

A detailed botanical illustration of a plant with several upright stems. The stems are green and have several long, narrow, lanceolate leaves. The plant features several clusters of small, blue, tubular flowers with white centers. Some flowers are fully open, while others are in bud. The background is a light yellowish-green.

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BOTANY READINGS

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What Is a Plant?

For this present reading, in order to answer the question, "What is a plant?", we must look at the major groups of living organisms that most biologists recognize.

Introduction to the Five Kingdoms

The major groups of living organisms are called kingdoms. Biologists used to recognize two kingdoms: 1) The plant kingdom (Kingdom Plantae) and 2) the animal kingdom (Kingdom Animalia). As more organisms were observed, it became obvious that not all organisms neatly fit into either the plant or animal kingdom. In some cases zoologists considered an organism an animal, but botanists considered the same organism a plant!

A three-kingdom system for some time was recognized by many biologists, then a four-kingdom system became popular, eventually a five-kingdom system was recommended, and many biologists currently recognize six kingdoms. As biologists study different organisms, new information becomes available for making decisions about how organisms may be grouped, and there probably never will be a system of classification that will satisfy all biologists.

In this set of on-line readings we use the five-kingdom system because it is convenient and is used in a variety of introductory textbooks. The five kingdoms are : 1) **Monera**, 2) **Fungi**, 3) **Protista**, 4) **Plantae**, and 5) **Animalia**. The basic criteria used to place organisms in the five kingdoms include cell structure, modes of nutrition, and level of complexity of the organism.

Although associated with living organisms, particularly in diseases, the viruses are a group that many biologists would not consider as living, and, therefore, do not fit into the classification system used in this set of readings about botany. Viruses do not consist of cells: Instead, they generally are several complex molecules that contain information for replicating themselves if they are in a suitable environment such as a plant or animal cell. The virus itself does not have the ability to replicate: It requires a living cell to provide the materials and machinery to perform the replication of new viruses.

In order to categorize various organisms into the five kingdoms, we use criteria that are based on properties of living things. The criteria that have been found to be the most useful are based on the cells that make up the organisms and how organisms obtain their nutrition.

Cell Structure

The cell theory states that all living things (with very few exceptions) consist of microscopic units called **cells** or of products of cells. Most cells can be seen only if observed with a compound light microscope, an instrument that allows the biologist to study material magnified approximately 2,000 times. The cell theory and the study of cells have helped biologists to understand many basic processes that occur in all types of organisms. By studying cell structure, biologists became better at distinguishing between and among different groups of organisms.

In the 1950s the transmission electron microscope (TEM) became available to biologists. The TEM allows biological specimens to be viewed at magnifications ranging from 2,000 to 500,000 times and even greater. Two basic cell types became evident from the early studies with TEM. **Prokaryotic cells** are smaller and do not contain the elaborate internal structures as do **eukaryotic cells**.

Organisms that consist of prokaryotic cells are either single-celled (unicellular organisms) or simple colonies of similar cells. Organisms consisting of prokaryotic cells are called the **prokaryotes**.

Organisms that are made up of eukaryotic cells are the **eukaryotes**. Eukaryotes can be either unicellular or multicellular (made up of many cells). Multicellular eukaryotes may have cells that become specialized in their function within the organism. Cells that become specialized are said to be **differentiated**; cells that are not specialized are undifferentiated. Animals and plants are multicellular, eukaryotic organisms that have cellular differentiation. Another way of stating this is that plants and animals are **complex** multicellular organisms. Other eukaryotes are unicellular while others are multicellular, but with undifferentiated cells.

Nutrition for Living Things

Three basic properties of living organisms are growth, reproduction, and movement. In order for a living organism to carry out its functions, it needs energy and raw materials. Organisms have different ways of obtaining raw materials and energy.

Food is what organisms consume that perpetuate the life processes. Foods that in part contribute to your life processes include, among others, eggs, milk, potatoes, tomatoes, hamburgers, bagels, cheese, and salad. All of these things we recognized as foods come either from animals or plants. The foods humans consume are complex structures that either were other organisms or products produced by other organisms. The term used for the mode of nutrition for organisms like humans is **heterotrophic nutrition**. Organisms that rely on heterotrophic nutrition are referred to **heterotrophs**.

Not all organisms require complex foods like heterotrophs. Plants survive with soil, air, water, and light. These do not fit into what we generally use for food for ourselves. Plants need only a few inorganic minerals such as nitrates, phosphates, and iron; water; carbon dioxide; and light to maintain their life processes. Plants use photosynthesis to convert simple molecules (carbon dioxide and water) into more complex molecules that are used in plant growth and reproduction. The type of nutrition in which the organism makes its own complex molecules from relatively simple molecules is **autotrophic nutrition**. Plants are **autotrophs**. The process of making food by using light energy is photosynthesis. Plants specifically, then, are **photosynthetic autotrophs**.

