Plant Systems

Tissues, Organs, and Systems of Living Things

Cells, Cell Division, and Cell Specialization	Animal Systems and Human Systems	**Plant Systems**

Plants include mosses, ferns, conifers, and flowering plants: all of these are multicellular organisms.

What is a plant?

- multicellular
- autotrophic (produces its own food)
- contains chlorophyll and plastids (i.e. chloroplasts)
- photosynthesizes

Chloroplasts, found only in plant cells and some algae, contain chlorophyll, which uses energy from the Sun to convert carbon dioxide and water into sugar and oxygen in a process called photosynthesis. (Carbon dioxide and oxygen are exchanged through the stomata in the leaves.)

Equation for photosynthesis: $6\,CO_2 + 6\,H_2O \longrightarrow C_6H_{12}O_6 + 6O_2$

The plant body like the human body is made up of different types of cells, organized into tissues, organs and organ systems.

Plants do not need complex organ systems that are found in animals.
However, plants still need to perform many of the same functions as those required by animals:

- plants need to exchange gases with their surroundings,
- plants require an internal transportation system to move water and nutrients around within their bodies, and
- they must have a way of reproducing.

The plant body is divided into two parts:

1. The root system, (often referred to as root), and
2. The shoot system, (often referred to as shoot) .

The root system is made up of one or more separate roots, whereas as the shoot system consists of the stem, leaves and the flower.

The shoot system, which is made up of the stem, leaves, buds, flowers, and fruits.

The roots, stem, leaves and flower are often referred to as simply plant "**organs**".
These organs work together to help the plant grow, reproduce, and ensure the plant survives changes in its environment.

Plant Structure

The following diagram illustrates the main features of a flowering plant:

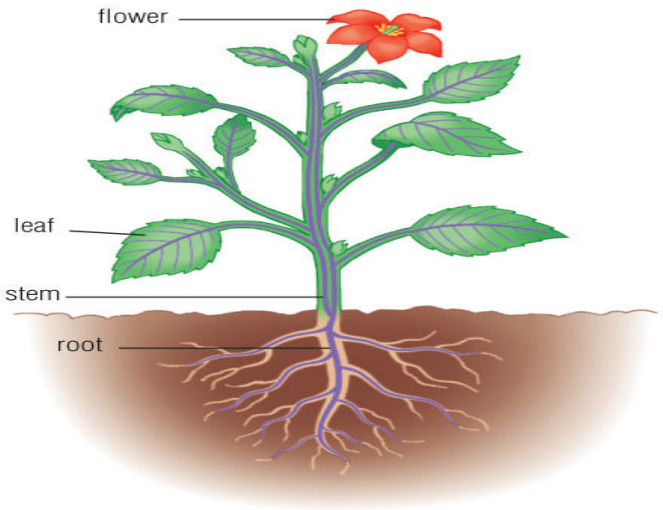

Figure 2.9 Groups of plant tissues form organs that perform specialized functions in a plant.

The Root System (made up of one or more separate roots):

- < includes everything underground (usually)
- < anchors the plant to the soil
- < absorbs water and nutrients from the soil and transport it to the stem, through the process of transpiration.
- < conducts water and nutrients
- < stores food made in other parts of the plant.

The Shoot System (made up of the stem, leaves, buds, flowers, and fruits)

- < includes everything above the ground (usually)
- < elevates the plant above the soil
- < many functions, including:
  - photosynthesis
  - reproduction & dispersal
  - food and water conduction

Two functions of the stem are to transport water and nutrients throughout the plant, and to support the leaves and flowers.
The epidermal tissue provides protection and allows the exchange of gases and water vapour.
Ground tissue provides support and strength.
Vascular tissue transports materials throughout the plant.

The stem generally does not perform photosynthesis, as it tends to be shielded from light from the Sun by the leaves.
Also, the stem does not collect nutrients from the ground as the roots do.
The stem connects the roots to the leaves.

The major job of the leaf is to accomplish photosynthesis.

