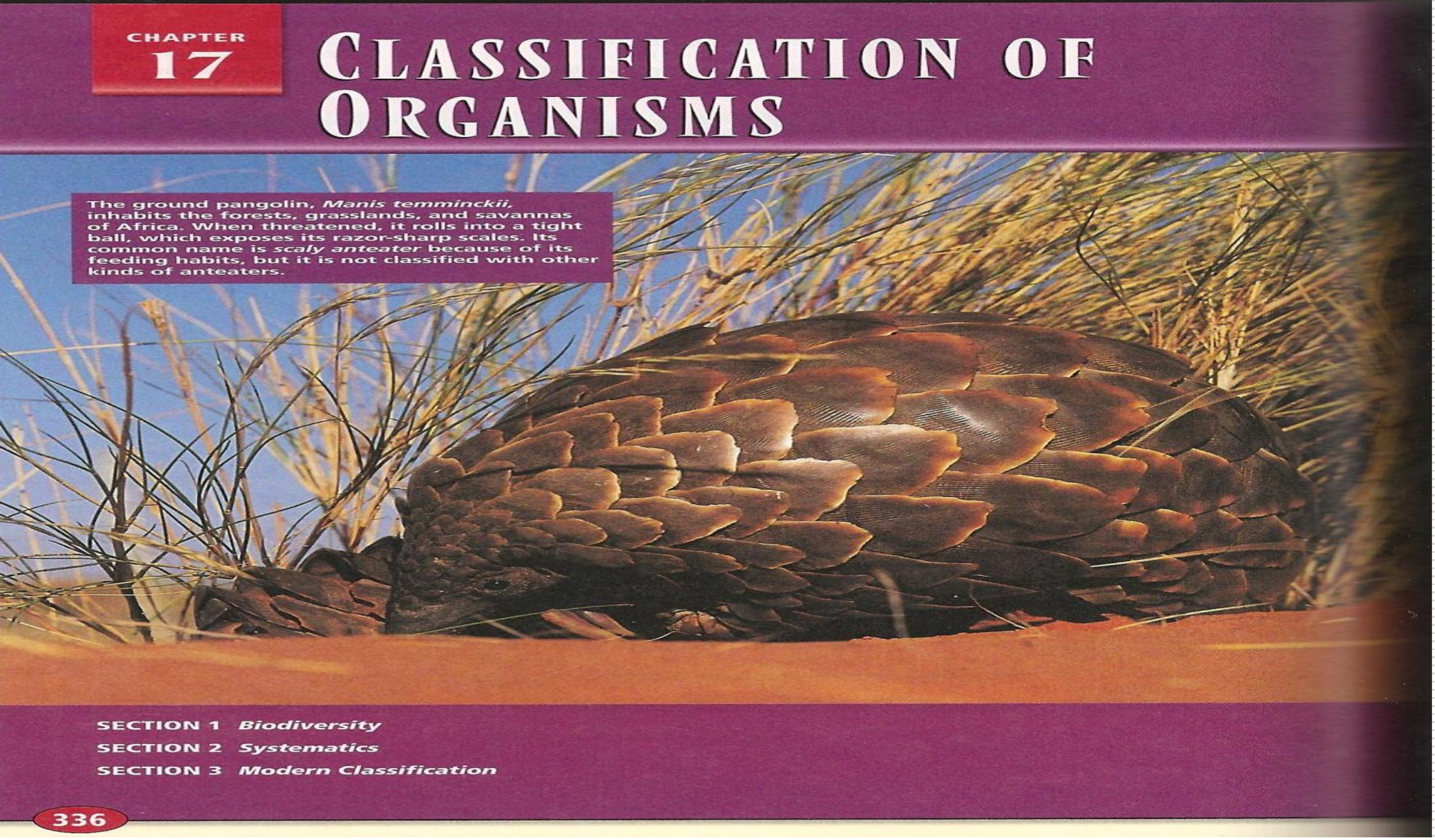

CLASSIFICATION OF ORGANISMS

CHAPTER 17

BIOLOGY

Chapter 17 Vocabulary (31 Words)