Now that you have been introduced to some basic concepts of modes of nutrition and cell structure, you are ready to answer the basic question of "What is a plant?" by looking at each of **The Five Kingdoms** with cell structure and nutrition in mind.

Kingdom Monera

Kingdom Monera contains all known organisms consisting of prokaryotic cells. In contrast, organisms in the other four kingdoms (Animalia, Plantae, Fungi, and Protista) are composed of eukaryotic cells. Some members of the Monera are unicellular organisms; others are simple colonies of undifferentiated cells. Depending on the organism, some colonies may be very simple, consisting of only two cells. Other monera may have colonies of four cells, and some may consist of a filament of cells like a string of beads.

Nutritionally, some members of the Kingdom Monera are autotrophic while others are heterotrophic. The most commonly encountered members of the Kingdom Monera are bacteria and cyanobacteria (formerly called blue-green algae). Cyanobacteria and some bacteria are photosynthetic autotrophs. Some bacteria are chemosynthetic autotrophs—they get energy for life processes from chemical bonds. Other bacteria are heterotrophs, and absorb the complex nutrients they need from the environment. There are two major groups of bacteria, and some authorities separate one of the groups of bacteria into their own kingdom, producing a total of six kingdoms. For this introductory set of on-line readings we have not followed that classification system, and have kept all the bacteria within the Kingdom Monera.

Kingdom Protista

Some authors name this group the Kingdom Protoctista. The rationale is that traditionally the term Protista was used for unicellular organisms only. Because this kingdom includes multicellular organisms in addition to unicellular organisms, many individuals prefer to use a term not traditionally associated with unicellular organisms, hence the term Protoctista. I have no preference for either term, but because most of the textbooks available for introductory general biology and plant biology use the term Protista, we use it in this set of on-line readings.

The Kingdom Protista is a diverse group of eukaryotes that are either heterotrophic or photosynthetically autotrophic. Some protists are unicellular, others are simple colonies of cells, while others are fairly complex colonies.

Protozoa are members of the Protista that are unicellular, animal-like organisms. When there were only two kingdoms used for classification, protozoa were defined as single-celled animals. Protozoa do not have cell walls and are heterotrophic: like animals, protozoa ingest food instead of absorbing it like the fungi. Common examples of protozoa include *Amoeba*, *Paramecium*, and *Trichomonas*.

Algae are either unicellular or colonial Protista that have plant-like characteristics, the most notable being photosynthesis and cell walls that contain cellulose. Many botany texts still include the algae in the plant kingdom because plants generally are considered to have evolved from one of the groups of algae. Algae are divided into subgroups based upon their pigmentation. Common algal groups include green, golden-brown, brown, and red algae. Representative well-known algae include *Chlamydomonas* (green), kelp (brown), diatoms (golden-brown), and *Spirogyra* (green).

Kingdom Fungi

Fungi are heterotrophic eukaryotes with cell walls that contain chitin, a compound also found in the shells of several members of the animal kingdom, including crabs, insects, and shrimp. Although fungi are multicellular and have some cellular differentiation, the degree of cellular specialization is not great. Many fungi obtain their food from dead organic matter such as plants or animals. Such fungi are saprophytic. Other fungi may absorb the complex molecules they need from living organisms. If such fungi harm the living organism from which they obtain their nutrients, the fungi are considered to be parasites. Common examples of fungi include mushrooms (both edible and poisonous), athlete's foot, mold on moldy bread, blue veins in blue cheese, Bakers' Yeast, jock itch, and yeast infection.

In older classification systems, fungi were defined as "plants without chlorophyll." That is not a valid definition for fungi in today's five-kingdom system.

Kingdom Animalia

Before there were three, four, and now the five kingdoms, the entire living world was divided into either "animal" or "vegetable." There are still hangovers from the two-kingdom system. These include treating members of the fungal kingdom as "non-green plants," and bacteria and cyanobacteria as "single-celled plants." In the present five-kingdom system, animals and plants are more narrowly defined than with the older systems.

Animals are multicellular, complex (i.e., have a high degree of differentiation), heterotrophic eukaryotes with cells that do not have cell walls. Examples include sponges, flatworms, round-worms, leeches, clams, starfish, insects, fish, frogs, lizards, birds, and our own group, the mammals. Mammals, the group with which we probably are most familiar, include among others, mice, rats, monkeys, and humans.

Kingdom Plantae

Plants are complex, multicellular organisms that are photosynthetic autotrophs: They produce their own complex foods from carbon dioxide and water through photosynthesis. Cells of plants have plastids (including chloroplasts), vacuoles, and cell walls that contain cellulose.