Equation for photosynthesis: $6\,CO_2 + 6\,H_2O \longrightarrow C_6H_{12}O_6 + 6O_2$

How the root and shoot systems work in photosynthesis:

1. The root system includes everything below the ground as well as aerial roots.
2. The shoot system includes everything above ground.
3. Nutrients and water are absorbed through the root system and transported to the rest of the plant through the shoots system.
4. Water moves from the roots to the leaves through the process of transpiration.
5. **Stomata** are small openings on the underside of the leaf. Water evaporates through these holes, which creates a pull to help draw water and nutrients up the stem.
6. Photosynthesis takes place in the leaves, a part of the shoot system.
7. The sugar produced during photosynthesis is moved throughout the shoots and roots to all parts of the plant.

Flowers are reproductive structures that produce seeds through sexual reproduction.
The flesh that surrounds a seed is the fruit.

Plants have organs and tissues just like animals. The **three main types of organs in plants** are shown below. Complete the chart:

Organ	Description/Function	Coloured illustration with labels
Leaves		
Stems		
Roots		

If the roots were damaged, the ability of the plant to grow and provide nutrients would be affected.

The tip of a root is called the **root cap** and provides protection to the epidermal layer of the root.

Below the epidermal layer is meristematic tissue, which allows the root to grow.

Various vascular tissues in the root allow for transportation of water and nutrients to the rest of the plant.

Plant cells have a cell wall to provide support, a large vacuole for storage of minerals, food, and chloroplasts where photosynthesis takes place.

Tissues are made up of specialized cells, (i.e. tissue is a group of cells with similar structure and function.).
Plant cells are organized into **four main types of tissue.** Each tissue system is responsible for a particular function and is located within the plant based on the function.

Plant Tissue Systems

Tissue	Function
epidermal tissue	< Forms protective outer coating of a plant, and allows the exchange of materials and gases into and out of the plant. < The epidermal tissue is a thin layer of cells and are tightly packed together to prevent loss of water and to limit materials getting in and out of the plant's cells. < Epidermal tissue is found on the top and bottom of a plant leaves, stem , and roots. The tissue is clear and very thin. < Within the epidermal tissue are specialized openings called **stomata** that allow for the exchange of gases and water. < Conserving water is a survival issue for plants in the desert.
Vascular Tissue in Stems	< Vascular tissue exists at the centre of roots, stems, and leaves. < Cells in vascular tissue are grouped together in tubes, occur in the leaves. This configuration helps in the function of transporting substances from the roots to the leaves. < Function of vascular system is to transport water, ions, minerals and food long distances through the plant, i.e. from the roots to the leaves and the sugars produced during photosynthesis to other parts of the plant. < **Xylem**, and **phloem** are the two types of tissue that make up the vascular tissue system.
Ground tissue	< Most of a plant is made of ground tissue. < Ground tissues are the filler between the epidermal and the vascular tissues, they are the larger cells with space between the cells. Cells are more rigid. This would help with the function of storing food and water, and with providing support. < The function of ground tissue depends on its location. < The ground tissue in the **roots** stores food and water; water is needed during photosynthesis. < It provides strength and support in the **stem** and leaves so they can be exposed to sunlight needed for photosynthesis. < In the **green parts** of the plant, they manufacture nutrients by the process of photosynthesis. < Photosynthesis takes place in ground tissue in the leaves. < **Mesophyll tissue** is specialized ground tissue. Photosynthesis and gas exchange occurs in the mesophyll tissue.
Meristematic Tissue	< Meristematic cells are **stem cells** in plants. < All plant tissues are formed out of meristematic tissue, which is made of unspecialized cells capable of dividing by mitosis. < They are found where growth takes place: root tips, stems, and the cambium. < Unlike animal stem cells, meristematic cells are active throughout a plant's life. < Meristematic tissue grows new parts of the plant.

The interaction between vascular tissue and ground tissue helps a plant survive.
The ground tissue provides structure and support, while the vascular tissue transports nutrients throughout the plant.

