

Summary

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.

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. 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 one another 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.

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 Archaeobacteria. By the 1990s, a six-kingdom system of classification was proposed. It includes the kingdoms Eubacteria, Archaeobacteria, 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 only the kingdom Eubacteria. All members of the domain Bacteria are single-celled organisms without a nucleus. They have cell walls containing a substance called peptidoglycan.

The domain Archaea includes only the kingdom Archaeobacteria. All members of the domain Archaea are single-celled organisms without a nucleus. They have cell walls without peptidoglycan.

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 single-celled 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.