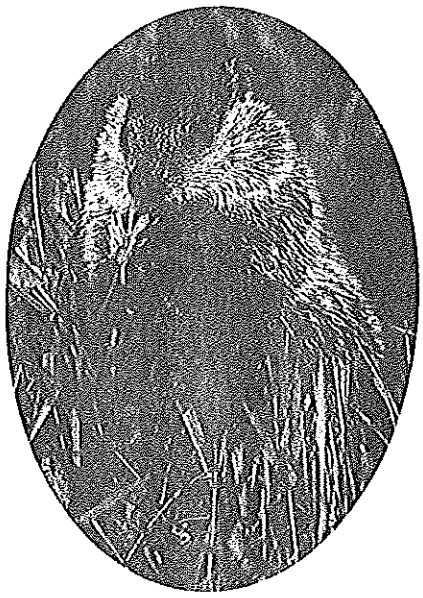
Felis marmorata (Marbled cat)
Notice the marbled pattern of this animal's coat. *Marmorata* means "marble."

Felis domesticus
(House cat)
Domesticus means "of the house."

Using Binomial Nomenclature Notice in Figure 8 that a complete scientific name is written in italics. Only the first letter of the first word is capitalized. Notice also that scientific names contain Latin words. Linnaeus used Latin because it was the language that scientists used during that time.

Binomial nomenclature makes it easy for scientists to communicate because everyone uses the same name for the same organism. Using different names can get confusing. For instance, people call the animal in Figure 9 a woodchuck, groundhog, or whistlepig. Fortunately, it has only one scientific name—*Marmota monax*.

FIGURE 9
Marmota monax
Although there are many common names for this animal, it has only one scientific name, *Marmota monax*.



Levels of Classification

The classification system that scientists use today is based on the contributions of Linnaeus. But today's classification system uses a series of many levels to classify organisms.

To help you understand the levels in classification, imagine a room filled with everybody from your state. First, all of the people from your town raise their hands. Then, those from your neighborhood raise their hands. Then, those from your street raise their hands. Finally, those from your house raise their hands. Each time, fewer people raise their hands. But you'd be in all of the groups. The most general group you belong to is the state. The most specific group is the house. The more levels you share with others, the more you have in common with them. Of course, organisms are not grouped by where they live, but rather by their shared characteristics.

The Major Levels of Classification Most biologists today classify organisms into eight levels. First, an organism is placed in a broad group, which in turn is divided into more specific groups. **The more classification levels that two organisms share, the more characteristics they have in common.**

Here are the eight classification levels that biologists commonly use.

- A domain is the highest level of organization.
- Within a domain, there are kingdoms.
- Within kingdoms, there are phyla (FY luh) (singular *phylum*).
- Within phyla are classes.
- Within classes are orders.
- Within orders are families.
- Each family contains one or more genera.
- Each genus contains one or more species.

Classifying an Owl Look at Figure 10 to see how the grea horned owl is classified. The top row shows a wide variety o organisms that share the owl's domain. Notice that as you move down the levels, there are fewer kinds of organisms in each group. The organisms in each new group have more in common, however. For example, the class Aves includes al birds. The order Strigiformes includes only owls.

