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Summary

18–1 Finding Order in Diversity

There are millions of different species on Earth. To study this great diversity of organisms, biologists must give each organism a name. Biologists also must organize living things into groups in a logical way. Therefore, biologists need a classification system. Taxonomy is the discipline of naming and classifying organisms. To be useful, the names that are assigned should be universally accepted. A good classification system should also group together organisms that are more similar to each other than they are to organisms in other groups.

Common names for organisms vary by language and region. This creates confusion. By the 1700s, scientists had tried to solve this problem by agreeing to use a single name for each species. At first, the names they used were very long. Then, Carolus Linnaeus developed a two-word naming system, called binomial nomenclature. This system is still used today. In binomial nomenclature, each species is assigned a two-part scientific name. The first part of the name refers to the genus (plural: genera). A genus is a group of closely related species. For example, the genus *Ursus* contains six bear species. The second part of the name, along with the genus name, refers to a single species (plural: species). Recall that species consist of individuals who can interbreed. The name *Ursus maritimus*, for example, refers to the species polar bear.

Linnaeus's system of classification has seven different levels. From smallest to largest, the levels are species, genus, family, order, class, phylum, and kingdom. Each of the levels is called a taxon (plural: taxa). Just as a genus is a group of similar species, a family is a group of similar genera, an order a group of similar families, a class a group of similar orders, a phylum (plural: phyla) a group of similar classes, and a kingdom a group of similar phyla. Linnaeus named two kingdoms of living things, the Animalia (animal) and Plantae (plant) kingdoms.

18–2 Modern Evolutionary Classification

Linnaeus and other taxonomists have always tried to group organisms according to biologically important characteristics. However, they have not always agreed upon which characteristics are most important.

Early classifications were based on visible similarities. Biologists now group organisms according to evolutionary relationships. The study of evolutionary relationships among organisms is called phylogeny. Classification based on evolutionary relationships is called evolutionary classification. Species within one genus are more closely related to each other than to species in another genus. This is because all members of a genus share a recent common ancestor. All genera in a family also share a common ancestor. However, this common ancestor is farther in the past than the common ancestor of species within a genus. The higher the level of the taxon, the farther back in time is the common ancestor of all the organisms in that taxon.

Many biologists now use a method called cladistic analysis to determine evolutionary relationships. Cladistic analysis is based on derived characters. Derived characters are new traits that arise as a group evolves over time. Derived traits are therefore found in closely related organisms but not in their distant ancestors. Derived characters can be used to construct a cladogram. A cladogram is a diagram that shows the evolutionary relationships among a group of organisms. A cladogram is basically an evolutionary tree, much like a family tree.

All organisms have DNA and RNA. Because DNA and RNA are so similar across all forms of life, these molecules can be compared in different species. The more similar the molecules are in different species, the more recently the species shared a common ancestor. Therefore, the more closely related they are.

Comparisons of DNA can also be used to estimate the length of time that two species have been evolving independently. A model called a molecular clock can be used for this purpose. The model assumes that neutral mutations, which do not affect phenotype, accumulate in gene pools. Two species evolving independently from each other will accumulate different neutral mutations through time. The more there are of these different neutral mutations, the longer the two species have been evolving independently.

18–3 Kingdoms and Domains

As biologists learned more about the natural world, they realized that Linnaeus's two kingdoms, Animalia and Plantae, did not represent all life forms. First, microorganisms, such as bacteria, were discovered. Microorganisms did not seem to fit into either kingdom, so they were placed in their own kingdom, called Protista. Then, mushrooms, yeast, and molds were separated from plants and placed in their own kingdom, called Fungi. Later, bacteria were separated from other Protista and placed in another new kingdom, called Monera. Finally, the Monera were divided into two kingdoms: Eubacteria and Archaebacteria. By the 1990s, a six-kingdom system of classification was proposed. It includes the kingdoms Eubacteria, Archaebacteria, Protista, Fungi, Plantae, and Animalia.

A new taxon, called the domain, is now used by many biologists. The domain is one level higher than the kingdom. Three domains are recognized: Bacteria, Archaea, and Eukarya.

The domain Bacteria includes unicellular organisms without a nucleus. They have cell walls containing a substance called peptidoglycan. The domain Bacteria corresponds to the kingdom Eubacteria.

