Plant Structure and Function

Plants have a high degree of organization, especially when compared with their algal ancestors that lacked true tissues. An individual plant constitutes an organism. Any member of the plant kingdom falls into one of four major groups: bryophytes (such as mosses); seedless vascular plants (ferns); gymnosperms (conifers); and angiosperms (lilies).

Section 1 – Plant Structures and Systems

Since an individual plant constitutes a living organism, plants will satisfy all of the characteristics of living things as well as specialized structures or adaptations that allow for their survival.

The Root and Shoot Systems

An individual plant is generally composed of two organ systems: the root system and the shoot system. The *root system* includes any of the plant organs that lie belowground; thus, it is generally focused on absorption of materials from the soil. The *shoot system,* on the other hand, includes any plant organs that lie aboveground. Consequently, these structures focus primarily on photosynthesis and reproduction.

Roots, Stems, and Leaves

Roots, stems, and leaves constitute plants' three basic organ types; roots make up the majority of the root system, and the stem and leaves make up the shoot system..

Roots are structured so they can best absorb water and minerals from the soil and transport the solution to the stem. Within the epidermal layer, tiny extensions of the cell wall (called *root* hairs) work to vastly increase surface area for absorption. Roots generally occur in one of two types: fibrous and taproots. When a sprouting seed's primary root emerges to become the largest, central root, it is called a *taproot.* Other, smaller roots emerge from the taproot; these are known as *lateral roots.* When many individual roots emerge from the stem and grow parallel to the primary root, they are described *as fibrous.*

Leaves are typically broad and thin to maximize their efficiency at trapping light energy, much like a solar panel. Leaves are generally structured to be broad and planar so they can most efficiently trap sunlight for photosynthesis. Some leaves are simple and composed of one major lobe, whereas others are called *multiple leaves.* In any case, the stem attached to the leaf is called the *petiole,* and the rest is the *blade.*

Stems are elongated and designed to prop up the leaves closer to the light source. Roots are highly branched, with increased surface area for the absorption of water and dissolved minerals. Stems generally constitute the major length of the plant body and are there to support the leaves toward the sun and to transport xylem sap to the leaves for photosynthesis. Some specialized stem types, such as the cactus stem, have evolved. This storage stem is also the primary photosynthetic organ, because the cactus leaves have become protective spines.

Dermal, Vascular, and Ground Tissues

Plants use combinations of dermal, vascular, and ground tissues to make up their organs. Dermal tissue is found along the external lining of the plant body and consists mainly of epidermal cells and guard cells; its functions are protection and regulation of water loss. Vascular tissue makes up the xylem and phloem tubes that function in circulating materials around the plant body. The rest of the plant comprises ground tissue. Photosynthesis, storage of materials, and support of the plant body are the major functions of ground tissue.

Parenchyma, Collenchyma, and Sclerenchyma Cells

Plant tissues are composed of one or more of three general cell types: parenchyma, collenchyma, and sclerenchyma. *Parenchyma* cells have a standard primary cell wall. They are alive at functional maturity and make important contributions to the plant's metabolic activities. Collenchyma cells, also alive at functional maturity, possess a thickened primary cell wall and a standard secondary cell wall; they provide flexible support of the plant body. *Scleren*chyma cells are dead at functional maturity and possess thick, irregular secondary cell walls. They function primarily to support. Each of the general cell types can specialize in structure and function to produce a wide variety of differentiated cells.

Section 2 - Characteristics of Plants

Plants often seem simpler from the outside than they actually are. Rooted in place, they appear inactive relative to their animal counterparts. In reality, plants use hormones to direct movement and growth in response to their environment on both a daily and a seasonal basis. Plants also are, in some rare cases, able to consume animals and parasitize fungi.

1. Organization (Cells – Systems)

Plants exhibit a high degree of organization, as already discussed. From cells to tissues, tissues to organs, organs to organ systems all are essential components to a functional plant organism. From the simplest bryophytes to the most complex angiosperms, plants are exclusively multicellular, and all of them possess some shoot and root system that enables their lifestyle.

2. Metabolism (Photosynthesis)

Almost without exception, plants are photoautotrophs. Of the nearly 300,000 named species, only a very few are either partially or exclusively parasitic. These include mistletoe, which retains the ability to make a small quantity of its own food, and the Indian pipe plant, which lacks any photosynthetic pigments and often appears white. The vast majority of plants obtain energy to build organic compounds from the sun using chlorophyll, so their green color is usually a dead giveaway.

3. Reproduction (Fruits and Flowers)

The angiosperm flower is highly beneficial to the reproductive fitness of the plant. Its brightly colored petals attract specific pollinators, which then unknowingly pick up some pollen to transfer to another plant. This coordinated pollination gives angiosperms a clear evolutionary advantage over other plants.

If the flower eventually develops into a fruit through the thickening and maturation of the ovary, then the seeds are packaged into a tasty and protective treat. A tempted animal ingests the fruit, swallows the seeds, and then eliminates them as waste after digestion. The tough seed coat protects the seed from the harsh conditions of the digestive tract, and this covering aids in dispersal of the seed. The young plant embryo can now germinate, grow, and eventually reproduce itself in a region potentially distant from the parent plant. This decreases the chance of inbreeding and contributes to genetic variation.

4. Growth (Meristems)

Meristems are regions of active mitosis within the plant body. Because of a plant's specialized metabolic and nutritional needs, it is mainly concerned with growing up toward the sun and down toward water. This primary growth is due to the activity of apical meristems at the tips of the roots and shoots.

Only some woody *plants* (like trees) are capable of secondary, lateral growth. Other meristems, called *vascular cambium* and *cork cambium,* are responsible for creating new vascular tissue and cork (or bark), respectively. The vascular cambium creates new growth rings observable in tree trunks.

5. Homeostasis (Regulation of Transpiration)

Transpiration is the movement of water from the roots of the plant to the leaves, where it is required for photosynthesis. The process is regulated by the guard cells on the underside of the leaves; these cells allow the stomata to be in either an open or a closed position. If they.'re open, water can evaporate from the air spaces inside the leaf to the external atmosphere. While plants don't want to lose too much water, they do need some to transpire out of the stoma so the column of water in the xylem is pulled into the leaf. This in turn encourages more water to flow into the roots.

6. Response to Stimuli (Tropisms)

While plants can't generally relocate their entire body, they can encourage growth in particular ways so they can move toward or away from a stimulus, a movement referred to as a *tropism.* In general, if the movement is toward the stimulus, then it is characterized as positive; when instead the movement is away from the stimulus, it is called negative. When light strikes one side of a plant disproportionately, a hormone called auxin moves to the shady side of the stem. There, it acts by elongating cells on that side. The extra slack that accumulates causes the plant stem to bend toward the light positive phototropism.

Other tropisms include thigmotropism, growth in response to a touch stimulus, and gravitropism, growth in response to the force of gravity. If keeping track of the variety of plant characteristics given here seems difficult, just remember the characteristics of life. Plants have myriad interesting and diverse adaptations that have enabled them to survive in all sorts of
environments and ecosystems. Referring back to the characteristics of life will help you generate examples of the more specific plant characteristics. Plants like the Venus flytrap and the pitcher plant are considered carnivorous because they consume animals. It is important to realize that, although they do trap small animals like insects and digest them with enzymes, they evolved this feeding method as a means of obtaining minerals because their soil was deficient. They are still able to photosynthesize to process organic compounds.