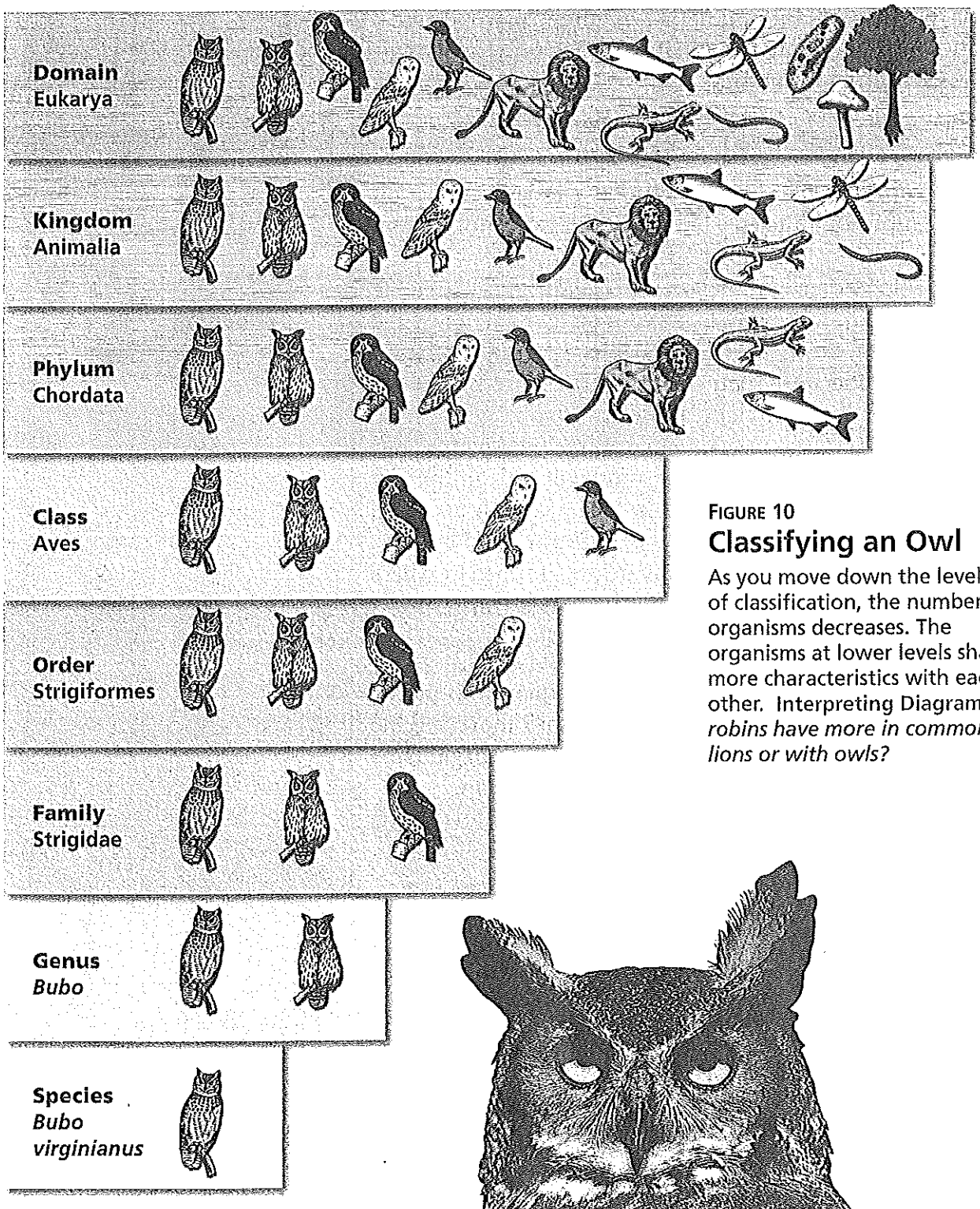


FIGURE 10
Classifying an Owl
As you move down the levels of classification, the number of organisms decreases. The organisms at lower levels share more characteristics with each other. Interpreting Diagrams *Do robins have more in common with lions or with owls?*

Domains and Kingdoms

Today, a three-domain system of classification is commonly used. Shown in Figure 11, the three domains are Bacteria, Archaea, and Eukarya. Within the domains are six kingdoms. **Organisms are placed into domains and kingdoms based on their cell type, their ability to make food, and the number of cells in their bodies.**

Bacteria Although you may not know it, members of the domain Bacteria (kingdom Eubacteria) are all around you. You can find them in the yogurt you eat, on every surface you touch, and inside your body, both when you are healthy and sick. Some bacteria are autotrophs, while others are heterotrophs.

Members of the domain Bacteria are prokaryotes (proh KA ree ohtz). **Prokaryotes** are organisms whose cells lack a nucleus. A **nucleus** (NOO klee us) (plural *nuclei*) is a dense area in a cell that contains nucleic acids—the chemical instructions that direct the cell's activities. In prokaryotes, nucleic acids are not contained within a nucleus.