The domain Archaea also includes unicellular organisms without a nucleus. These organisms have cell walls that do not contain peptidoglycan. The domain Archaea corresponds to the kingdom Archaebacteria.

The domain Eukarya includes the four remaining kingdoms: Protista, Fungi, Plantae, and Animalia. All members of the domain Eukarya have cells with a nucleus. Most members of the kingdom Protista are unicellular organisms. Some Protista are autotrophs; others, heterotrophs. Most members of the kingdom Fungi are multicellular, and all are heterotrophs. All members of the kingdom Plantae are multicellular autotrophs. Most plants cannot move about, and their cells have cell walls. All members of the kingdom Animalia are multicellular heterotrophs. Most animals can move about, and their cells lack cell walls.

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Section 18–1 Finding Order in Diversity

(pages 447–450)

Key Concepts

- How are living things organized for study?
- What is binomial nomenclature?
- What is Linnaeus's system of classification?

Why Classify? (page 447)

1. Why do biologists use a classification system to study the diversity of life?

_____

_____

2. The science of classifying organisms and assigning them universally accepted names is known as _____.

3. Is the following sentence true or false? In a good system of classification, organisms placed into a particular group are less similar to each other than they are to organisms in other groups. _____

Assigning Scientific Names (page 448)

4. Why is it confusing to refer to organisms by common names? _____

_____

_____

_____

_____

5. Circle the letter of each sentence that is true about early efforts at naming organisms.
   a. Names were usually in English.
   b. Names often described detailed physical characteristics of a species.
   c. Names could be very long.
   d. It was difficult to standardize the names.

6. The two-word naming system developed by Linnaeus is called _____

_____.

7. Circle the letter of each sentence that is true about binomial nomenclature.
   a. The system is no longer in use today.
   b. Each species is assigned a two-part scientific name.
   c. The scientific name is always written in italics.
   d. The second part of the scientific name is capitalized.

8. What is the genus of the grizzly bear, *Ursus arctos*? _____

_____

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Linnaeus's System of Classification (pages 449–450)

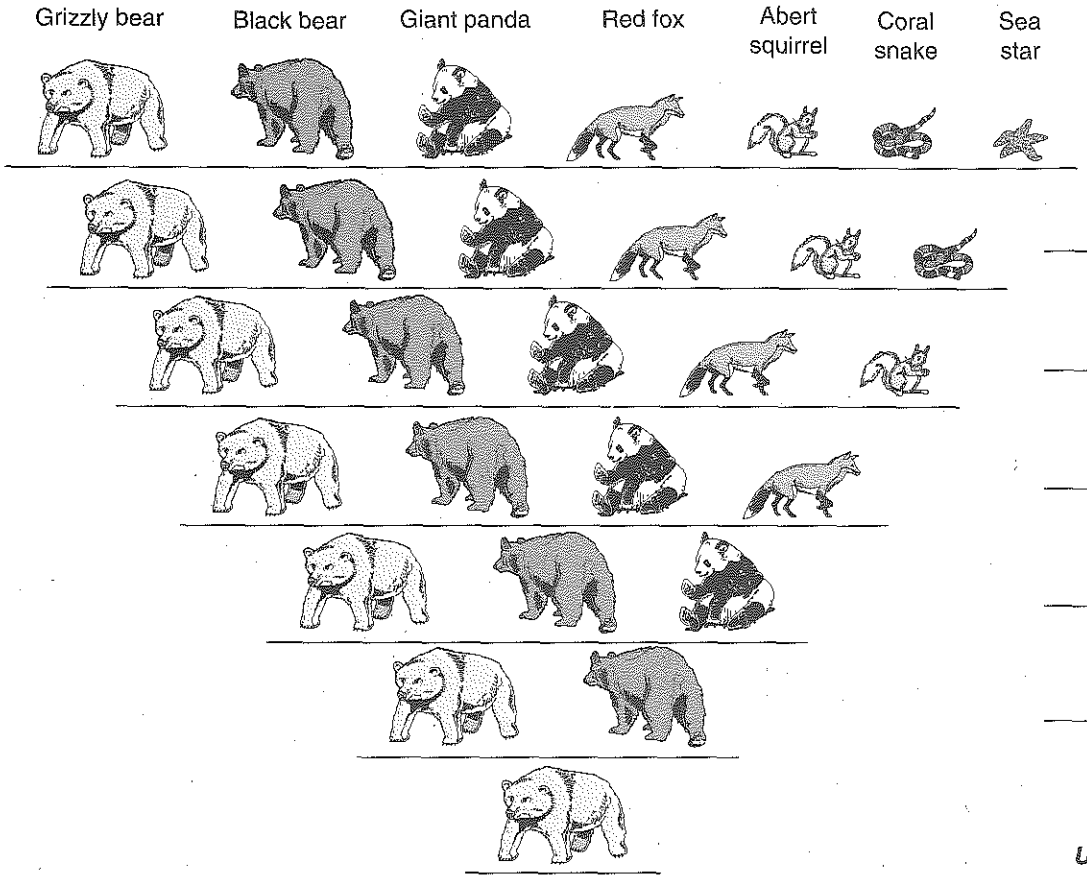
9. A group or level of organization in taxonomy is called a taxonomic category, or _____.

