

Classification of Living Things

ESSENTIAL QUESTION

How are organisms classified?

By the end of this lesson, you should be able to describe how people sort living things into groups based on shared characteristics.

Scientists use physical and chemical characteristics to classify organisms. Is that a spider? Look again. It's an ant mimicking a jumping spider!



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Lesson Labs

Quick Labs

- Using a Dichotomous Key
- Investigate Classifying Leaves

Exploration Lab

- Developing Scientific Names

Engage Your Brain

1 Predict Check T or F to show whether you think each statement is true or false.

- | | | |
|--------------------------|--------------------------|---|
| T | F | |
| <input type="checkbox"/> | <input type="checkbox"/> | The classification system used today has changed very little since it was introduced. |
| <input type="checkbox"/> | <input type="checkbox"/> | To be classified as an animal, an organism must have a backbone. |
| <input type="checkbox"/> | <input type="checkbox"/> | Organisms can be classified according to whether they have nuclei in their cells. |
| <input type="checkbox"/> | <input type="checkbox"/> | Scientists can study genetic material to classify organisms. |
| <input type="checkbox"/> | <input type="checkbox"/> | Organisms that have many physical similarities are always related. |



2 Analyze The flowering plant shown above is called an Indian pipe. It could be mistaken for a fungus. Write down how the plant is similar to and different from other plants you know.

Active Reading

3 Word Parts Many English words have their roots in other languages. Use the Latin suffix below to make an educated guess about the meaning of the word *Plantae*.

Latin suffix	Meaning
-ae	a group of

Example sentence

Maples are part of the kingdom Plantae.

Plantae:

Vocabulary Terms

- | | |
|------------|------------|
| • species | • Eukarya |
| • genus | • Protista |
| • domain | • Fungi |
| • Bacteria | • Plantae |
| • Archaea | • Animalia |

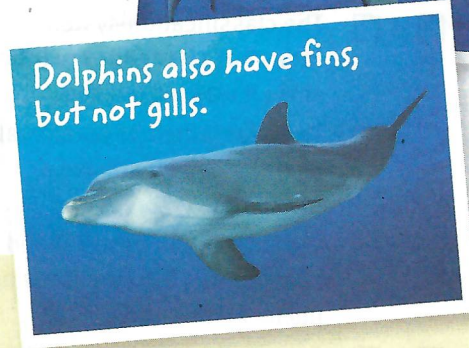
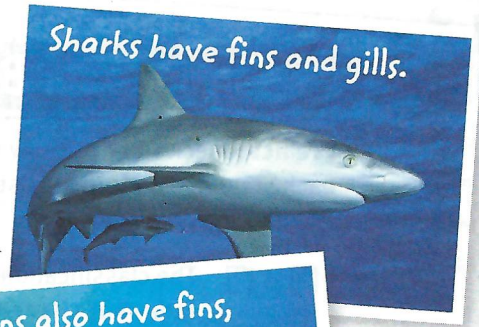
4 Apply As you learn the definition of each vocabulary term in this lesson, write your own definition or make a sketch to help you remember the meaning of each term.

Sorting Things Out!

Why do we classify living things?

There are millions of living things on Earth. How do scientists keep all of these living things organized? Scientists *classify* living things based on characteristics that living things share. Classification helps scientists answer questions such as:

- How many kinds of living things are there?
- What characteristics define each kind of living thing?
- What are the relationships among living things?



Visualize It!

5 Analyze The photos show two organisms. In the table, place a check mark in the box for each characteristic that the organisms have.



	Wings	Antennae	Beak	Feathers
Yellow pansy butterfly				
American goldfinch				

6 Summarize What characteristics do yellow pansy butterflies have in common with American goldfinches? How do they differ?

How do scientists know living things are related?

If two organisms look similar, are they related? To classify organisms, scientists compare physical characteristics. For example, they may look at size or bone structure. Scientists also compare the chemical characteristics of living things.

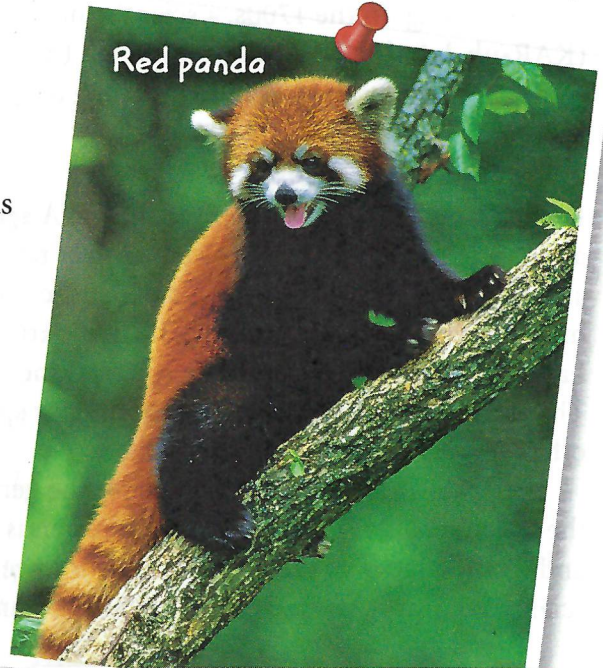
Physical Characteristics

How are chickens similar to dinosaurs? If you compare dinosaur fossils and chicken skeletons, you will see that chickens and dinosaurs share many physical characteristics. Scientists look at physical characteristics, such as skeletal structure. They also study how organisms develop from an egg to an adult. For example, animals with similar skeletons and development may be related.