Archaea Deep in the Pacific Ocean, hot gases and molten rock spew out from a vent in the ocean floor. Surprisingly, a group of tiny organisms thrives there. They are members of the domain Archaea (kingdom Archaebacteria), whose name comes from the Greek word for "ancient." Archaea can be found in some of the most extreme environments on Earth, including hot springs, very salty water, swamps, and the intestines of cows! Scientists think that the harsh conditions in which archaea live are similar to those of ancient Earth.

Like bacteria, archaea are unicellular prokaryotes. And like bacteria, some archaea are autotrophs while others are heterotrophs. Archaea are classified in their own domain, however, because their structure and chemical makeup differ from that of bacteria.

Reading Checkpoint **What is a nucleus?**

Lab zone Skills Activity

Classifying

Test your classifying skills using Figure 10. Look carefully at the organisms pictured together at the kingdom level. Make a list of the characteristics that the organisms share. Then make two more lists of shared characteristics—one for the organisms at the class level and the other for those at the genus level. How does the number of shared characteristics on your lists change at each level?

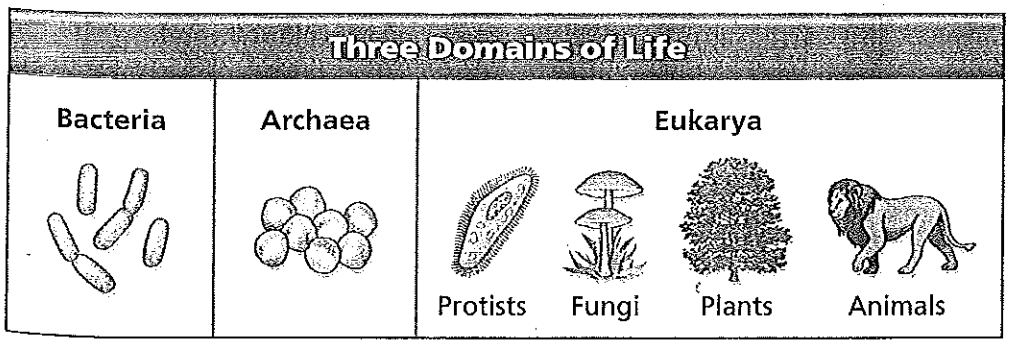
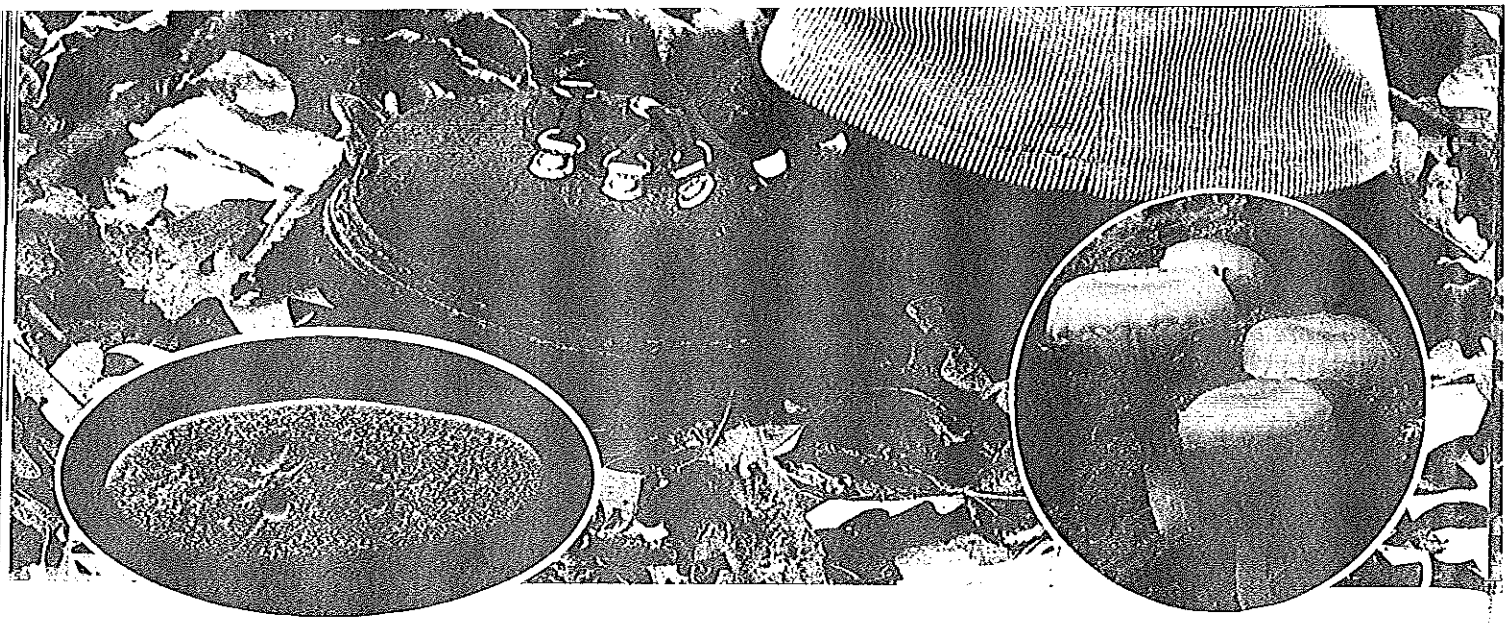