1. Biodiversity
2. taxonomy
3. taxon
4. Kingdom
5. domain
6. phylum
7. Division
8. class
9. order
10. Family
11. genus
12. species
13. Binomial nomenclature
14. systematics
15. Phylogenetics
16. phylogenetic diagram
17. Cladistics
18. shared character
19. Derived character
20. clade
21. cladogram
22. Bacteria
23. Archaea
24. Eukarya
25. Eubacteria
26. Archaebacteria
27. Protista
28. Fungi
29. Plantae
30. Animalia
31. Subspecies

I. Biodiversity

A. Classifying Organisms

1. biodiversity: the variety of organisms considered at all levels, from populations to ecosystems

2. Every year, biologists discover thousands of new species and seek to classify them

3. Classification systems have been proposed and modified over the years

FIGURE 17-1

These researchers are fogging a tree with insecticide to collect the insects that live on its leaves and branches.

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B. Taxonomy

1. taxonomy: the science of describing, naming, and classifying organisms
2. Taxon: a particular group within a taxonomic system
3. Over time, scientists have created taxonomic systems that have different numbers and levels of taxa
4. Ancient Greeks- classified as either Plants or Animals
5. Common names are tough to use since not all places call things the same

6. The Linnaean System

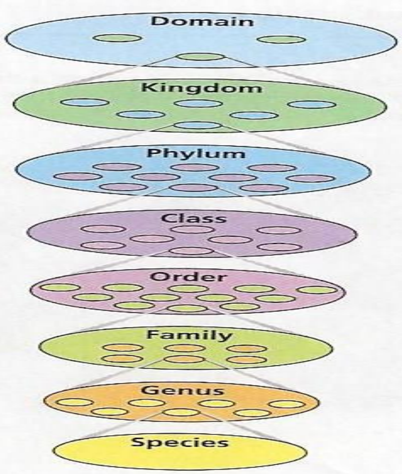
a. Carolus Linnaeus devised a system of grouping organisms into hierarchical categories according to form and structure.

b. Our modern structure is similar to that used by Linnaeus.

ships among organisms.

FIGURE 17-2

Under the modern Linnaean system, the classification of an organism places the organism within a nested hierarchy of taxa. The hierarchy ranges from the most general category (domain) to the most specific (species).



The Linnaean System

Swedish naturalist Carolus Linnaeus (1707–1778) devised a sys of grouping organisms into hierarchical categories accord their form and structure. Each category represents a level of gro ing from larger, more general categories to smaller, more spe categories. Linnaeus's original system had seven levels. Figure and Table 17-1 show a modern classification of different orga in a hierarchical system similar to that used by Linnaeus.

TABLE 17-1 Classification Hierarchy of Organisms

	Pangolin	Dandelion
Domain	Eukarya	Eukarya
Kingdom	Animalia	Plantae
Phylum/division	Chordata	Magnoliophyta
Class	Mammalia	Magnoliopsida
Order	Pholidota	Asterales
Family	Manidae	Asteraceae
Genus	Manis	Taraxacum
Species	*Manis temminckii*	*Taraxacum officina*

C. Levels of Classification

1. Modern biologists adopted this system, but added several other kingdoms as well as domains, categories above the kingdom level
2. Domain, kingdom, phylum, class, order, family, genus, and species

D. Binomial Nomenclature

1. A system for giving each organism a two-word scientific name that consists of the genus name followed by the species name

II. Systematics

A. Phylogenetics

1. systematics: the classification of living organisms in terms of their natural relationships; it includes describing, naming, and classifying the organisms

2. phylogenetics: the analysis of evolutionary, or ancestral, relationships between taxa

3. Scientists represent their findings in a form called a phylogenetic diagrams (tree)

4. Evidence of Shared Ancestry

a. Evidence supporting phylogentic relationships include fossils, homologous features, and embryological features