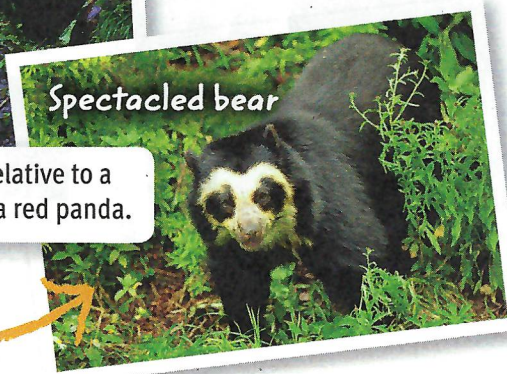
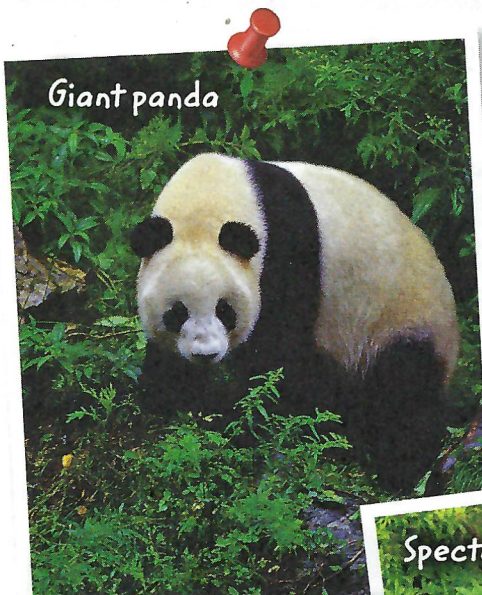
Chemical Characteristics

Scientists can identify the relationships among organisms by studying genetic material such as DNA and RNA. They study mutations and genetic similarities to find relationships among organisms. Organisms that have very similar gene sequences or have the same mutations are likely related. Other chemicals, such as proteins and hormones, can also be studied to learn how organisms are related.

The two pandas below share habitats and diets. They look alike, but they have different DNA.



The red panda is a closer relative to a raccoon than it is to a giant panda.



The giant panda is a closer relative to a spectacled bear than it is to a red panda.

7 List How does DNA lead scientists to better classify organisms?

What's in a Name?

How are living things named?

Early scientists used names as long as 12 words to identify living things, and they also used common names. So, classification was confusing. In the 1700s, a scientist named Carolus Linnaeus (KAR•uh•luhs lih•NEE•uhs) simplified the naming of living things. He gave each kind of living thing a two-part *scientific name*.

Scientific Names

Each species has its own scientific name. A **species** (SPEE•sheez) is a group of organisms that are very closely related. They can mate and produce fertile offspring. Consider the scientific name for a mountain lion: *Puma concolor*. The first part, *Puma*, is the genus name. A **genus** (JEE•nuhs; plural, *genera*) includes similar species. The second part, *concolor*, is the specific, or species, name. No other species is named *Puma concolor*.

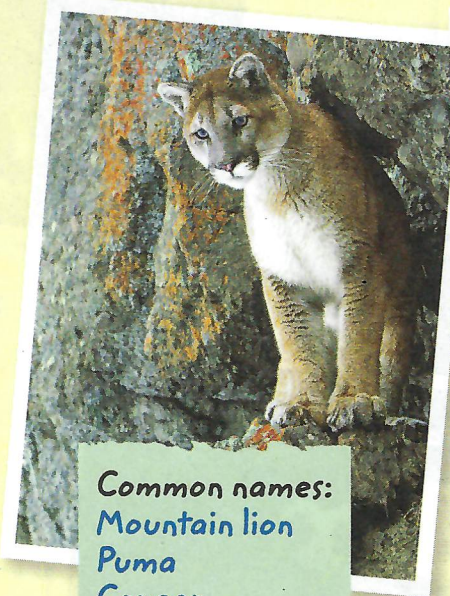
A scientific name always includes the genus name followed by the specific name. The first letter of the genus name is capitalized, and the first letter of the specific name is lowercase. The entire scientific name is written either in italics or underlined.



The A.K.A. Files

Some living things have many common names. Scientific names prevent confusion when people discuss organisms.