FIGURE 11
Three Domains
In the three-domain system of classification, all known organisms belong to one of three domains—Bacteria, Archaea, or Eukarya.



▲ **Protists:** Paramecium

▲ **Fungi:** Mushrooms

FIGURE 12
Domain Eukarya
You can encounter organisms from all four kingdoms of Eukarya on a hike through the woods.
Making Generalizations *What characteristic do all Eukarya share?*

Domain Eukarya

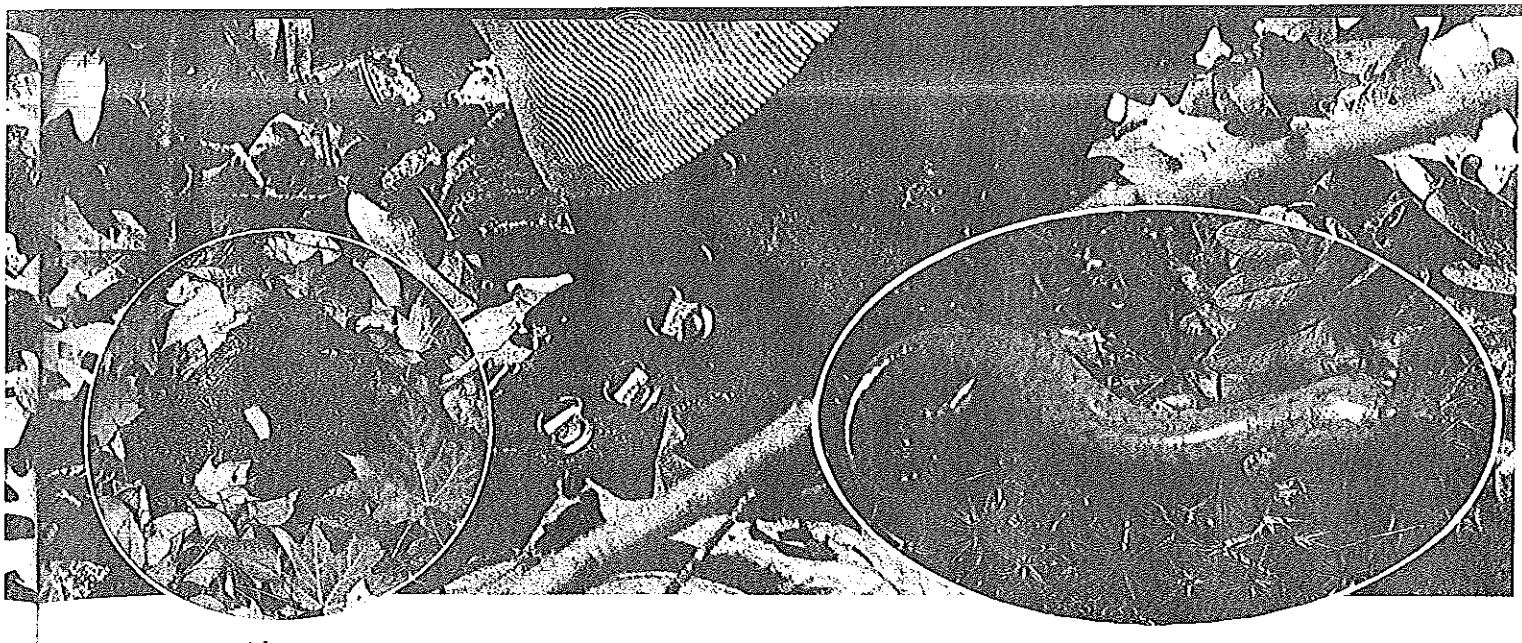
What do seaweeds, mushrooms, tomatoes, and dogs have in common? They are all members of the domain Eukarya. Organisms in this domain are **eukaryotes** (yoo KA ree ohtz)—organisms with cells that contain nuclei. **Scientists classify organisms in the domain Eukarya into one of four kingdoms: protists, fungi, plants, or animals.**