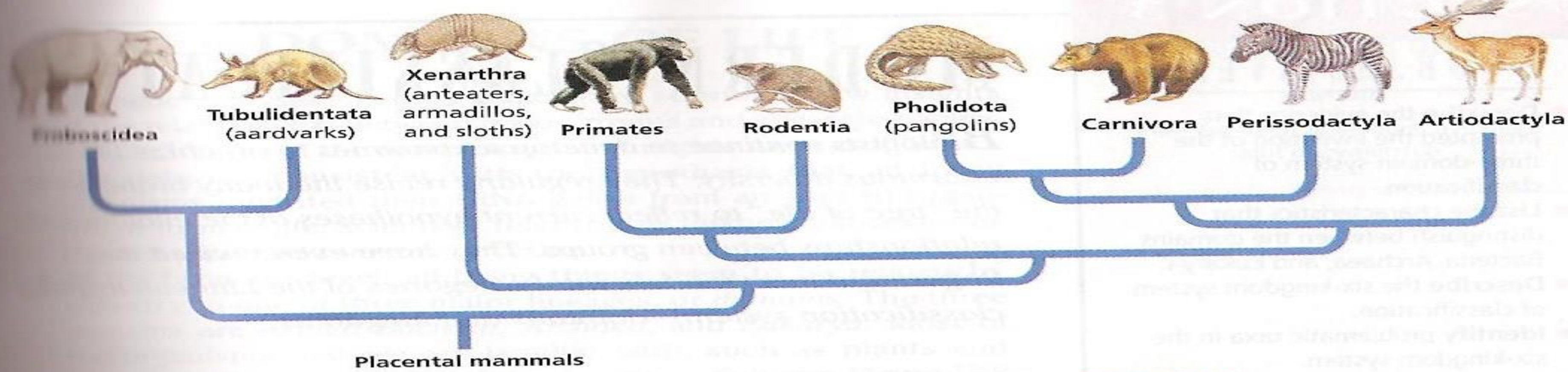


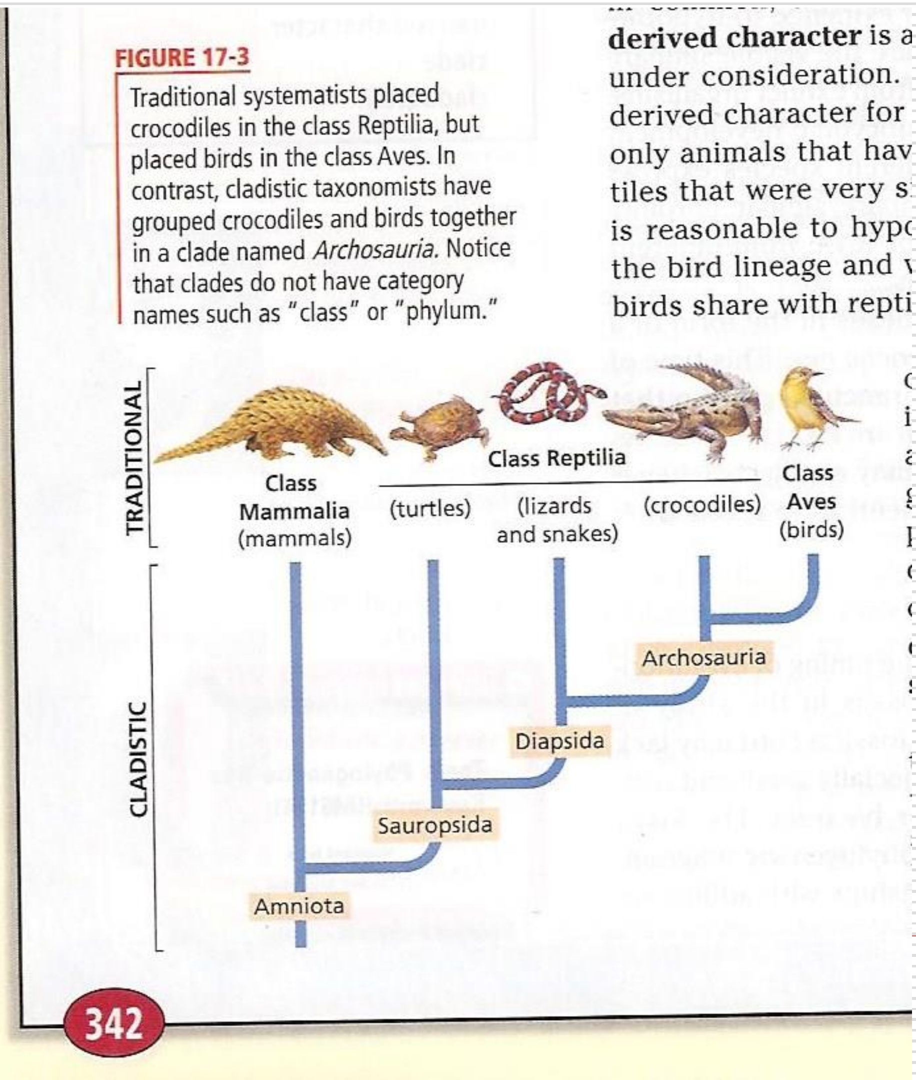
FIGURE 17-7
This phylogenetic diagram is based on analyses of the DNA of many kinds of mammals. These analyses do not support a systematic grouping of pangolins with either African aardvarks or South American anteaters. Instead, pangolins seem to be most closely related to carnivores, such as bears and dogs. Biologists sometimes revise their classifications in light of such new evidence.

