Introduction

Angiosperms, the flowering plants, are the most highly evolved plants and the most dominant in present times. The cells of angiosperms are prearranged into different tissues and organs *(Curtis et al 1989)*. The three main organs of flowering plants are roots, stems, and leaves. All the flowering plants are basically divided into two major groups or classes, the Dicots and the Monocots based on a variety of the structural appearance. Most of these features can be identified with the naked eye including, the number of seed leaves, root system, appearance of vascular bundles in stems, vein arrangement in the leaves and the number of floral parts *(Blake et al 2001)*. While monocots and dicots are composed of the same tissues (ground, vascular and dermal tissues) the arrangement of these tissues differs *(Curtis et al 1989)*.

The internal structure of the angiosperm root is comparatively simple *(Curtis et al 1989)*. In dicots and most monocots, the three tissue systems (dermal, ground and vascular) are arranged in three layers: the epidermis, the cortex, and the vascular cylinder *(Curtis et al 1989)*. The epidermis, which covers the entire surface of the root, absorbs water and minerals from the soil and protects the internal tissues *(Curtis et al 1989)*. The epidermal cells of the root are characterized by fine, tubular outgrowths, known as root hairs *(Curtis et al 1989)*. Most of the water and minerals that enter the root are absorbed by these root hairs *(Curtis et al 1989)*. The second layer of the root is the cortex which occupies by far the greatest volume of the root *(Curtis et al 1989)*. The cells of the cortex usually lack functional chloroplasts. Instead, the plastids are specialized for food storage and contain organic compounds such as starch *(Curtis et al 1989)*. The many spaces in the cortex allow oxygen from the soil to enter through the epidermal cells *(Curtis et al 1989)*. Unlike the rest of the cortex, the cells of the innermost layer, the endodermis, are condensed and have no spaces between them in order to regulate the passage of water and dissolved minerals *(Curtis et al 1989)*. The third and the inner layer of the root is called the vascular cylinder. It consists of xylem and phloem surrounded by one or more layers of cells from which branch root arise *(Curtis et al 1989)*. In most plants, the vascular tissues of the root (xylem and phloem) are grouped in a solid cylinder. However, in some monocots, the vascular tissues form a cylinder around a pith *(Curtis et al 1989)*.

Stems display leaves to the light and the chief functions of stems are the production and support of leaves and reproductive structures, conduction of water and dissolved minerals *(Blake et al 2001)*. They may also in some plants, have the specialized functions of storing water and manufacturing food *(Blake et al 2001)*. The dermal tissue or the outer surface of stems is made up of epidermal cells *(Blake et al 2001)*. Green stems are photosynthetic and are covered with a waxy cuticle that contains stomata to prevent the loss of water by evaporation *(Blake et al 2001)*. The arrangement of vascular bundles differs in the stems of monocots and dicots. In monocots, the vascular tissue occurs in many scattered bundles throughout the stem. In dicots, the vascular bundles are arranged in a ring; the remainder of the stem makes up the fundamental tissue and is usually divided into the cortex, the portion outside the ring of vascular bundles, and the pith, the portion inside the ring *(Curtis et al 1989)*.

A leaf is an extension of a plant's stem. The structure of a leaf is a compromise between three conflicting pressures; to expose to maximum photosynthetic surface to sunlight, to conserve water, and at the same time, to provide for gas exchange that is necessary for photosynthesis *(Curtis et al 1989)*. The photosynthetic cells of leaves are parenchyma cells of two types: palisade parenchyma, which are densely packed, and spongy parenchyma, which are irregularly, shaped cells in the interior of the leaf and there is often a large space between them that is filled with gases such as water vapour and oxygen *(Blake et al 2001)*. These two layers (palisade and spongy parenchyma) make up the mesophyll which is the ground tissue of the leaf. The mesophyll is enclosed between epidermal cells which secrete a waxy substance called cutin *(Curtis et al 1989)*. The cutin forms a coating, the cuticle, over the outer surface of the epidermis *(Curtis et al 1989)*. The epidermal cells and the cuticle only permit light to penetrate to the photosynthetic cell *(Curtis et al 1989)*s. Water and dissolved minerals are transported into and out of leaves by the way of vascular bundles which are known in leaves as veins (xylem and phloem) *(Curtis et al 1989)*. Veins are conspicuously different in monocots and dicots *(Curtis et al 1989)*. In monocots the major veins are usually parallel and in dicots the veins are usually netted. Gases (o_2 and co_2) move into and out of leaves by diffusion through stomata *(Blake et al 2001)*. Stomata consist of a small opening or pore, guard cells, which open and close the pore *(Blake et al 2001)*.

