

18.3 Building the Tree of Life

Changing Ideas About Kingdoms

This diagram shows some of the ways in which organisms have been classified into kingdoms since the 1700s.

First Introduced	Names of Kingdoms					
1700s	Plantae					Animalia
Late 1800s	Protista			Plantae		Animalia
1950s	Monera		Protista	Fungi	Plantae	Animalia
1990s	Eubacteria	Archaeobacteria	Protista	Fungi	Plantae	Animalia

Three Domains

Genetic analysis has revealed that the two main prokaryotic kingdoms are more different from each other, and from eukaryotes, than previously thought. So, biologists established a new taxonomic category—the domain. A **domain** is a larger, more inclusive category than a kingdom.

Under this system, there are three domains—domain Bacteria (corresponding to domain Eubacteria), domain Archaea (corresponding to kingdom Archaeobacteria), and domain Eukarya (corresponding to kingdoms Fungi, Plantae, Animalia, and kingdom “Protista”).

Quotes are put around kingdom “Protista” to indicate that it is not a monophyletic group.

Three Domains

Classification of Living Things

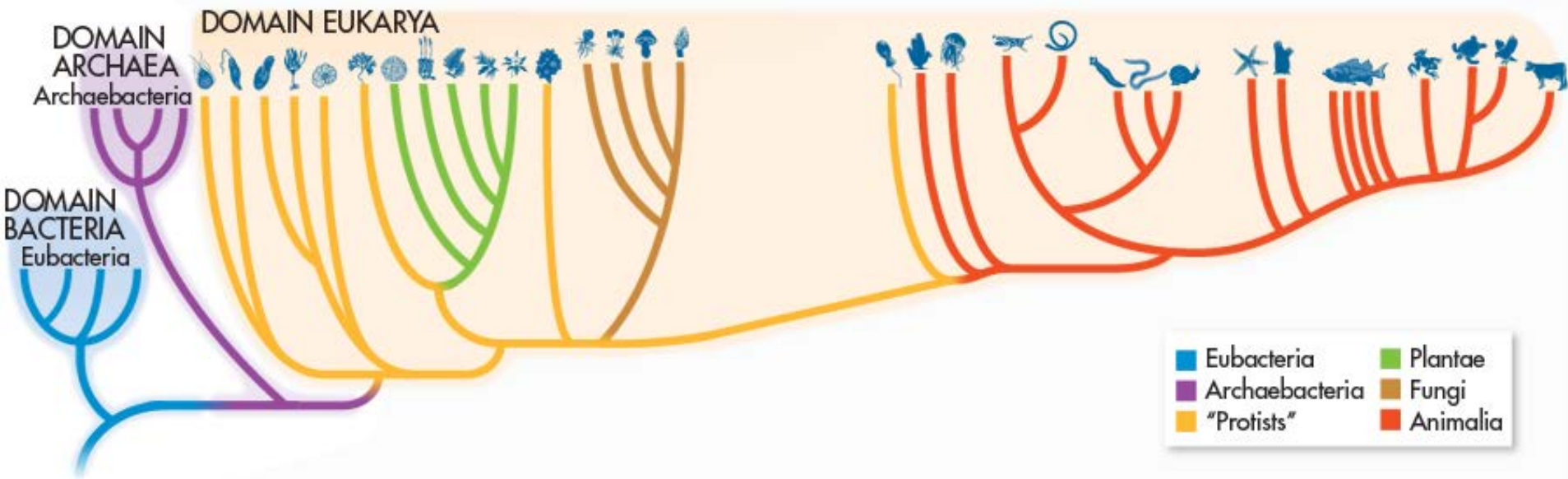
DOMAIN	Bacteria	Archaea	Eukarya			
KINGDOM	Eubacteria	Archaeobacteria	"Protista"	Fungi	Plantae	Animalia
CELL TYPE	Prokaryote	Prokaryote	Eukaryote	Eukaryote	Eukaryote	Eukaryote
CELL STRUCTURES	Cell walls with peptidoglycan	Cell walls without peptidoglycan	Cell walls of cellulose in some; some have chloroplasts	Cell walls of chitin	Cell walls of cellulose; chloroplasts	No cell walls or chloroplasts
NUMBER OF CELLS	Unicellular	Unicellular	Most unicellular; some colonial; some multicellular	Most multicellular; some unicellular	Multicellular	Multicellular
MODE OF NUTRITION	Autotroph or heterotroph	Autotroph or heterotroph	Autotroph or heterotroph	Heterotroph	Autotroph	Heterotroph
EXAMPLES	<i>Streptococcus</i> , <i>Escherichia coli</i>	Methanogens, halophiles	Amoeba, Paramecium, slime molds, giant kelp	Mushrooms, yeasts	Mosses, ferns, flowering plants	Sponges, worms, insects, fishes, mammals