PUTTING IT ALL TOGETHER

To classify an organism and represent its systematics in an evolutionary context, biologists use many types of information to build and revise phylogenetic models. Systematists will use data about physical features, embryos, genes in the nucleus, mitochondrial DNA, and ribosomal RNA.

Consider the classification of pangolins that is shown in Figure 17-7. African and Asian pangolins share several adaptations with other mammals that eat ants, including African aardvarks and

B. Cladistics (Cladogram)



1. German biologist, Willi Henning developed cladistics, a phylogenetic classification system that uses shared and derived characters and ancestry as the sole criterion for grouping taxa

2. Shared character: a feature that is shared by all members of a particular group of organisms

3. Derived character: a feature that evolved only within a particular taxonomic group

character is seeds. Because ferns lack seeds, they are on the second branch of the cladogram. The least common character is flowers. Because pines lack flowers, they are on the third branch. Finally, flowering plants are placed on the last branch.

The resulting "tree" is a cladistic hypothesis for evolutionary relationships among these plants. In addition to considering obvious physical characters, such as seeds and flowers, cladists may consider molecular characters, such as an individual nucleotide in a gene sequence or an amino acid sequence within a protein.

FIGURE 17-4

This cladogram groups several major kinds of plants according to their shared, derived characters. The most common character (vascular tissue) is shared by all groups. The least common character (flowers) separates flowering plants from all the other plants.

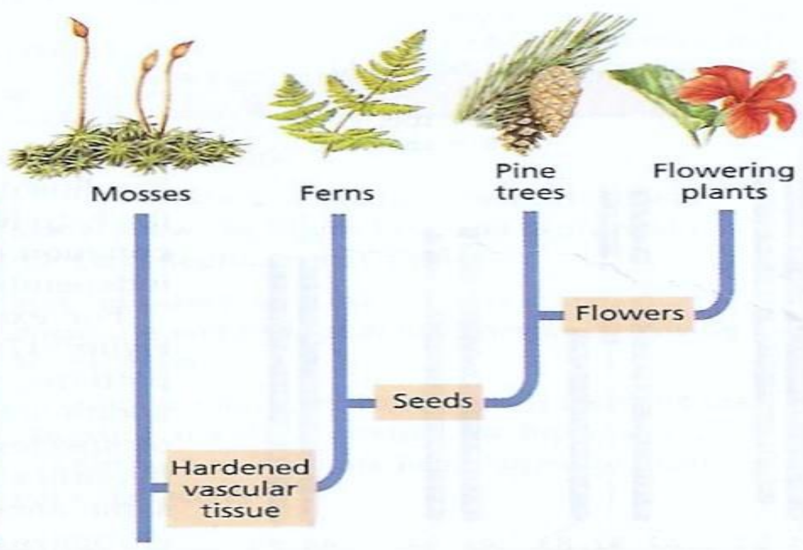


TABLE 17-2 Data Table for Cladogram

	Characters		
Groups of organisms	Vascular tissue	Seeds	Flowers
Mosses (out-group)	0	0	0
Ferns	1	0	0
Pine trees and other conifers	1	1	0
Flowering plants	1	1	1

