Plant Structure

Objectives

- Be able to identify plant organs and give their functions.
- Learn distinguishing characteristics between monocot and dicot plants.
- Understand the anatomy of the root and the functions of the tissues
- Be able to distinguish between a monocot root and a dicot root
- Be able to recognize and identify the anatomical structures in stems
- Become familiar with the differences between dicot and monocot stems
- Become familiar with the structure of woody stems
- To become familiar with and be able to identify the anatomical structures of leaves
- Be able to distinguish between monocot and dicot leaves

Introduction

In this exercise you will identify and examine the external features and internal anatomy of flowering plants. Differences between the two major groups of flowering plants, the monocots and the dicots, are emphasized. Besides the basic structures to be identified, keep in mind how the structures aid in the function of the plant for your use in future labs.

A number of terms are used when describing the location of plant structures or the perspective from which one is viewing a plant structure. Become familiar with these terms and use them where appropriate.

Terms

Apical: located at or near the apex (top) of the structure.

Axially: locate in or near the upper angle between a stem and a twig or leaf.

Basal: located away from the apex.

Cross section: a cut or section made at right angles to the long axis of an organ, the same as a transverse section.

Oblique: a cut or section at an angle between a longitudinal section and a cross section.

Radial section: a longitudinal cut or section of a root or stem along a radius.

Tangential section: a longitudinal cut or section of a root or stem at right angles to a radius.

Transverse section: a cut or section made at right angles to the long axis of an organ, the same as a cross section.

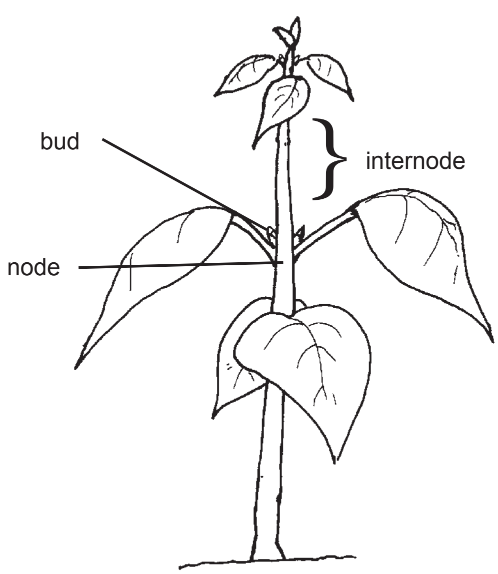
Activity 24.1
Whole Plant Structure

In the Plants section of the BiologyOne DVD, go to the Plant Structure simulation. Click on the forward arrow (lower right corner) to continue.

Here, examine the illustration of a plant and its organs. Note the locations on the stem where the leaves are attached. These locations are referred to as nodes. The spaces between the leaf attachment points on the stem are referred to as internodes. If a plant has only one leaf attached to the stem at each node, the leaf arrangement is said to be alternate. If there are two leaves attached at each node, the leaf arrangement is opposite. If three or more leaves are attached at a node, the leaf arrangement is whorled. What is the leaf arrangement in this illustration? Leaf arrangement is used to help distinguish among species of plants.

When leaves fall from a plant, callous tissue is formed on the stem leaving a leaf scar. Thus, even when there are no leaves on the plant, you can determine its leaf arrangement as discussed in activity 4.