10. The largest taxonomic category in Linnaeus's system of classification is the _____, and the smallest is the _____.

11. What two kingdoms did Linnaeus name? _____

_____

12. Fill in the name of each missing taxonomic category in the chart below.



Reading Skill Practice

Taking notes can help you identify and remember the most important information when you read. Take notes on Section 18–1 by writing the main headings and under each heading listing the most important points. Include in your notes the boldface terms and sentences. Do your work on a separate sheet of paper.

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Section 18–2 Modern Evolutionary Classification (pages 451–455)

Key Concepts

- How are evolutionary relationships important in classification?
- How can DNA and RNA help scientists determine evolutionary relationships?

Introduction (page 451)

1. What traits did Linnaeus consider when classifying organisms? _____

Which Similarities Are Most Important? (page 451)

2. What problems are faced by taxonomists who rely on body-structure comparisons?

Evolutionary Classification (page 452)

3. Is the following sentence true or false? Darwin's theory of evolution changed the way biologists thought about classification. _____
4. How do biologists now group organisms into categories? _____
5. Is the following sentence true or false? Genera placed within a family should be less closely related to one another than to members of any other family. _____
6. The strategy of grouping organisms together based on their evolutionary history is called _____.

Classification Using Cladograms (page 453)

7. Circle the letter of each sentence that is true about cladistic analysis.
   a. It considers only traits that are evolutionary innovations.
   b. It considers all traits that can be measured.
   c. It considers only similarities in body structure.
   d. It is a method of evolutionary classification.
8. Characteristics that appear in recent parts of a lineage, but not in its older members, are called _____.

Name_____ Class_____ Date _____

9. A diagram that shows the evolutionary relationships among a group of organisms is called a(an) _____.
10. Is the following sentence true or false? Derived characters are used to construct a cladogram. _____

Similarities in DNA and RNA (page 454)

11. Is the following sentence true or false? Some organisms do not have DNA or RNA.

_____

12. How do similarities in genes show that humans and yeasts share a common ancestry?

_____

_____

_____

_____

Molecular Clocks (page 455)

13. A model that uses DNA comparisons to estimate the length of time that two species have been evolving independently is known as a(an) _____.
14. A molecular clock relies on the repeating process of _____.
15. Why are only neutral mutations useful for molecular clocks? _____

_____

_____

_____

_____

16. Is the following sentence true or false? The degree of dissimilarity in DNA sequences is an indication of how long ago two species shared a common ancestor.

_____

17. Why are there many molecular clocks in a genome instead of just one?

_____

_____

Name_____ Class_____ Date _____

Section 18–3 Kingdoms and Domains (pages 457–461)

Key Concepts

- What are the six kingdoms of life as they are now identified?
- What is the three-domain system of classification?

The Tree of Life Evolves (pages 457–458)

1. Is the following sentence true or false? The scientific view of life was more complex in Linnaeus's time. _____
2. What fundamental traits did Linnaeus use to separate plants from animals?