Scientific name:
Puma concolor



Common names:
Mountain lion
Puma
Cougar
Panther

Scientific name:
Acer rubrum



Common names:
Red maple
Swamp maple
Soft maple

8 Apply In the scientific names above, circle the genus name and underline the specific name.

Active Reading

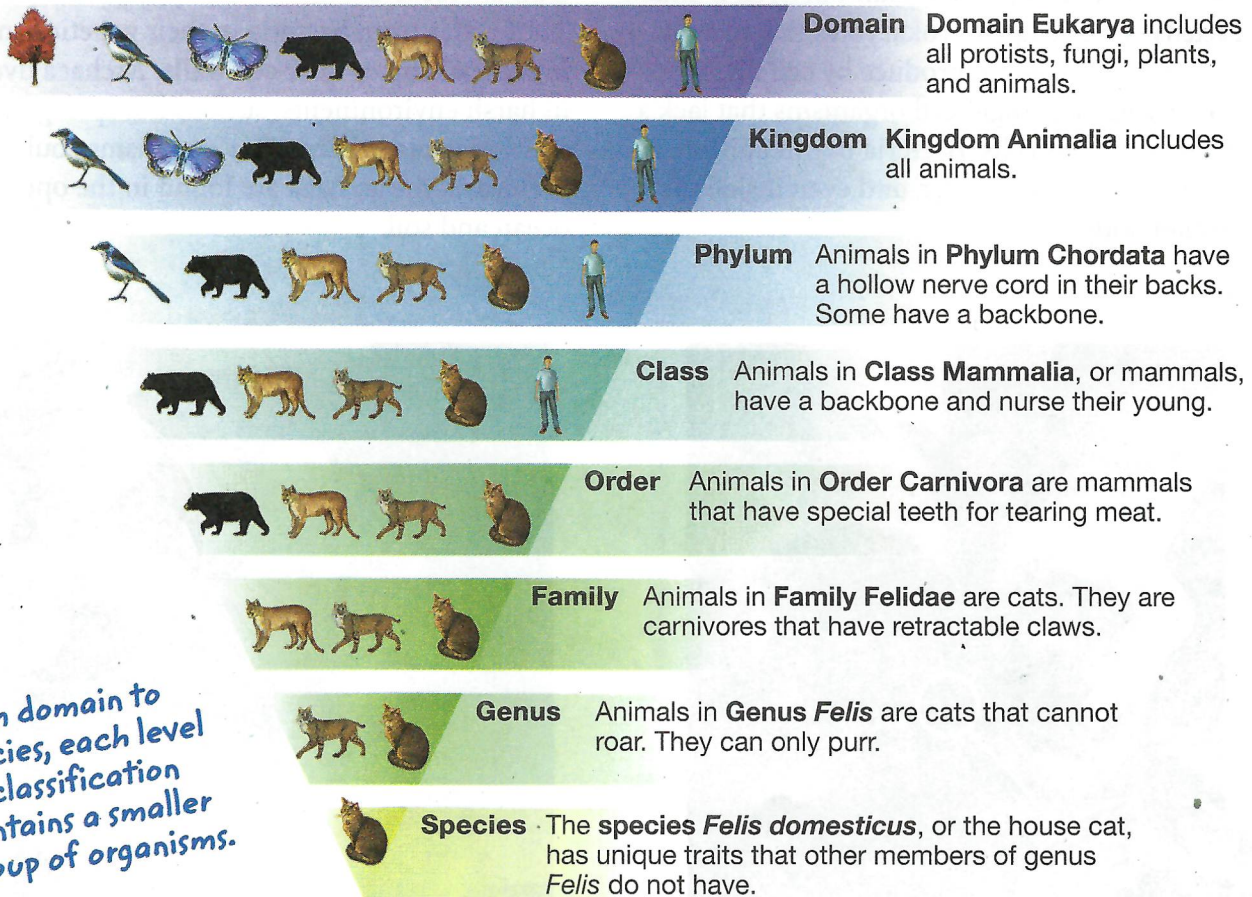
9 Identify As you read, underline the levels of classification.

What are the levels of classification?

Linnaeus's ideas became the basis for modern taxonomy (tak•SAHN•uh•mee). *Taxonomy* is the science of describing, classifying, and naming living things. At first, many scientists sorted organisms into two groups: plants and animals. But numerous organisms did not fit into either group.

Today, scientists use an eight-level system to classify living things. Each level gets more specific. Therefore, it contains fewer kinds of living things than the level above it. Living things in the lower levels are more closely related to each other than they are to organisms in the higher levels. From most general to more specific, the levels of classification are domain, kingdom, phylum (plural, *phyla*), class, order, family, genus, and species.

Classifying Organisms



From domain to species, each level of classification contains a smaller group of organisms.

Visualize It!