Diagram of Dicot Plant



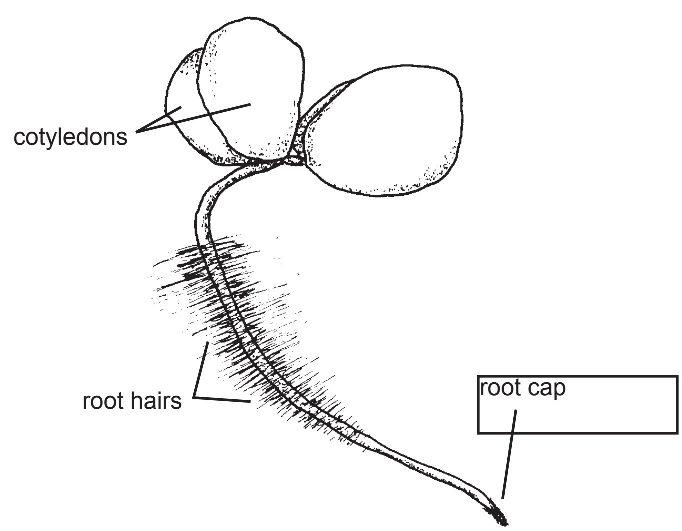
Activity 24.2
Roots

Advance to the root section of the simulation. Roots function to anchor the plant to the soil and to absorb water and nutrients from the soil. They must also be able to transport the water and minerals to the above ground portions of the plant. Some roots, such as those found in carrots and yams, also specialize to store starch that may be used as food by the plant or by animals which eat the plant.

There are two basic arrangements of root systems in plants. They may have a central main root with smaller secondary roots or they may lack a central root, having numerous roots of equal size. The former system is called a taproot system; the latter is called a fibrous root system. Dicots typically have taproots while monocots typically have fibrous root systems.

First we'll examine the structures at the tip of roots. You can see the overall structure of the root tip by examining young plants such as a radish seedling. Note the lack of nodes on the roots. Roots do not produce leaves or buds. When you look closely at the root tip, you will see a cap of cells that appear to cover the root (these appear yellowish). This is the root cap that is produced to protect the delicate tip of the root from abrasion with the soil.

Radish Seedling



Observe the longitudinal section of the root tip. When you examine this under the microscope, you will note that many cells are undergoing cell division near the root tip. This region of active cell division, which is partly responsible for elongation of the root, is called the apical meristem. Protecting the delicate cells of this apical meristem is a structure called the root cap. Make a drawing in the Report Section.

On the side of the radish seedling root you probably noticed the root hairs along its side. These start a short distance from the root tip and extending along the side of the root for perhaps a few centimeters. Root hairs are extensions of the epidermal cells and greatly increase the root surface areas. This increases the efficiency of water absorption by the root.

Next, examine the micrograph of the cross section of a mature dicot root. Locate the following tissues:

Epidermis - The outer layer of cells of the plant body which protect the inner areas.

Cortex - Tissue (composed of parenchyma cells) filling the space between the epidermis and the vascular (transport) system.

Endodermis - A single layer of cells which encircles the vascular system.

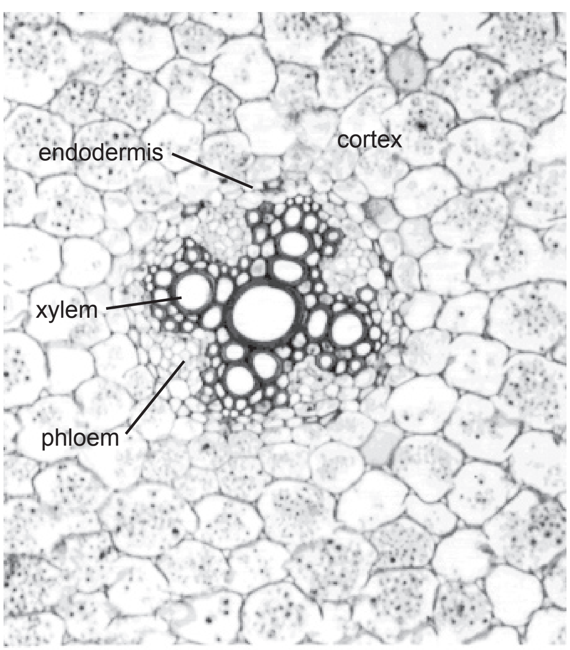
Casparian Strip - A waxy suberin layer secreted by endodermal cells which prevents water flow between these cells.

Pericycle - A single layer of cells just inside the endodermis which gives rise to lateral roots.