Location of Plant Tissue

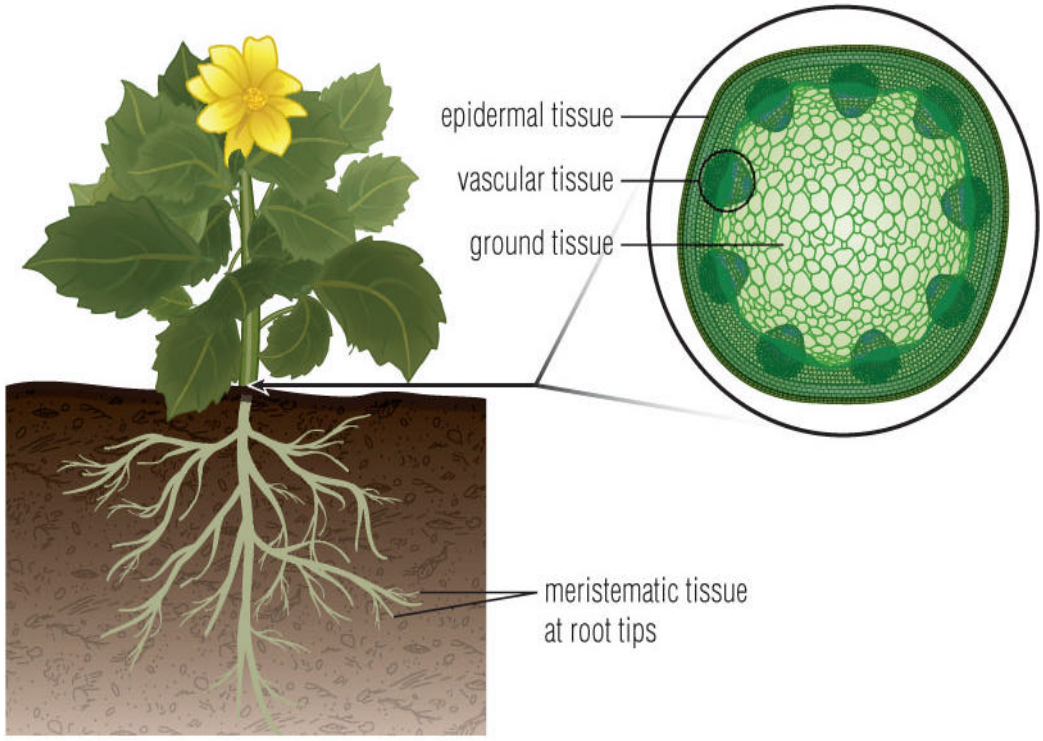

Figure 1.44 Location of plant tissues

Connective tissue in animals and **vascular tissue** in plants have similar functions in that they both are responsible for the movement of nutrients, gases, and wastes.

Epithelial tissue in animals and **epidermal tissue** in plants both cover and protect the organism.

If plants were not covered in epidermal tissue, the plant would likely lose a great deal of water. In many plants, the waxy substance secreted on epidermal tissues greatly reduces water loss.

Xylem, and **phloem** are the two types of tissue that make up the vascular tissue system.

Xylem: Xylem acts as a conduit is responsible for moving water and minerals from the roots up the stem to the shoot system where these substances are used for photosynthesis. The movement in xylem tissue is in one direction, upward.

Phloem: Vascular tissue called phloem transports the sugar that is produced during photosynthesis to other parts of the plant where it can be used to provide energy. The movement in phloem is in both directions.

Tissues in a Leaf

The tissues that work together to accomplish photosynthesis in a leaf are

1. vascular tissue, which carries water needed for photosynthesis from the roots to the leaf;

2. epidermal tissue, which controls the movement of gases and water vapour into and out of the leaf; and
3. ground tissue, which is where photosynthesis takes place.