_____

_____

_____

3. What type of organisms were later placed in the kingdom Protista?

_____

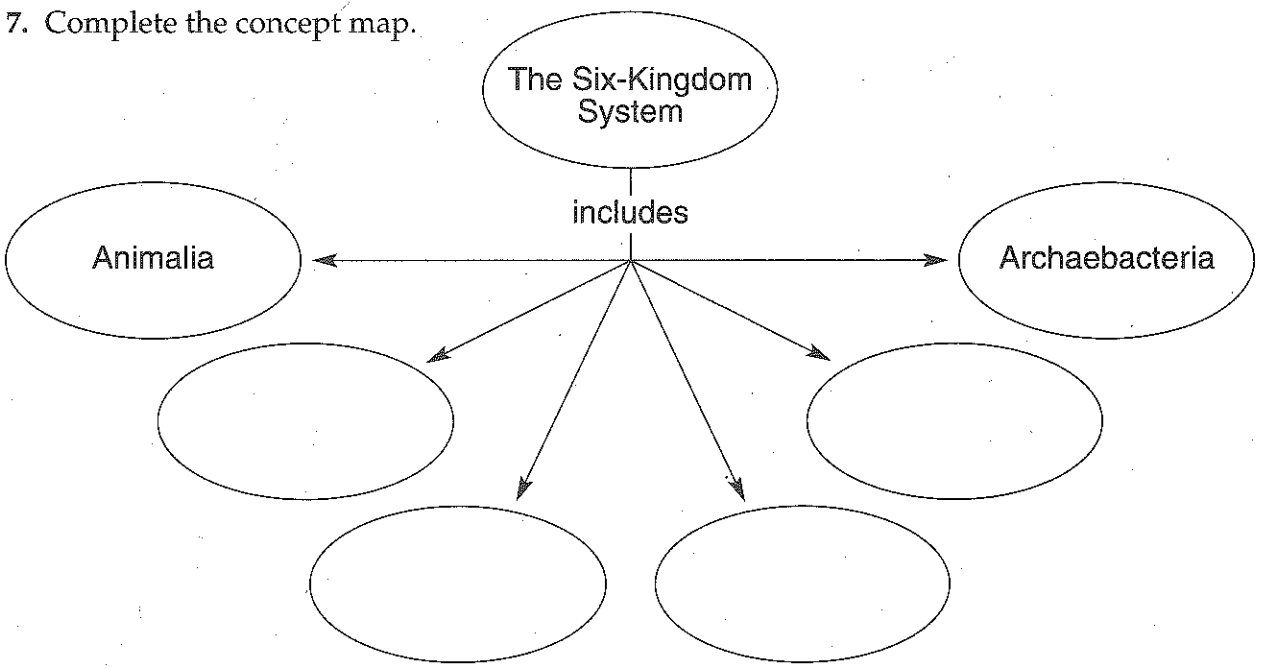
_____

4. Mushrooms, yeast, and molds have been placed in their own kingdom, which is called _____.
5. Why did scientists place bacteria in their own kingdom, the Monera? _____

_____

_____

6. List the two groups into which the Monera have been separated.
   a. _____
   b. _____
7. Complete the concept map.



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The Three-Domain System (page 458)

8. A more inclusive category than any other, including the kingdom, is the _____.

9. What type of analyses have scientists used to group modern organisms into domains? _____

10. List the three domains.
    a. _____
    b. _____
    c. _____

11. Complete the chart below.

CLASSIFICATION OF LIVING THINGS

Domain	Kingdom	Examples
	Eubacteria	*Streptococcus, Escherichia coli*
Archaea		
	Protist	
		Mushrooms, yeasts
	Plantae	
		Sponges, worms, insects, fishes, mammals

Domain Bacteria (page 459)

12. Circle the letter of each sentence that is true about members of the domain Bacteria.
    a. They are multicellular.
    b. They are prokaryotes.
    c. They have rigid cell walls.
    d. The cell walls contain peptidoglycans.