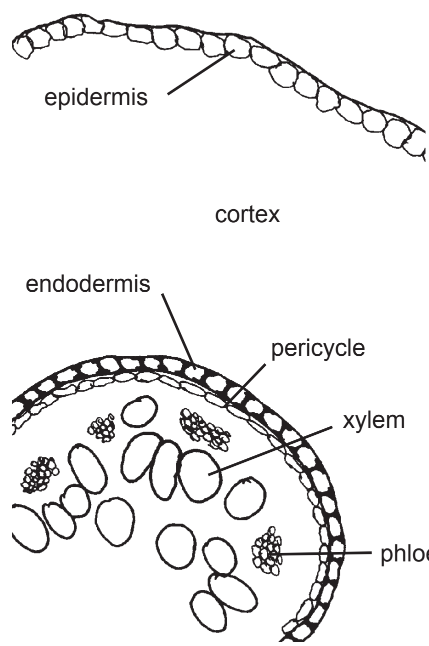
Phloem - One of the principle tissues in the vascular system. Phloem is specialized to transport the products of photosynthesis (sugars) throughout the plant. This is where one will find sieve tube elements and companion cells.

Xylem - The other principle tissue of the vascular system. Xylem is specialized to transport water and dissolved minerals from the soil to the rest of the plant. Note the thickened lignified wall of the cells (frequently stained red). Here you will find the tracheid and vessel member cells.

Dicot Root Cross Section



Monocot Root Cross Section



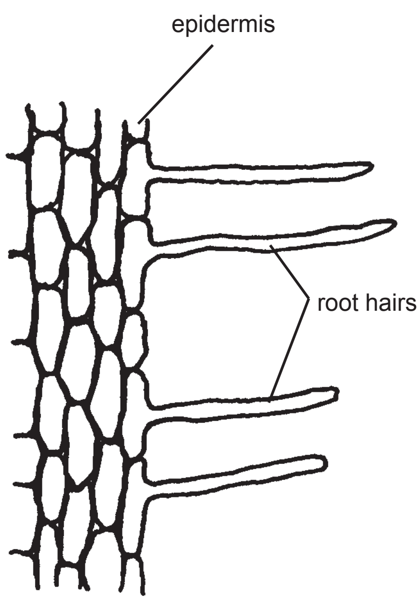
Note the overall arrangement of these tissues in the dicot root.

Now contrast the dicot root cross section with the monocot root cross section. The same tissues are present but the arrangement of these tissues differs. The central portion of the root that contains parenchyma cells is called the pith.

Label the illustration of the root cross section in the Results Section.

Before leaving the root section, observe how lateral roots are produced. Rather than being initiated from buds along the sides of the root (as we'll see in stems below), lateral roots are initiated from deep in the root's tissues. Near the center of the root, cells just below the endodermis (the pericycle) become meristematically to produce the lateral root. As the lateral root grows, it erupts through the cotex and out the side of the parent root. This pattern of growth maintains a continuous connection between the vascular tissue of the main root and its branches.

Root Hairs



Activity 24.3 Stem

Advance to the stem section of the Plant Structure simulation on the BiologyOne DVD. The primary functions of the stem are to support the leaves in a position for effective photosynthesis and to provide a system to allow transport of water, minerals, and sugars throughout the plant. The stem must be strong enough to support the plant against the force of gravity.

The stem grows from a region of cell division at its tip. This region is called the apical meristem. One or more layers of cells covers and protects the dividing cells. These layers are called the tunica. The mass of actively dividing cells is called the corpus.

Just below the apical meristem, cells of the stem begin to mature into functional tissue. Tissue developing into the epidermis of the stem is called the protoderm. The tissue that is developing into the cortex and pith of the stem is called the ground meristem. Tissue maturing into the vascular tissue is named the procambium.

Along the margins of the stem, you will see the tissue of young leaves. Near the apical meristem, these may appear as small bumps on the stem. At this stage these are called leaf primordia. At the base of the largest leaves, you may also be able to see another bump in the stem. This is the developing bud at the base of the leaf.

Observe the longitudinal section of the Coleus stem tip. Examine this using low and a higher power of the microscope. Draw the longitudinal section, labeling the tissues.

Lateral buds are found along the sides of the stem. When you observe these, you'll see that the structure of a lateral bud is very similar to the structure of the stem tip. When buds resume growth they will develop into lateral branches or reproductive structures.

