

Background Information:

Plants, like animals, have specialized tissues that carry out particular life functions. These tissues make up the three major vegetative organs of the plant, the roots, stems, and leaves. Botanists have divided the plant tissues into four basic types: They are as follows: **dermal tissue** for protection, **vascular tissue** for conducting nutrients, **ground tissue** for storage and photosynthesis, and **meristematic tissue** for cell division and growth of the plant parts. We will start our discussion with the most abundant tissue in soft plants - the ground tissue.

Ground Tissue

Ground tissue is the most abundant cell types in the plants with **soft parts**. It makes up the bulk of the internal regions of leaves, roots, stems, flowers, fruits, and seeds. The role of this tissue will vary depending upon where it is located in the plant. In the leaf, the ground tissue is responsible for photosynthesis. In the stems and roots, the ground tissue is for support and storage of nutrients. There are three basic types of cells that make up the ground tissue, each differing in its physical appearance and, therefore, its function. The three types of cells that make up the ground tissue are **parenchyma**, **collenchyma**, and **sclerenchyma**.

- a) Parenchyma is a basic, nonspecialized type of tissue found in all organs of the plant. The cell walls of parenchyma are thin and there will be a large vacuole in the center of each cell. These cells will retain their nucleus and therefore are capable of cell division. Most photosynthetic tissues are of this type, and parenchyma that contains chloroplasts is often called chlorenchyma. Storage of starches is also a main function of parenchyma cells. When you bite into a potato or an apple, you will be eating thousands and thousands of parenchyma cells storing starch or sugar.
- b) Collenchyma is a supporting tissue generally found in stems and in the stalks of leaves. The cellulose containing walls of the collenchyma cells are thickened, particularly at the corners. The cells have a central vacuole and may contain chloroplasts. Mature collenchyma cells are alive and can grow even after their walls thicken.
- c) Sclerenchyma, like collenchyma, is a supporting tissue. However, the walls of sclerenchyma cells contain both cellulose and lignin (a cellulose-like substance) and are uniformly thick. Also, in mature sclerenchyma cells only the walls are retained at maturity. There are no living contents inside the cells. This type of tissue is found both in stems and in roots. The cells vary in shape. Some are in the form of long fibers, others are spindle shaped and are called bast fibers, and still others are rounded and are called stone cells. Stone cells are found in the shells of nuts.

Questions to Answer

1. The cells of parenchyma are characterized by _____, _____ and the retention of its _____.
2. Parenchyma that contain chloroplasts are called _____.
3. What are the functions of parenchyma tissue?
4. Parenchyma, sclerenchyma and collenchyma are _____ tissues. Collenchyma and sclerenchyma function mostly as _____ cells with their thick cell walls.
5. Collenchyma is generally found in _____ and _____.

6. Sclerenchyma is generally found in _____ and _____ .
7. The thickened cell walls of collenchyma are made of _____ .
8. The cell walls of sclerenchyma contain both _____ and _____ .

Dermal Tissue

Dermal tissue is the name given to the cells that cover the outside of the plant. They serve the same basic function as your skin that is to protect against dehydration and infectious agents, like bacteria, fungi, and viruses. The dermal tissue is divided into two main categories, the **epidermis** and the **bark**. There will be many different types of cells that are found as part of the epidermis. Some of these specialized cells are known as root hairs, leaf and stem hairs, and guard cells.

- a) Epidermis is a protective tissue that generally forms the outer layer of leaves, young stems, and roots. The thick, walled cells of the epidermis physically protect the thin, walled cells beneath. The outer walls of epidermis cells contain a waxy substance called the **cuticle** that helps slow down water loss.
- b) Bark is found on older stems and roots. It is made up of many layers of cells called cork. The walls of the cork cells contain a waterproof substance called **suberin** that slows down water loss. The closely packed cork cells live only a short time, so that in the outer cork layer the interiors of the cells are empty.

Questions to Answer

9. Two types of protective tissue are _____ and _____ .
10. How do these protective tissues perform their function?

Vascular Tissue

The generalized conducting tissues of the plant are **xylem** and **phloem**. Xylem conducts water and minerals upward through the plant and also serves as a supporting tissue because the cell walls are made of thick layers of cellulose. Phloem conducts food, such as sucrose, and other dissolved substances in all directions.