Protists A protist (PROH tist) is any eukaryotic organism that cannot be classified as an animal, plant, or fungus. Because its members are so different from one another, the protist kingdom is sometimes called the "odds and ends" kingdom. For example, some protists are autotrophs, while other protists are heterotrophs. Most protists are unicellular, but some, such as seaweeds, are large multicellular organisms.

Fungi If you have eaten mushrooms, then you have eaten fungi (FUN jy). Mushrooms, molds, and mildew are all fungi. Most fungi are multicellular eukaryotes. A few, such as the yeast you use for baking, are unicellular eukaryotes. Fungi are found almost everywhere on land, but only a few live in fresh water. All fungi are heterotrophs. Most fungi feed by absorbing nutrients from dead or decaying organisms.

Plants Dandelions on a lawn, mosses in a forest, and peas in a garden are familiar members of the plant kingdom. Plants are all multicellular eukaryotes and most live on land. In addition, plants are autotrophs that make their own food. Plants provide food for most of the heterotrophs on land.

The plant kingdom includes a great variety of organisms. Some plants produce flowers, while others do not. Some plants, such as giant redwood trees, can grow very tall. Others, like mosses, never grow taller than a few centimeters.



▲ **Plants:** Moss

▲ **Animals:** Salamander

Animals A dog, a flea on the dog's ear, and a cat that the dog chases have much in common because all are animals. All animals are multicellular eukaryotes. In addition, all animals are heterotrophs. Animals have different adaptations that allow them to locate food, capture it, eat it, and digest it. Members of the animal kingdom live in diverse environments throughout Earth. Animals can be found from ocean depths to mountaintops, from hot, scalding deserts to cold, icy landscapes.

Reading Checkpoint **Which two kingdoms consist only of heterotrophs?**

Section 2 Assessment

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

Reviewing Key Concepts

1. a. Reviewing Why do biologists classify?
   b. Inferring Suppose someone tells you that a jaguarundi is classified in the same genus as a house cat. What characteristics do you think a jaguarundi might have?
   c. Predicting What genus name would you expect a jaguarundi to have? Explain.
2. a. Listing List in order the levels of classification, beginning with domain.
   b. Applying Concepts Woodchucks are classified in the same family as squirrels, but in a different family than mice. Do woodchucks have more characteristics in common with squirrels or mice? Explain.
3. a. Identifying What are the three domains into which organisms are classified?
   b. Classifying Which two domains include only organisms that are prokaryotes?
   c. Comparing and Contrasting How do the members of the two domains of prokaryotes differ?

Lab zone At-Home Activity

Kitchen Classification With a family member, go on a "classification hunt" in the kitchen. Look in your refrigerator, cabinets, and drawers to discover what classification systems your family uses to organize items. Then explain to your family member the importance of classification in biology.