Next, examine the dicot stem cross section. The tissues seen here should look somewhat similar to the root cross section but the arrangement of tissues differs and some are absent.

Outermost is an epidermis that surrounds a cortex region. In the dicot stem the vascular tissues are now found in discrete bundles called, appropriately enough, vascular bundles. Note that the bundles are arranged in a ring around the stem. Each bundle is composed of xylem tissue located toward the center of the stem and phloem tissue toward the epidermis. You will not find an endodermis or pericycle in the stem. The central region of the stem is composed of unspecialized parenchyma cells called the pith. It is the thickened cell walls of the xylem tissue that support the above ground portions of the plant.

Make your own drawing of a dicot stem cross section in the Results Section.

Now, examine a cross section of a monocot stem. Again, you will note that the tissues and structures are similar but arranged slightly different. Most notable is the arrangement of the vascular bundles. They are not found in a concentric ring but are scattered throughout the stem. However, just as with the dicots, you will find that the xylem is always located toward the center of the stem while the phloem is located toward the epidermis. Monocots do not produce a vascular cambium so you will never find wood in a monocot plant.

Label the illustration of a monocot stem cross section in the Results Section.

Activity 24.4 Leaves

Leaves serve a number of functions essential to a plant's survival. Not only are they the principal site of photosynthesis, supplying carbohydrates to the plant, but they are also the primary 'pump' to pull water up from the roots and to push sugars down toward the roots. To effectively perform these functions, leaves are generally flattened to provide a large surface area for intercepting light and exchanging gases with the atmosphere, have openings for gas exchange called stomata and are richly provided with vascular tissue for transport.

Advance to the leaf section of the Plant Structure simulation.

One variable feature of between plant species is their number of leaf blades per leaf (the part of the leaf with a flattened surface). Many plants only have a single leaf blade per leaf. These are referred to as simple leaves. In some plants, the leaves have multiple blades. These leaves are referred to as compound leaves. The figures here show several different types of compound leaves. This characteristic is often one of the first asked for when trying to identify a plant.

Another characteristic used to help identify a plant species is the number of leaves attaches per stem node. If a plant has only one leaf attached to the stem at each node, the leaf arrangement is said to be alternate. If there are two leaves attached at each node, the leaf arrangement is opposite. If three or more leaves are attached at a node, the leaf arrangement is whorled. What is the leaf arrangement of this dicot?

Examine the micrographs of the dicot leaf cross section. The leaf is bounded by an upper and lower epidermis. You should be able to see a clear layer of material on the surface of the epidermis. This is the cuticle. It is a waxy layer secreted by the epidermis to protect the plant from excessive water loss and disease. Below the upper epidermis are one or more layers of columnar cells called the palisade mesophyll. In some plants, palisade mesophyll will occur on both the upper and lower sides. Beneath the palisade mesophyll is a layer of loosely organized cells called the spongy mesophyll. These cells have a large surface area exposed to the air spaces inside the leaf. This makes for more efficient gas exchange.

The internal air spaces of leaves are connected to the atmosphere by pores through the epidermis. These pores, called stomata, are surrounded by guard cells which can regulate the size of the pore and control the amount of gas exchange and water loss that will occur in the leaf. Most if not all of the stomata will be found on the lower surface of the leaf. What advantage might this arrangement serve?

Vascular bundles are also located in the leaves. In the leaves, xylem is located toward the upper leaf surface and the phloem is located toward the lower leaf surface. Are the vascular bundles evenly spaced or all oriented in the same direction? Label the illustration of a dicot leaf in the Report Section.