10 Apply What is true about the number of organisms as they are classified closer to the species level?

Triple Play

Active Reading

11 Identify As you read, underline the first mention of the three domains of life.

What are the three domains?

Once, kingdoms were the highest level of classification. Scientists used a six-kingdom system. But scientists noticed that organisms in two of the kingdoms differed greatly from organisms in the other four kingdoms. So scientists added a new classification level: domains. A **domain** represents the largest differences among organisms. The three domains are Bacteria (bak•TIR•ee•uh), Archaea (ar•KEE•uh), and Eukarya (yoo•KAIR•ee•uh).

Bacteria

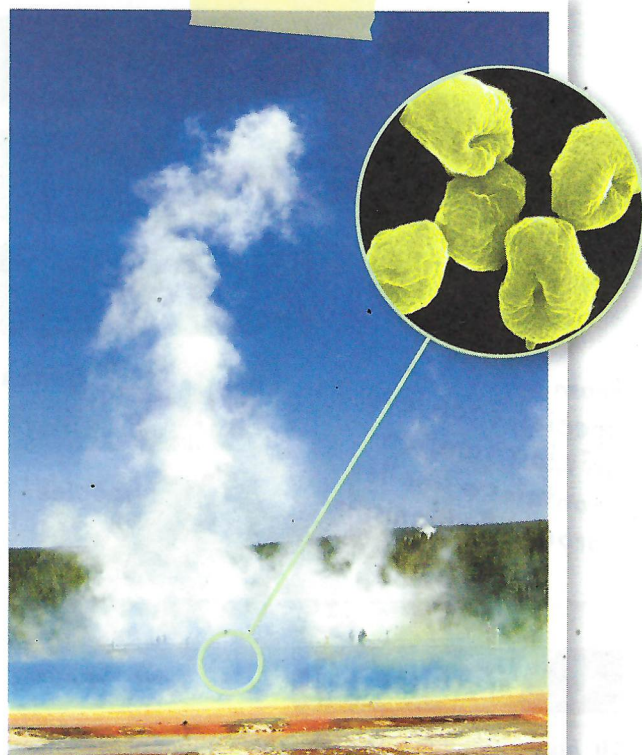
All bacteria belong to Domain Bacteria. Domain **Bacteria** is made up of prokaryotes that usually have a cell wall and reproduce by cell division. *Prokaryotes* are single-cell organisms that lack a nucleus in their cells. Bacteria live in almost any environment—soil, water, and even inside the human body!

Archaea

Domain **Archaea** is also made up of prokaryotes. They differ from bacteria in their genetics and in the makeup of their cell walls. Archaea live in harsh environments, such as hot springs and thermal vents, where other organisms could not survive. Some archaea are found in the open ocean and soil.



Bacteria from the genus Streptomyces are commonly found in soil.



Archaea from the genus Sulfolobus are found in hot springs.

Eukarya

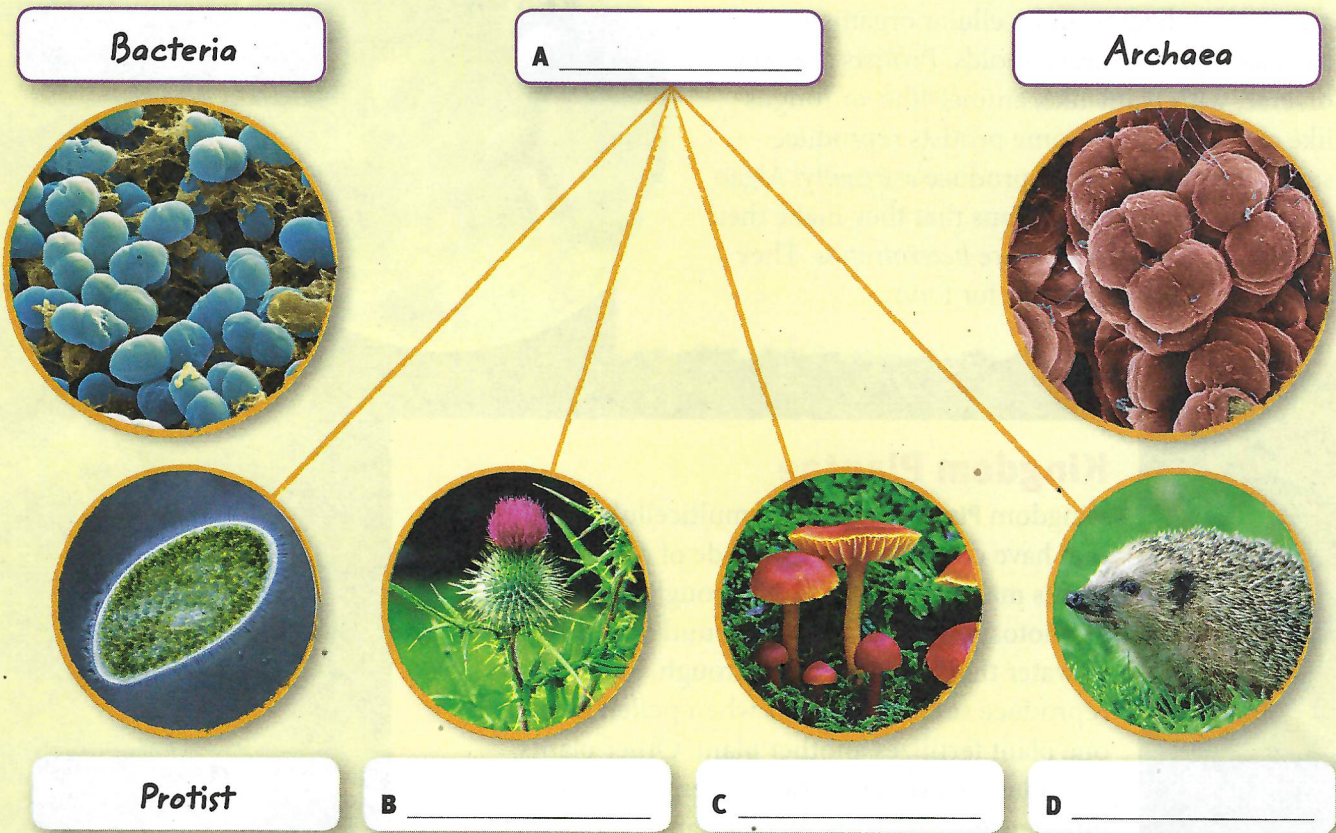
What do algae, mushrooms, trees, and humans have in common? All of these organisms are *eukaryotes*. Eukaryotes are made up of cells that have a nucleus and membrane-bound organelles. The cells of eukaryotes are more complex than the cells of prokaryotes. For this reason, the cells of eukaryotes are usually larger than the cells of prokaryotes. Some eukaryotes, such as many protists and some fungi, are single-celled. Many eukaryotes are multicellular organisms. Some protists and many fungi, plants, and animals are multicellular eukaryotes. Domain **Eukarya** is made up of all eukaryotes.