Purpose:

- To examine the root, stem and leaf tissue layers of monocotyledonous and dicotyledonous plants.
- To observe any similarities or differences between monocot and dicot tissues.

Hypothesis:

If it is true that the vascular bundles in the stems are scattered in monocots and arranged in a ring in dicots, and they are arranged in a circular pattern in monocots and arranged in a cross shaped pattern in dicots, then based on this information it can be concluded distinct differences between monocot and dicot cells will be seen in the experiment.

Materials:

- Microscope
- Prepared slides of monocot and dicot root cross-sections
- Prepared slides of monocot and dicot leaf cross-sections
- Prepared slides of monocot and dicot stem cross-sections
- Living leaf section
- Blank paper and drawing apparatus

Procedure:

Part A: Root Cross Sections:

- The slides containing monocot and dicot root cross-sections were examined.
- Detailed drawings of the tissues were drawn.
- The following structures were labelled:
  - Epidermis
  - Endodermis
  - Phloem
  - Xylem
  - Cortex
  - Pith

Part B: Stem Cross-section:

- The slides containing monocot and dicot stem cross-sections were examined.
- Detailed drawings of the tissues were drawn.
- The following structures were labelled:
  - Epidermis
  - Cuticle
  - Phloem
  - Xylem
  - Cortex
  - Pith

Part C: Leaf Cross-section

- The slides containing monocot and dicot stem cross-sections were examined
- Detailed drawings of the tissues were drawn.
- The following structures were labelled:
  - Epidermis
  - Palisade parenchy
  - Spongy parenchyn
  - Stomata
  - Guard cell
  - Vascular bundle
  - Xylem
  - Phloem

Part D: A section of a living leaf

- A section of a living leaf was examined and observed for any evidence of the presence of the stomata, the guard cells and chloroplasts. A detailed drawing was drawn.

Discussion questions:

1. The roots of a plant absorb water and minerals from the soil and pass them upward through xylem and phloem to the stem and leaves *(Blake et al 2001)*. They are also responsible for storing the plant's organic nutrients such as starch, which are passed downward from the leaves through the phloem . Also, roots anchor the plant in the soil *(Blake et al 2001)*.
2. The tap root is a single thick vertical root from which smaller, secondary roots extend *(Blake et al 2001)*. It is the primary root that follows the downward line of the plant's stem, often deeply into the ground. A tap root can penetrate deeper into the soil so that it gets the water it needs in the harsh environments and also it makes the plant hard to pull from the ground *(Curtis et al 1989)*.
3. The fibrous root is an adventitious root system usually formed by thin and moderately branching roots, growing from the stem *(Curtis et al 1989)*. The important ecological role that it plays is that it holds soil in place, preventing erosion and protecting ecosystems *(Curtis et al 1989)*.
4. The meristematic region root is found behind the root cap where the cells divide and additional cells are provided for the zone of elongation *(Blake et al 2001)*.
5. Root hairs are formed in a short distance above the region of elongation *(Blake et al 2001)*. They arise and form by growing out of a specialized subset of epidermal cells called trichoblasts *(Curtis et al 1989)*. They are short and short-lived and develop on the primary and secondary roots. Their function is to increase the surface area available for absorption of water and water-soluble minerals *(Curtis et al 1989)*.
6. The cells of the cortex are mostly parenchyma cells. They store food such as starch and take up minerals that that have entered the root through the epidermis *(Blake et al 2001)*.
7. Many plants live a water limited environment. In order for them to survive, they develop roots that can penetrate very deep in the soil to capture as much water and nutrients as they can . For example, Cactuses such as a barrel cactus have extremely long roots to reach out through the sandy, rocky soil in order to survive in the desert *(Curtis et al 1989)*. Some trees grow in very unstable soil so that they develop a complex prop root system that helps keep the tree stable in an unstable environment *(Curtis et al 1989)*. For example, Epiphytes and vines also have special roots that help them grab onto a tree's bark and stay put *(Curtis et al 1989)*. Some plants such as orchids and bromeliads often grow in tropical rainforests that they have very poorly developed roots or none at all *(Curtis et al*

1989). These plants live on the bark of other trees, thus they do not have access to the wet soil and need ways to capture and store water for themselves *(Curtis et al 1989)*.