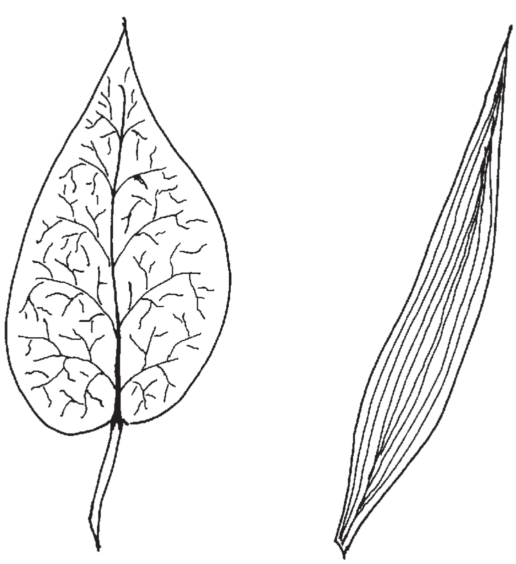
Examine the cross section of the monocot leaf. When you examine a monocot leaf, you should note the less organized palisade mesophyll layer. This layer is even lacking in some monocots. Surrounding the vascular bundles is a distinct ring of cells, the bundle sheath. As you examine this leaf, what is the distribution of the vascular bundles? Do you see how easily the two types of flowering plants can be distinguished? Make a sketch of a monocot leaf cross section in your Report Section.

The primary ‘pump’ for moving water in plants is the evaporation of water that occurs on the surface of the cells in the plant’s leaf. This evaporation acts like a flame at the end of a wick, drawing the water up the stem. The water vapor leaves the inner spaces of the leaf through openings call stomata. This type of water loss is called transpiration.

To regulate water loss, stomata are surrounded by specialized cells that can change their shape to open or close the opening. These cells are the guard cells. Observe the structure of the stomata. Make a drawing of stomata in the Results Section.

Finally, as noted earlier, when the leaves fall from the stem they leave behind a leaf scar. This is formed at the base of the leaf’s petiole. Callus tissue builds here and literally blocks off all connections between the leaf and the stem. Eventually, the leaf will break off at this point. This region of callous tissue is called the abscission layer.

Venation Types



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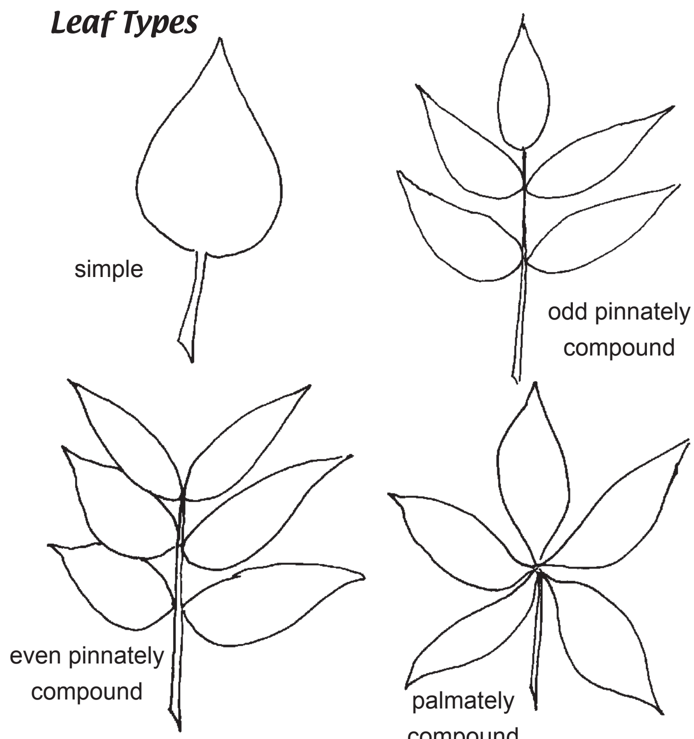
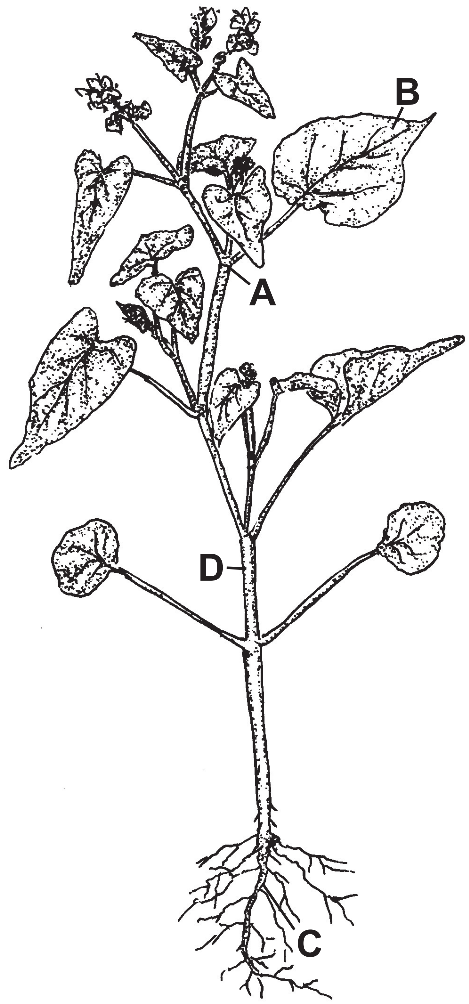
Leaf Types