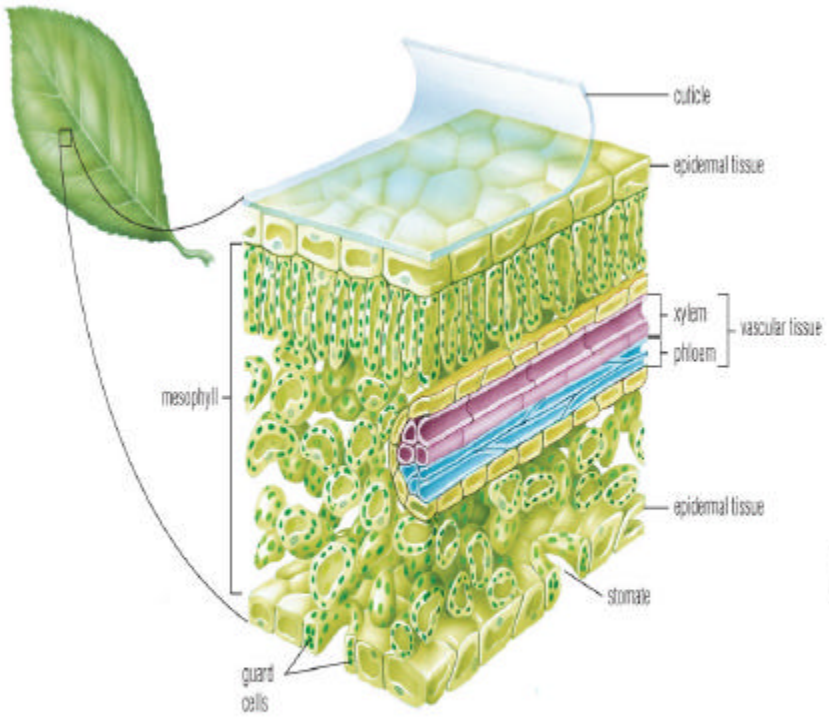

Figure 2.10 A cross section of a leaf showing the tissues

The processes in the transport of materials in plants:

1. Water travels from the roots to the chloroplasts in the leaves; when water enters the root hairs through the root epidermis, it travels to the **xylem**, and moves against gravity up the stem to the leaves through the process of transpiration.

2. When the water reaches the leaf, it moves from the xylem to the ground tissue through transpiration.

3. Small openings on the underside of the leaf called **stomata** allow water to evaporate, which maintains the transpiration pull.

4. **Phloem** transports the sugar produced during photosynthesis from the leaves to other parts of the plant where it is used to provide energy.

The steps involved in gas exchange in a leaf:

1. First, the water is carried up from the roots through the vascular tissues, through the stem to the leaves.

2. Carbon dioxide enters through the stomate (an opening in the epidermal tissue) in the leaf.

3. In the mesophyll tissue of the leaf, photosynthesis takes place, using sunlight, carbon dioxide, and water, to produce oxygen and sugar.

4. The oxygen and excess water exit the leaf through the stomate.

Guard Cells

Guard cells control the movement of materials in and out of the leaf cells.

Carbon dioxide needs to be able to enter the leaf cells, and oxygen and excess water need to be able to exit through openings in the leaf.

If these openings were not controlled, too much water might be released.

Also, if the guard cells were not there, other harmful materials might be able to enter the leaf cells.

Assignment

1. What are the main differences between plants and animals?
2. Name the three tissue types in plants and briefly describe them.
3. Compare the functions of the stem and the root in plants.
4. Describe the primary function of a flower.
5. How can roots, stems, and leaves all be involved in food storage. Explain.
6. What is the purpose of cell division in plants?
7. What are the main functions of the three plant tissue systems?
8. Compare the structure and function of xylem and phloem.
9. Explain why it is important for plant leaves to be waterproof?
10. Explain why the movement of water and minerals in xylem is always upward.
11. Briefly describe how guard cells are able to control stomata.
12. List the functions of a plant's roots.
13. Draw a simple diagram of a plant and label the main parts.
14. How are meristems in plants similar to and different from stem cells in animals?
15. How can a plant easily regrow a damaged stem or leaf?
16. What is a fruit?
17. Use a flow chart to show how gas is exchanged in a leaf.
18. Explain what would happen if plants were not covered with epidermal tissue.
19. Describe how vascular tissue is involved in the functions of the root and leaf of a plant.
20. Give an example to show how the root and the shoot system of a plant act in and interdependent fashion.