Amino Acid Sequence of a Petal-Forming Gene in Different Plants

Aster	M G R G K I E I K K I E N N T N R Q V T Y S K R R N G I F K K A H E L T V L C D A K V S L I M F S N T G K F
Tomato	– – – G K I E I K K I E N S T N R Q V T Y S K R R N G I F K K R K E L T V L C D A K I S L I M L S S T R K Y
Snapdragon	M A R G K I Q I K R I E N Q T N R Q V T Y S K R R N G L F K K A H E L S V L C D A K V S I I M I S S T Q K L
Rice	M G R G K I E I K R I E N A T N R Q V T Y S K R R T G I M K K A R E L T V L C D A Q V A I I M F S S T G K Y

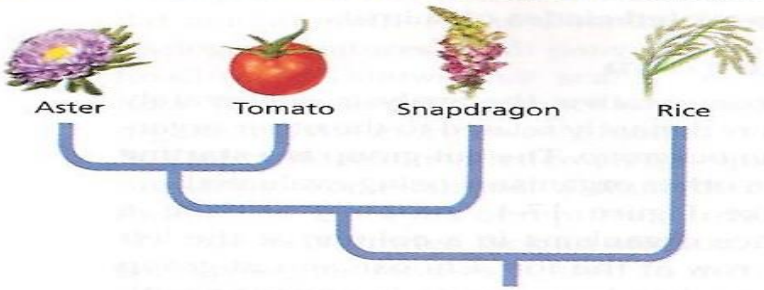


FIGURE 17-5
This cladogram is based on similar amino acid sequences in a specific protein produced by these plants. The initials M, G, and so on indicate different amino acids. The yellow squares indicate differences within the otherwise-identical sequences.

Molecular Cladistics

A biologist can count the shared, derived amino acids at each position in a protein and, from the analysis, construct a tree that hypothesizes relationships between various species. On a molecular cladogram, branch lengths are proportional to the number of amino acid changes. Such molecular data are independent of physical similarities or differences. The analysis shown in Figure 17-5 is of the amino acid sequence of a protein involved in flower development.

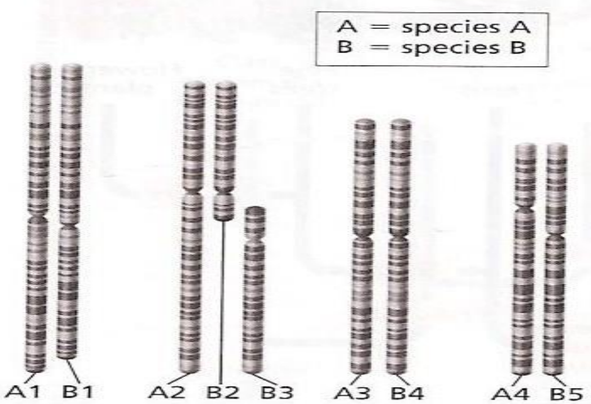
Biologists have used evolutionary changes in the sequences of macromolecules, such as DNA, RNA, and proteins, as a form of *molecular clock,* a tool for estimating the sequence of past evolutionary events. The molecular clock hypothesis suggests that the greater the differences between a pair of sequences, the longer ago those two sequences diverged from a common ancestor. A researcher who matches a molecular clock carefully with the fossil record can use it to hypothesize when various characteristics arose and when organisms diverged from ancestral groups.

Chromosomes

Analyzing karyotypes can provide still more information on evolutionary relationships. As Figure 17-6 shows, chromosomes can be stained to reveal a pattern of bands. If two species have the same banding pattern in regions of similar chromosomes, the regions are likely to have been inherited from a single chromosome in the last common ancestor of the two species. Karyotypic data are totally independent of both physical similarities and molecular data.