 Name ______________________

Results Section

Activity 24.1
Whole Plant Structure



Describe Position of:	Relative to:	Directional Term:
location A	location B	1.
location C	location D	2.
location A	location D	3.
location C	location A	4.

Activity 24.2
Roots

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object

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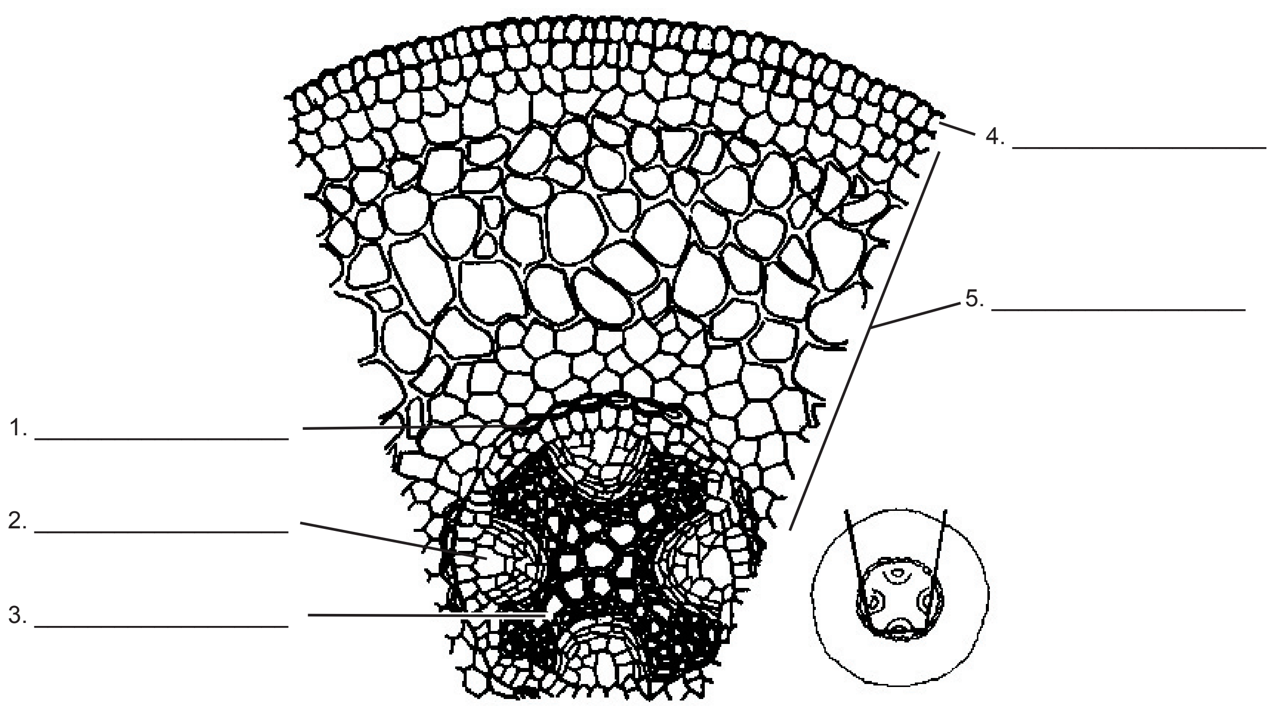
object



What part of the root woudl most easily be adapted for food storage? Why?