8. Stems are usually aerial, upright, and elongate *(Curtis et al 1989)*. In order to support leaves and reproductive structures, conduct water and nutrients and food storage. Stems have specialized tissues that can do such things. The stem has a special structure, xylem that can transport water and dissolved minerals from the roots to the leaves. Also, they have phloem that can transport food molecules from the leaves to the roots for storage *(Curtis et al 1989)*.
9. The stomata cells on a stem allow for gas exchange to occur, they are usually found on herbaceous stems that contain chlorophyll and are capable of photosynthesis *(Blake et al 2001)*.
10. The purpose of the stem's nutrient transport role is to transport water and dissolved nutrients to the site of photosynthesis of the plant (the leaves), transport newly manufactured food molecules from the leaves to the roots and to transport food stored in the root to any part of the plant *(Blake et al 2001)*.
11. The leaves are the sites of photosynthesis on a plant. Their principle function is to convert the sun's energy into usable forms of chemical energy. They collect sunlight and convert it to a usable source of energy such as glucose *(Blake et al 2001)*.
12. Chlorophyll is a pigment molecule found in leaves. It is contained inside a special network of thylakoid membrane called the grana. The chlorophyll pigment is found within these thylakoid sacs. The chlorophyll has the ability to attract and absorb energy from sunlight and use it to make glucose molecules in a process called photosynthesis *(Blake et al 2001)*.
13. The veins in leaves are composed of vascular bundles called xylem and phloem. These bundles are part of the vascular system of the plant. They are "tube-like" strands that connect the vascular tissues of the roots to the vascular tissues of the leaves. The 2 important functions of these veins are to transport water and dissolved nutrients and minerals into the leaf and transport dissolved carbohydrates (nutrients) out of the leaf (*Blake et al 2001)*.
14. The cuticle is a waterproof waxy substance found on the top and bottom surfaces of the leaf. The cuticle's function is to reduce the amount of water loss by plants and to block the passage of gases through the cells of the epidermis (*Blake et al 2001)*.
15. The stomata are the pore like openings found in the epidermis all over the leaf's surface. Their function is to permit gas exchange between the leaf's interior and the external environment. The stomata are surrounded by guard cells that control its opening and closing. When water flows into guard cells they expand and become turgid and the opening of the stoma becomes larger (*Blake et al 2001)*. When the water leaves the guard cells they return to their original size and the opening of the stoma becomes smaller and closer (*Blake et al 2001)*.

Conclusion:

The root, stem, and leaf cells of monocots and dicots were studied in this experiment. Distinct differences were observed between monocot and dicot root, leaf, and stem cells in this experiment. It was found that monocots had no pattern in the placement of vascular tissues but dicots had a circular or cross shaped patterns.

Error Analysis

The margins for errors in this experiment were very low because the slides were pre-prepared and were labeled correctly. The samples were all clearly visible. There is a possible error which is that some cells were pretty similar that it was hard to distinguish between them. So, there could be some errors in labeling the cells that were drawn. Another possible error that could have occurred is when calculating the size of the specimen or in its magnification.

Application

The information learned in this experiment can be used when distinguishing between monocots and dicots in the future. For example, a farmer can examine the leaves of a plant and decide whether the plant is monocot or dicot, which may help him to choose the type of fertilizers to use or the type of plant that will give him maximum produce. Also, it will be useful to know the differences between monocots and dicots, when planting trees since monocots tend to have weak herbaceous stems.

Bibliography:

- **Blake et al. Biology 11. Ontario: McGraw-Hill Ryerson. 2001.**
- **Curtis et al. Biology. New York: Worth Publishers. 1989.**