For example, the chromosomes of two species are shown in Figure 17-6. Several of the chromosomes have similar banding patterns, suggesting that the chromosomes are homologous. In addition, two of species B's chromosomes are similar to parts of one of species A's chromosomes. In such cases, biologists may still hypothesize that all of the chromosomes were inherited from the same ancestor. It is possible that in one of the descendants, one chromosome became two or two chromosomes became one.

FIGURE 17-6
In this example, the karyotype of species A is very similar to that of species B. The diagram compares 4 of species A's chromosomes with 5 of species B's chromosomes. The banding pattern similarities suggest that chromosomes B2 and B3, combined, are homologous to chromosome A2.



III. Modern Classification

A. Three Domains of Life

1. Domain Bacteria: single-celled, prokaryotic (no nucleus)

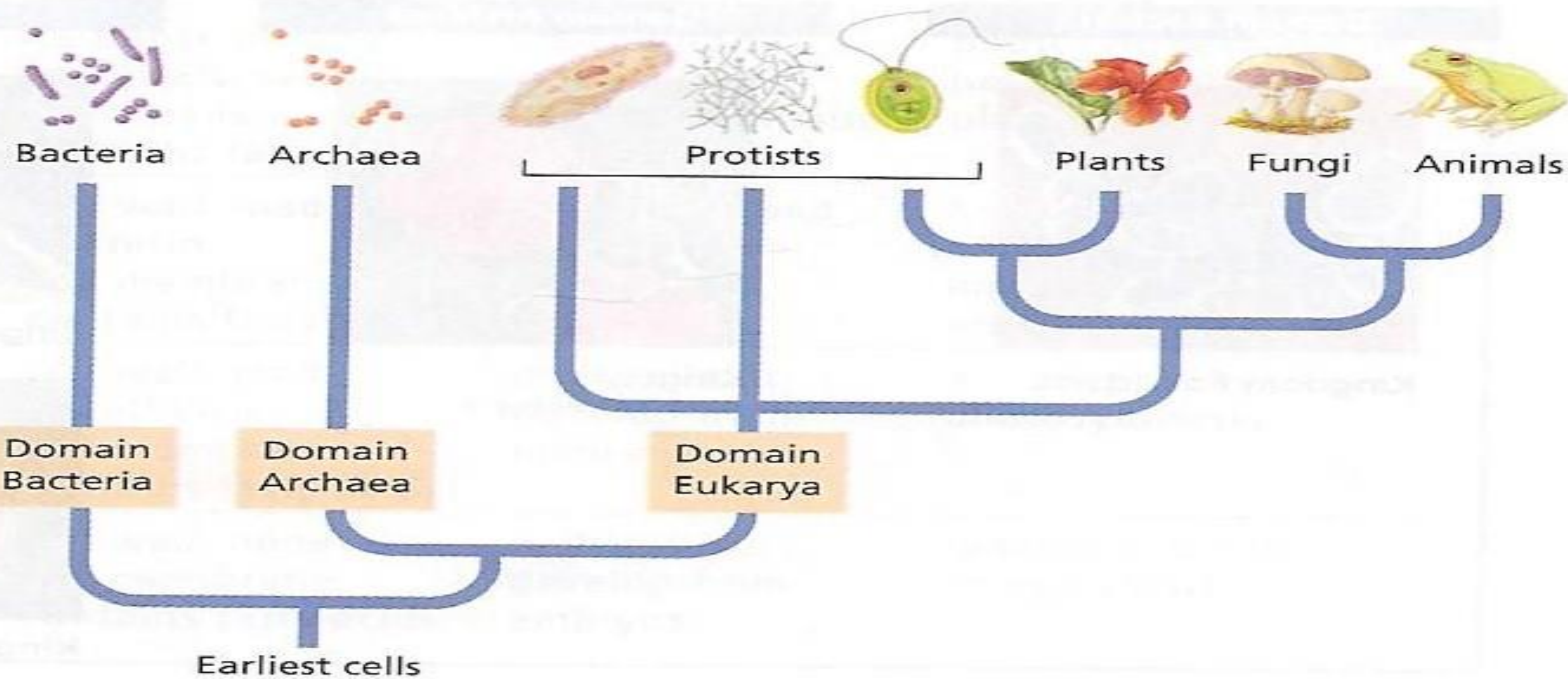
2. Domain Archaea: single-celled, prokaryotic with distinctive cell membranes and other unique biochemical and genetic properties