13. Is the following sentence true or false? All members of the domain Bacteria are parasites. _____

Name_____ Class_____ Date _____

Domain Archaea (page 459)

14. Circle the letter of each sentence that is true about members of the domain Archaea.
    a. They are unicellular.
    b. They are eukaryotes.
    c. They lack cell walls.
    d. They lack cell membranes.
15. Is the following sentence true or false? Many members of the domain Archaea can survive only in the absence of oxygen. _____

Domain Eukarya (pages 460–461)

16. Circle the letter of each sentence that is true about all the members of the domain Eukarya.
    a. They have a nucleus.
    b. They are multicellular.
    c. They are heterotrophs.
    d. They have cell walls and chloroplasts.

Match each kingdom with the description that applies to members of that kingdom.

Kingdom	Description
_____ 17. Protista	a. They have cell walls of chitin.
_____ 18. Fungi	b. They have no cell walls or chloroplasts.
_____ 19. Plantae	c. They include slime molds and giant kelp.
_____ 20. Animalia	d. They include mosses and ferns.

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Vocabulary Review

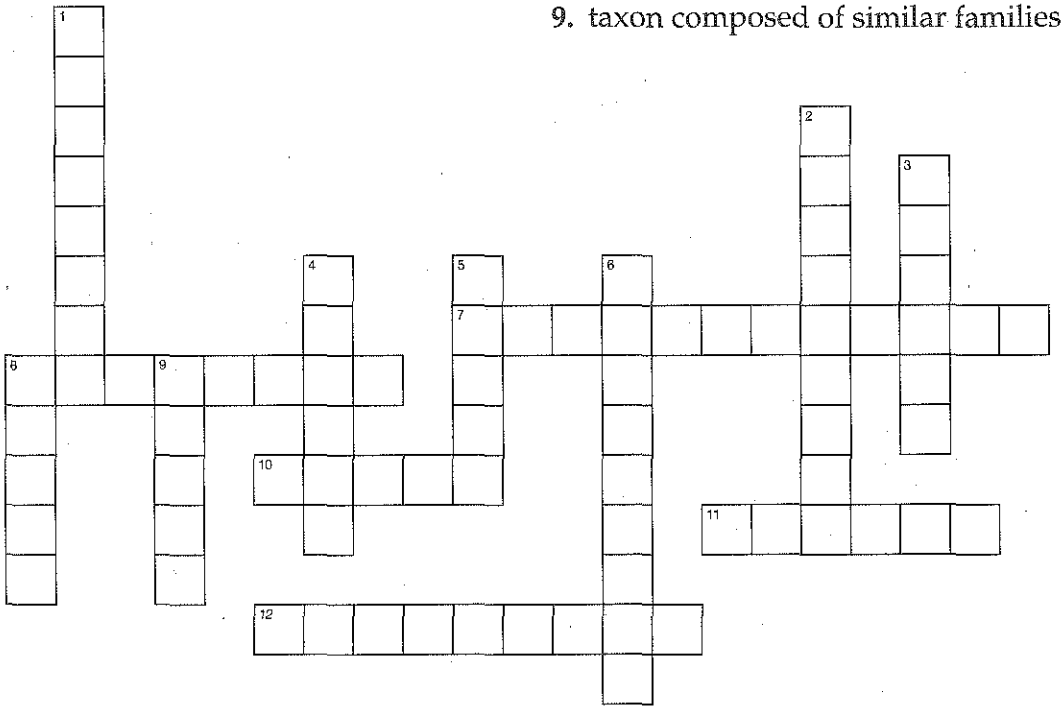
Crossword Puzzle *Complete the puzzle by entering the term that matches each numbered description.*

Across

7. type of classification that is based on evolutionary history
8. discipline of classifying and naming organisms
10. taxon composed of similar orders
11. taxon composed of similar classes
12. type of clock that estimates how long species have been evolving independently

Down

1. kingdom in the Eukarya domain that includes unicellular autotrophs
2. study of evolutionary relationships among organisms
3. new taxon that is higher than the kingdom
4. taxon composed of similar genera
5. taxon composed of closely related species
6. diagram based on derived characters
8. general term for any level, or category, in a taxonomic system
9. taxon composed of similar families



Answering Questions *Write one or more sentences to answer each question.*

13. In what ways are members of the domain Bacteria and the domain Archaea similar?

_____

_____

14. Which domain includes only organisms with a nucleus in their cells? _____

_____

15. What are two ways that most members of the kingdom Plantae and the kingdom Animalia differ? _____

_____

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