The Tree of All Life

Modern evolutionary classification is a rapidly changing science with the difficult goal of presenting all life on a single evolutionary tree.

The tree of life shows current hypotheses regarding evolutionary relationships among the taxa within the three domains.

The Tree of All Life



Domain Bacteria

Members of the domain **Bacteria** are unicellular and prokaryotic. This domain corresponds to the kingdom Eubacteria.

Their cells have thick, rigid walls that surround a cell membrane and contain a substance known as peptidoglycan.

These bacteria are ecologically diverse, ranging from free-living soil organisms to deadly parasites. Some photosynthesize, while others do not. Some need oxygen to survive, while others are killed by oxygen.

Domain Archaea

The domain Archaea corresponds to the kingdom Archaeobacteria.

Members of the domain **Archaea** are unicellular and prokaryotic, and they live in some extreme environments—in volcanic hot springs, brine pools, and black organic mud totally devoid of oxygen. Many of these bacteria can survive only in the absence of oxygen.

Their cell walls lack peptidoglycan, and their cell membranes contain unusual lipids that are not found in any other organism.

Domain Eukarya

The domain **Eukarya** consists of all organisms that have a nucleus. It comprises the four remaining kingdoms of the six-kingdom system: "Protista," Fungi, Plantae, and Animalia.

The “Protists”: Unicellular Eukaryotes

The kingdom Protista has long been viewed by biologists as a “catchall” group of eukaryotes that could not be classified as fungi, plants, or animals.

Recent molecular studies and cladistic analyses have shown that “the eukaryotes formerly known as “Protista” do not form a single clade. Current cladistic analysis divides these organisms into at least five clades.

Since these organisms cannot be properly placed into a single taxon, we refer to them as “protists.”

The “Protists”: Unicellular Eukaryotes

Most “protists” are unicellular, but one group, the brown algae, is multicellular.

Some “protists” are photosynthetic, while others are heterotrophic.

Some display characters that resemble those of fungi, plants, or animals.

Fungi

Members of the kingdom Fungi are heterotrophs with cell walls containing chitin.

Most fungi feed on dead or decaying organic matter. They secrete digestive enzymes into their food source, which break the food down into smaller molecules. The fungi then absorb these smaller molecules into their bodies.

Mushrooms and other recognizable fungi are multicellular, like the ghost fungus shown. Some fungi—yeasts, for example—are unicellular.

Plantae

Members of the kingdom Plantae are multicellular, have cell walls that contain cellulose, and are autotrophic.

Autotrophic plants are able to carry on photosynthesis using chlorophyll.

Plants are nonmotile—they cannot move from place to place.

The entire plant kingdom is the sister group to the red algae, which are “protists.” The plant kingdom, therefore, includes the green algae along with mosses, ferns, cone-bearing plants, and flowering plants.

Animalia

Members of the kingdom Animalia are multicellular and heterotrophic.

Animal cells do not have cell walls.

Most animals can move about, at least for some part of their life cycle.

There is incredible diversity within the animal kingdom, and many species of animals exist in nearly every part of the planet.