It may look like a pinecone, but the pangolin is actually an animal from Africa. It is in Domain Eukarya.

Visualize It!

12 Identify Fill in the blanks with the missing labels.



13 Compare What are the differences between Bacteria and Eukarya?

My Kingdom for a

What are the four kingdoms in Eukarya?

Scientists have classified four types of Eukarya. They ask questions to decide in which kingdom to classify an organism.

- Is the organism single-celled or multicellular?
- Does it make its food or get it from the environment?
- How does it reproduce?

Kingdom Protista

Members of the kingdom **Protista**, called *protists*, are single-celled or multicellular organisms such as algae and slime molds. Protists are very diverse, with plant-like, animal-like, or fungus-like characteristics. Some protists reproduce sexually, while others reproduce asexually. Algae are *autotrophs*, which means that they make their own food. Some protists are *heterotrophs*. They consume other organisms for food.



Kingdom Plantae

Kingdom **Plantae** consists of multicellular organisms that have cell walls, mostly made of cellulose. Most plants make their own food through the process of photosynthesis. Plants are found on land and in water that light can pass through. Some plants reproduce sexually, such as when pollen from one plant fertilizes another plant. Other plants reproduce asexually, such as when potato buds grow into new potato plants. While plants can grow, they cannot move by themselves.

14 Compare How are protists different from plants?

Eukaryote!

Kingdom Fungi

The members of the kingdom **Fungi** get energy by absorbing materials. They have cells with cell walls but no chloroplasts. Fungi are single-celled or multicellular and include yeasts, molds, and mushrooms. Fungi use digestive juices to break down materials around them for food. Fungi reproduce sexually, asexually, or in both ways, depending on their type.



Active Reading 15 Identify As you read, underline the characteristics of the kingdom Animalia.

Kingdom Animalia

Kingdom **Animalia** contains multicellular organisms that lack cell walls. They do not have chloroplasts like plants and algae, so they must get nutrients by consuming other organisms. Therefore, they are heterotrophic. Animals have specialized sense organs, and most animals are able to move around. Birds, fish, reptiles, amphibians, insects, and mammals are just a few examples of animals. Most animals reproduce sexually, but a few types of animals reproduce asexually, such as by budding.