Lab zone Skills Lab

What's That Organism?

Problem

How can you make and use dichotomous keys to classify living things?

Skills Focus

observing, classifying, inferring

Materials

- group of objects or images for Part 2
- group of objects or images for Part 3

Procedure

PART 1 Examining a Dichotomous Key

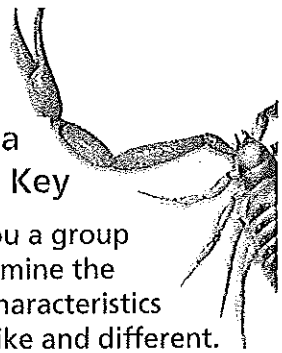
1. Dichotomous keys, also called taxonomic keys, can be used to classify groups of organisms. Use Dichotomous Key 1 to classify the unidentified organism shown at the right. Start by reading statements 1a and 1b. Notice that they describe opposite characteristics. Choose the statement that applies to the unknown organism.
2. Read the direction after the statement you just chose. Since the unidentified organism has two body regions, go to Step 2. Choose either statement 2a or 2b. Continue the process until the key leads you to the organism's identity. Write the name of the organism in your notebook.

PART 2 Classifying Into Kingdoms With a Dichotomous Key

3. Your teacher will give you a group of numbered organisms or images of organisms. Create a data table with four columns: (1) Number of the Organism, (2) Observed Physical Characteristics, (3) Kingdom, and (4) Questions or Problems.
4. Use Dichotomous Key 2 and your data table to classify each organism. Record the characteristics you observe. Classify each organism. If you have any questions or problems, describe them in the last column.

Dichotomous Key 1

Step 1	1a.	Has two body regions	Go to Step 2
	1b.	Does not have two body regions	Go to Step 4
Step 2	2a.	Has clawlike pincers	Go to Step 3
	2b.	Has no clawlike pincers	Spider
Step 3	3a.	Has a long tail with a stinger	Scorpion
	3b.	Has no tail or stinger	Pseudoscorpion



PART 3 Constructing a Dichotomous Key

5. Your teacher will give you a group of objects for Part 3. Examine the objects. List about five characteristics that make the objects alike and different.
6. Use your list to construct a dichotomous key for the objects. Remember that your key must consist of paired statements similar to those in the other keys in this lab. Try out your key to make sure it classifies all the objects.
7. Exchange your objects and key with a partner. If your partner cannot identify all the objects, revise the key as needed.

Dichotomous Key 2			
Step 1	1a.	Can be seen without a microscope (multicellular)	Go to Step 2
	1b.	Can be seen only with a microscope (unicellular)	Go to Step 4
Step 2	2a.	Has chloroplasts (green cell parts)	Plants
	2b.	Has no chloroplasts	Go to Step 3
Step 3	3a.	Absorbs food; may be attached to food source	Fungi
	3b.	Captures and eats food; moves or has appendages	Animals
Step 4	4a.	Has no nucleus; cell is very small	Eubacteria or Archaebacteria
	4b.	Has a nucleus and other cell parts	Go to Step 5
Step 5	5a.	Has a cell wall made of chitin, but no chloroplasts	Fungi
	5b.	May or may not have cell wall; may have chloroplasts	Protists

Analyze and Conclude

1. Classifying What is the unidentified organism you examined in Part 1?
2. Classifying To which kingdom does each organism from Part 2 belong?
3. Interpreting Data Did you have any problems classifying any organisms in Part 2? If so, describe those problems.
4. Inferring Explain why the paired statements in a dichotomous key must be opposites.
5. Applying Concepts In Part 3, did your partner have any problems using your key? If so, what revisions did you make?
6. Communicating What advice would you give to someone who has to make up a dichotomous key? Write an explanation of the parts of the task you found easy. What was difficult? How did you overcome your difficulties?

Design an Experiment

Suppose you are planning to hike through the woods. You expect to see a variety of flowers. What characteristics would you include in a dichotomous key that would help identify the flowers?