- a) Xylem is formed from several different types of cells. **Tracheids** are long, thin, tapering cells. They are the most primitive xylem cells and are found in both gymnosperms and angiosperms. They have an inner, or secondary, cell wall that forms a circular, pitted, or spiral pattern. Mature tracheids consist only of the cell wall. They are nonliving at maturity. Xylem **vessels** are nonliving cells whose secondary walls show the same pattern as tracheids. The difference between vessel elements (cells) and tracheids lies in their general appearances. Tracheids are spindle shaped while vessels are cylinder shaped. Conducting tubes are formed by vessel cells positioned end to end. The end walls between the vessel elements dissolve forming a continuous tube appearing much like a long, soda straw. Conifers lack the more efficient vessel elements. They use the tracheid cells to conduct their water and minerals. Tracheids and vessels are the conducting cells in xylem. **Sclerenchyma fibers** are commonly found in xylem tissue but their duty is to help provide support to the plant. Woody plants are made almost entirely of **secondary xylem**. Wood is layer upon layer of xylem tissue.
- b) Phloem cells are living and they will only transport substances in this condition. Xylem, on the other hand, is dead at maturity. Phloem is made up of special cells called **sieve tube elements** which are thin walled cells with holes in their end walls. The sieve elements join end to end to form sieve tubes. Unlike xylem, which is made up of dead cells, sieve tubes are made up of living cells. **Companion cells** lie beside the sieve elements, and it is thought that the metabolism of the sieve elements is regulated by these cells. **Sclerenchyma fibers** contribute to the support of the stem. In woody stems, the inner bark consists of phloem cells.

Question to Answer

11. Water and minerals are conducted up from the roots to the rest of the plant by the _____ .
12. Sugar and other dissolved substances are conducted throughout the plant by the _____ .
13. The three types of cells that make up xylem are _____ , _____ ,
and _____ .
14. The conducting elements of xylem are the _____ and the _____ .
15. The types of cells found in phloem include _____ , _____ ,
and _____ .
16. The _____ cells are dead at maturity, while the _____ are living
when mature.
17. In what ways do phloem and xylem differ?

Meristematic Tissue

Unlike animal tissues, almost all of which can undergo cell division, only certain tissues in plants are capable of cell division. Such tissues are called meristematic tissues, or **meristem**. It is only in these tissues, which are found in particular parts of the plant that growth can occur. The tips of stems and branches are meristematic tissue, as are the growing tips of roots. The cells of meristematic tissue are thin walled and small. They contain few vacuoles, if any. The cells divide and then differentiate into the other types of tissues. When growth occurs at the tips of stems and roots, the plant increases in height. This is called **primary** growth and is caused by the cells in the apical meristem. Some plants can increase their thickness, or diameter. This growth is called **secondary** growth and is caused by meristematic tissue known as the vascular cambium. The vascular cambium is a cylinder of tissue found inside roots and stems. Often as a plant develops secondary growth, it become woody. The plant produces secondary xylem which forms tree rings and secondary phloem which produces the inner bark.

Questions to Answer

18. Plant tissues that can divide are called _____ .
19. In what parts of the plant are such tissues found?
20. From what type of tissue does primary growth occur? _____ . From what type of tissue
does secondary growth occur? _____ .
21. In what respects are meristematic tissues different from other plant tissues?

Using Analogies: Understanding the Main Ideas

In an analogy, pairs of words have a similar relationship. For example, “dark is to black as short is to small” is an analogy in which the words in each pair are similar.

Key terms from this section are listed below. Choose the term from the list that correctly completes each of the analogies that follow. You may use some terms more than once.

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|---------------------|------------------|---------------------|
| meristematic tissue | companion cells | sclerenchyma |
| cork | vessel element | tracheid |
| parenchyma | apical meristem | sieve tube elements |
| vascular tissue | vascular cambium | root hair |

22. Parenchyma is to storage as _____ is to support.
23. _____ is to growth as vascular tissue is to transport.
24. Tracheids are to xylem tissue as _____ are to phloem tissue.
25. Vascular cambium is to secondary growth as _____ is to growth in length.
26. Parenchyma is to potatoes as _____ is to bark.
27. _____ is to water absorption as xylem is to water transport.

Distinguishing Plant Tissues

Label the plant tissues found in a typical cross section of a leaf. The only tissue not present is the meristematic tissue. The other three should be labeled appropriately. Use the terms dermal, vascular, and ground tissue.