16 Classify Place a check mark in the box for the characteristic that each kingdom displays.

Kingdom	Cells		Nutrients		Reproduction	
	Unicellular	Multicellular	Autotrophic	Heterotrophic	Sexual	Asexual
Protista						
Plantae						
Fungi						
Animalia						

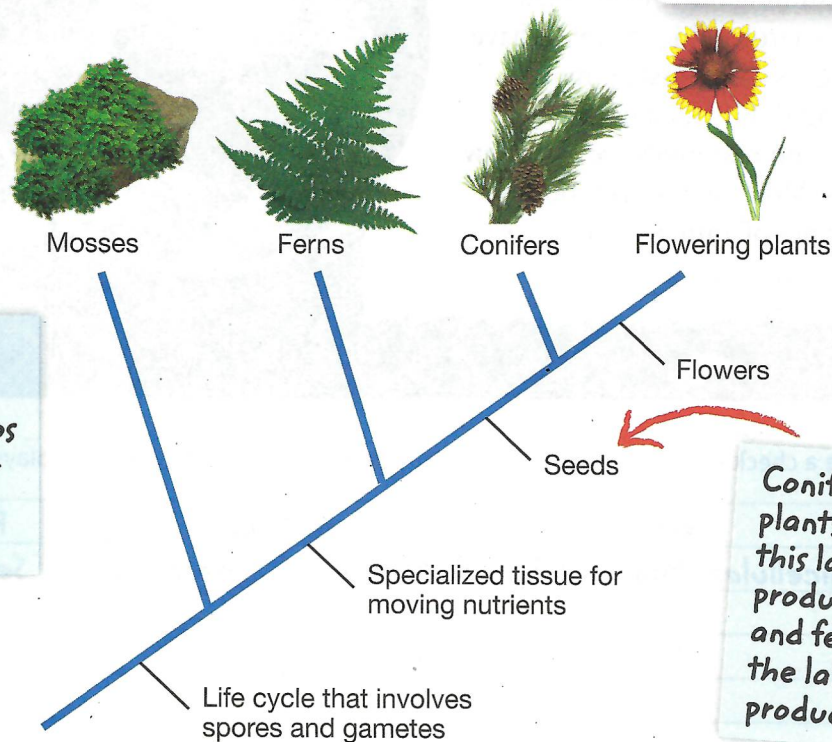
How do classification systems change over time?

Millions of organisms have been identified, but millions have yet to be named. Many new organisms fit into the existing system. However, scientists often find organisms that don't fit. Not only do scientists identify new species, but sometimes these species do not fit into existing genera or phyla. In fact, many scientists argue that protists are so different from one another that they should be classified into several kingdoms instead of one. Classification continues to change as scientists learn more about living things.

How do branching diagrams show classification relationships?

How do you organize your closet? What about your books? People organize things in many different ways. Linnaeus' two-name system worked for scientists long ago, but the system does not represent what we know about living things today. Scientists use different tools to organize information about classification.

Scientists often use a type of branching diagram called a *cladogram* (KLAD•uh•gram). A cladogram shows relationships among species. Organisms are grouped according to common characteristics. Usually these characteristics are listed along a line. Branches of organisms extend from this line. Organisms on branches above each characteristic have the characteristic. Organisms on branches below lack the characteristic.



This branching diagram shows the relationships among the four main groups of plants.

Conifers and flowering plants are listed above this label, so they both produce seeds. Mosses and ferns, listed below the label, do not produce seeds.

Active Reading

17 Predict How might the classification of protists change in the future?

Visualize It!

18 Apply How can you use the branching diagram to tell which plants produce seeds?

A Class by Themselves

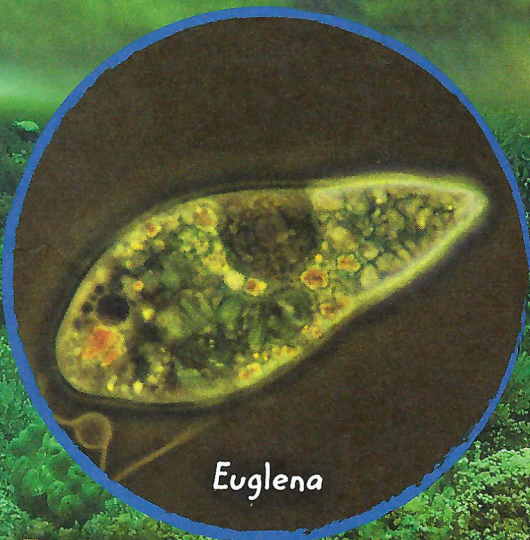
As scientists find more living things to study, they find that they may not have made enough classifications, or that their classifications may not describe organisms well enough. Some living things have traits that fall under more than one classification. These organisms are very difficult to classify.



Sea spider

Sea Spider

The sea spider is a difficult-to-classify animal. It is an arthropod because it has body segments and an exoskeleton. The problem is in the sea spider's mouth. They eat by sticking a straw-like structure into sponges and sea slugs and sucking out the juice. No other arthropod eats like this. Scientists must decide if they need to make a new classification or change an existing one to account for this strange mouth.



Euglena

Euglena

An even stranger group of creatures is Euglena. Euglena make their own food as plants do. But, like animals, they have no cell walls. They have a flagellum, a tail-like structure that bacteria have. Despite having all of these characteristics, Euglena have been classified as protists.