Activity 24.3
Stem

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object

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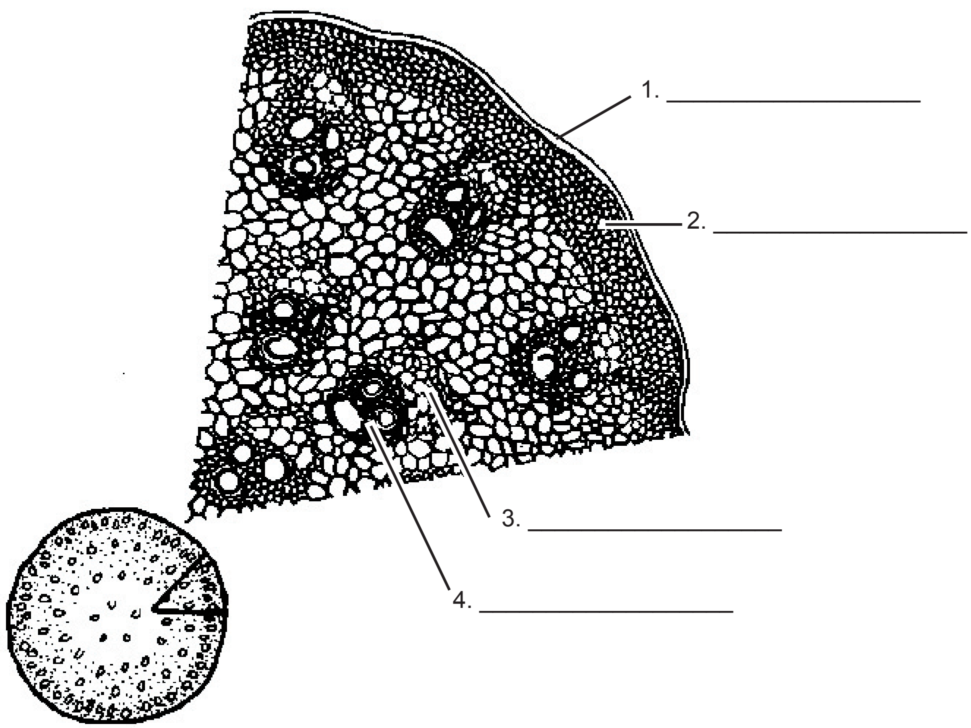
object



After observing the structure of herbaceous (nonwoody) stems, how are they structurally adapted to serve their function?

Activity 24.4
Leaves

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object

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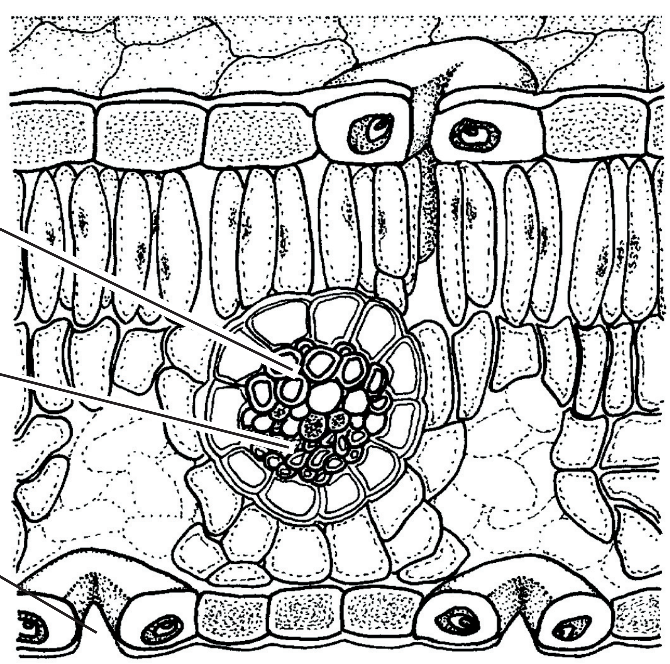
object



How is the leaf adapted for photosynthesis?