3. Domain Eukarya: eukaryotic (nucleus) with complex cellular organelles

nall, single-celled prokaryotic
all and reproduce by cellular
, a plasma membrane, a cyto-
nd at least one circular chro-
nbrane-bound DNA and thus
e small—many are just 2 µm
n be 6 µm long or more. The
be bacterial cells.

FIGURE 17-8

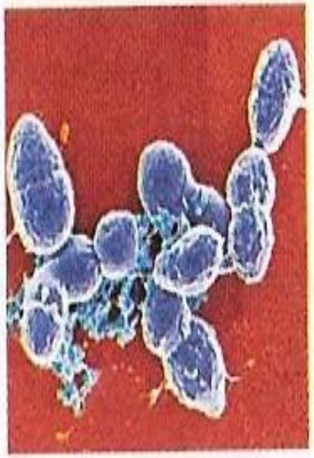
This phylogenetic diagram represents hypotheses of the evolutionary relationships between the major recognized groups of organisms. Notice the alignment of the three domain names (*Bacteria, Archaea,* and *Eukarya*) with three major "branches" of the "tree" of all life. For updates on phylogenetic information, visit **go.hrw.com** and enter the keyword **HM6 Phylo**.



B. Six Kingdoms

1. Eubacteria: true bacteria
2. Archaebacteria: ancient bacteria
3. Protista: eukaryotes that are NOT plants, animals, or fungi
4. Fungi: eukaryotic, heterotrophic organisms
5. Plantae: eukaryotic, multicellular plants
6. Animalia: eukaryotic, multicellular heterotrophic organisms

Domain Bacteria



Kingdom Eubacteria

Domain Archaea

Kingdom Archaebacteria

Domain Eukarya

Kingdom Protista

Kingdom Plantae

Kingdom Fungi

Kingdom Animalia

TABLE 17-3 *Kingdom and Domain Characteristics*

[illegible]	Cell type	Cell surfaces	Body plan	Nutrition
Domain Bacteria (aligns with Kingdom Eubacteria)	prokaryotic; lack nucleus and other organelles	cell wall:contains peptidoglycans; cell membrane: contains fatty acids	unicellular	heterotrophic and autotrophic by chemosynthesis or photosynthesis
Domain Archaea (aligns with Kingdom Archaebacteria)	prokaryotic; lack nucleus and other organelles	cell wall: lacks peptidoglycan; cell membrane: contains hydrocarbons other than fatty acids	unicellular	heterotrophic and autotrophic by chemosynthesis
Domain Eukarya Kingdom Protista	eukaryotic; have nucleus and complex organelles	cell wall: made of cellulose or other materials; cell membrane: contains fatty acids	mostly unicellular; multicellular forms: lack tissue organization	autotrophic by photosynthesis, some heterotrophic by phagocytosis, or both
Domain Eukarya Kingdom Fungi	eukaryotic; have nucleus and complex organelles	cell wall: made of chitin; cell membrane: contains fatty acids	unicellular and multicellular	heterotrophic by secreting digestive enzymes into environment
Domain Eukarya Kingdom Plantae	eukaryotic; have nucleus and complex organelles	cell wall: made of cellulose; cell membrane: contains fatty acids	multicellular; develop from embryos	autotrophic by photosynthesis
Domain Eukarya Kingdom Animalia	eukaryotic; have nucleus and complex organelles	cell wall: none cell membrane: contains fatty acids	multicellular; develop from embryos	heterotrophic by phagocytosis