Extend

- 19 Explain** In which domain would the sea spider be classified? Explain your answer.
- 20 Research** Investigate how scientists use DNA to help classify organisms such as the sea spider.

Inquiry

- 21 Debate** Find more information on Euglena and sea spiders. Hold a class debate on how scientists should classify the organisms.

Keys to Success

How can organisms be identified?

Imagine walking through the woods. You see an animal sitting on a rock. It has fur, whiskers, and a large, flat tail. How can you find out what kind of animal it is? You can use a dichotomous key.

Dichotomous Keys

A *dichotomous key* (dy•KAHT•uh•muhs KEE) uses a series of paired statements to identify organisms. Each pair of statements is numbered. When identifying an organism, read each pair of statements. Then choose the statement that best describes the organism. Either the chosen statement identifies the organism, or you will be directed to another pair of statements. By working through the key, you can eventually identify the organism.

22 Apply Use the dichotomous key below to identify the animals shown in the photographs.

Dichotomous Key to Six Mammals in the Eastern United States

1	A The mammal has no hair on its tail.	Go to step 2
	B The mammal has hair on its tail.	Go to step 3
2	A The mammal has a very short naked tail.	Eastern mole
	B The mammal has a long naked tail.	Go to step 4
3	A The mammal has a black mask.	Raccoon
	B The mammal does not have a black mask.	Go to step 5
4	A The mammal has a flat, paddle-shaped tail.	Beaver
	B The mammal has a round, skinny tail.	Possum
5	A The mammal has a long furry tail that is black on the tip.	Long-tailed weasel
	B The mammal has a long tail that has little fur.	White-footed mouse



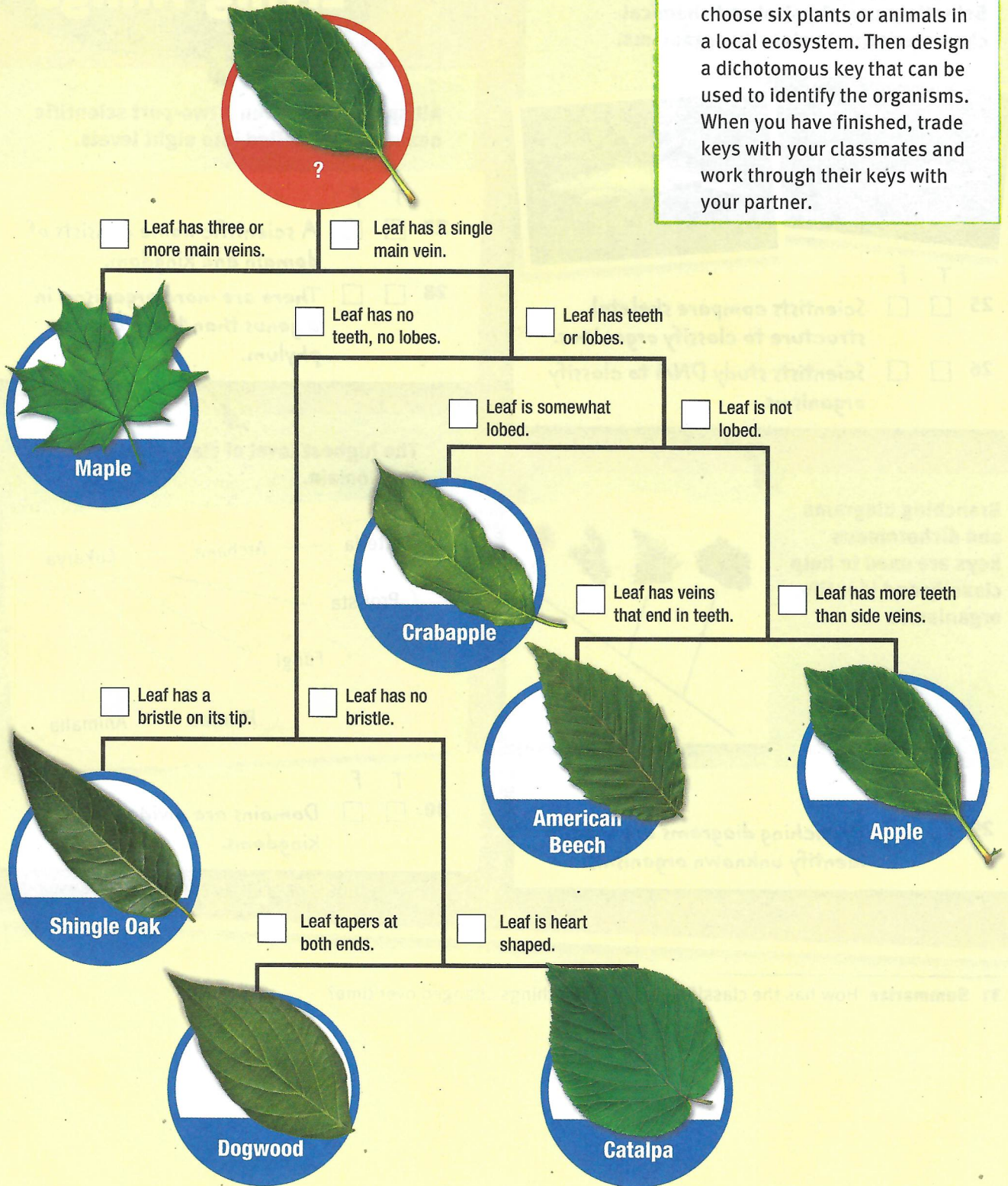


Visualize It!

23 Apply Some dichotomous keys are set up as diagrams instead of tables. Work through the key below to identify the unknown plant.

Think Outside the Book **Inquiry**

24 Summarize With a partner, choose six plants or animals in a local ecosystem. Then design a dichotomous key that can be used to identify the organisms. When you have finished, trade keys with your classmates and work through their keys with your partner.



Visual Summary

To complete this summary, check the box that indicates true or false. Then, use the key below to check your answers. You can use this page to review the main concepts of the lesson.

Classification of Living Things

Scientists use physical and chemical characteristics to classify organisms.

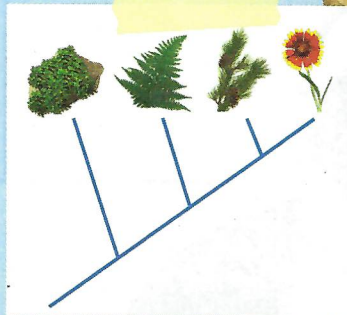


- T F
- 25 Scientists compare skeletal structure to classify organisms.
- 26 Scientists study DNA to classify organisms.

All species are given a two-part scientific name and classified into eight levels.

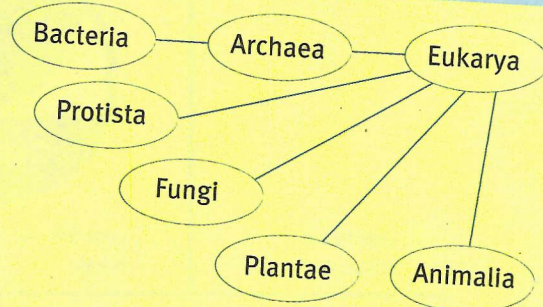
- T F
- 27 A scientific name consists of domain and kingdom.
- 28 There are more organisms in a genus than there are in a phylum.

Branching diagrams and dichotomous keys are used to help classify and identify organisms.



- T F
- 29 Branching diagrams are used to identify unknown organisms.

The highest level of classification is the domain.



- T F
- 30 Domains are divided into kingdoms.

Answers: 25 T; 26 T; 27 F; 28 F; 29 F; 30 T

31 Summarize How has the classification of living things changed over time?

Lesson Review

Vocabulary

Fill in the blanks with the term that best completes the following sentences.

- 1 A _____ contains paired statements that can be used to identify organisms.
- 2 The kingdoms of eukaryotes are _____, Fungi, Plantae, and Animalia.
- 3 Domains _____ and _____ are made up of prokaryotes.

Key Concepts

- 4 **List** Name the eight levels of classification from most general to most specific.

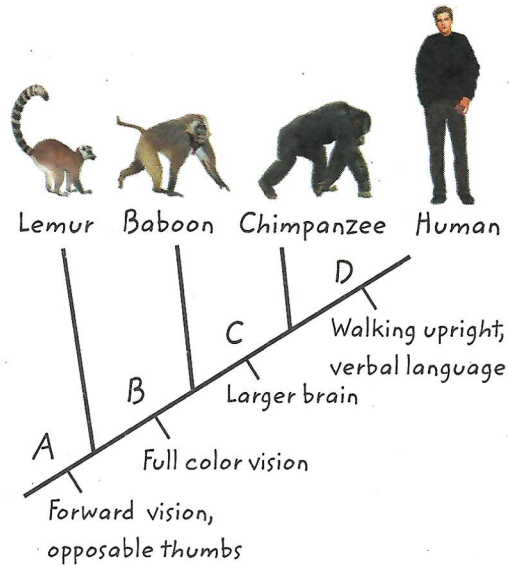
- 5 **Explain** Describe how scientists choose the kingdom in which a eukaryote belongs.

- 6 **Identify** What two types of evidence are used to classify organisms?

- 7 **Compare** Dichotomous keys and branching diagrams organize different types of information about classification. How are these tools used differently?

Critical Thinking

Use the figure to answer the following questions.



- 8 **Identify** Which traits do baboons have?

- 9 **Analyze** Which animal shares the most traits with humans?

- 10 **Synthesize** Do both lemurs and humans have the trait listed at point D? Explain.

- 11 **Classify** A scientist finds an organism that cannot move. It has many cells, produces spores, and gets food from its environment. In which kingdom does it belong? Explain.

