Internal Root Structure

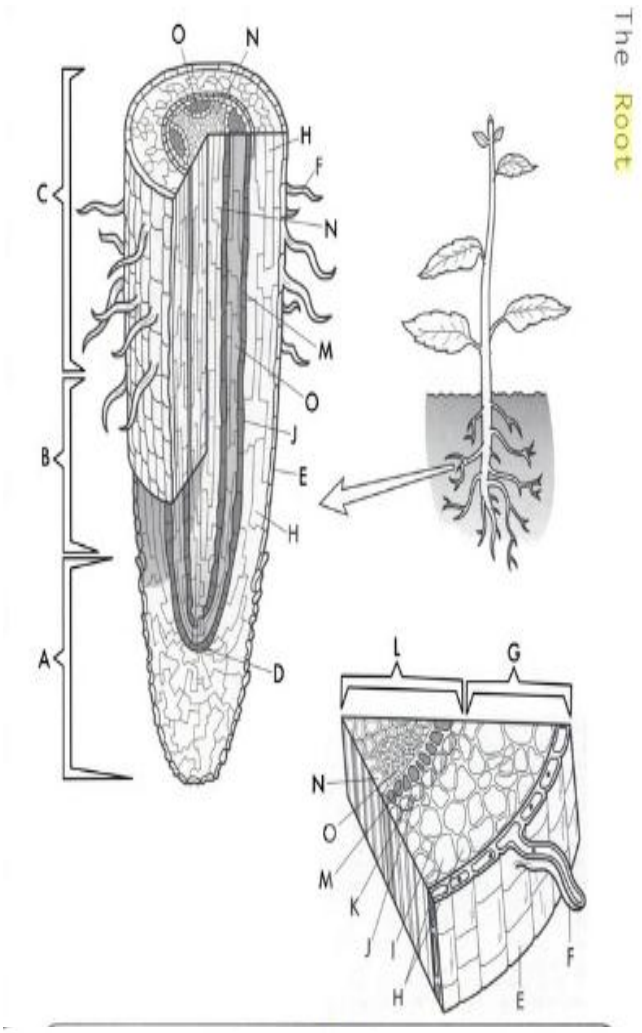
Learning Objectives

- Describe the different structures and zones of a root.
- Compare and contrast a monocot root to a dicot root.
- Describe secondary root growth and the function of vascular and cork cambium.

Introduction

The internal structure of the root shows the different cells and tissues that form the root system, it varies from plant to another depending on the group to which it belongs, there are differences between monocotyledonous plants and dicotyledonous plants, between plants from various environments, and it differs in the same plant.

Longitudinal Section



The first organ to emerge from a germinated seed is the root, and the diagram at the left shows the four major regions of the root. The **root cap (A)** at the tip of the root provides protection as the root forces its way through soil particles. New cells are also produced at the root cap to replace those that are worn away.

One of the functions of the root cap is to protect the **apical meristem (D)**, which is the second major region of the root. Apical meristem tissue is composed of undifferentiated cells that give rise to new cells through mitosis. In this way, the plant grows outward from the root tip. The third region is the **zone of elongation (B)**, which is enclosed by a bracket. Cells from the apical meristem increase in size in this zone. Highest up is the **zone of differentiation (C)**, in which cells that were once part of the zone of elongation start to become specialized cells of the epidermis, cortex, and vascular cylinder.

Beginning at the surface of the plant, the first tissue we encounter is **epidermis (E)**, shown in both the longitudinal and cross sections. The epidermis protects the plant against invading microorganisms and environmental stresses. Some epidermal cells near the zone of differentiation become extensions called **root hairs (F)**. Many root hairs are seen in the longitudinal section, and one is shown in the cross section. The root hair is an

The Root

○ Root Cap .....A	○ Root Hair.....F	○ Casparian Strip.....K
○ Zone of Elongation ....B	○ Cortex .....G	○ Vascular Cylinder.....L
○ Zone of Differentiation.....C	○ Cortex Parenchyma Cells .....H	○ Pericycle.....M
○ Apical Meristem.....D	○ Air Spaces I	○ Xylem.....N
○ Epidermis.....E	○ Endodermis .....J	○ Phloem .....O

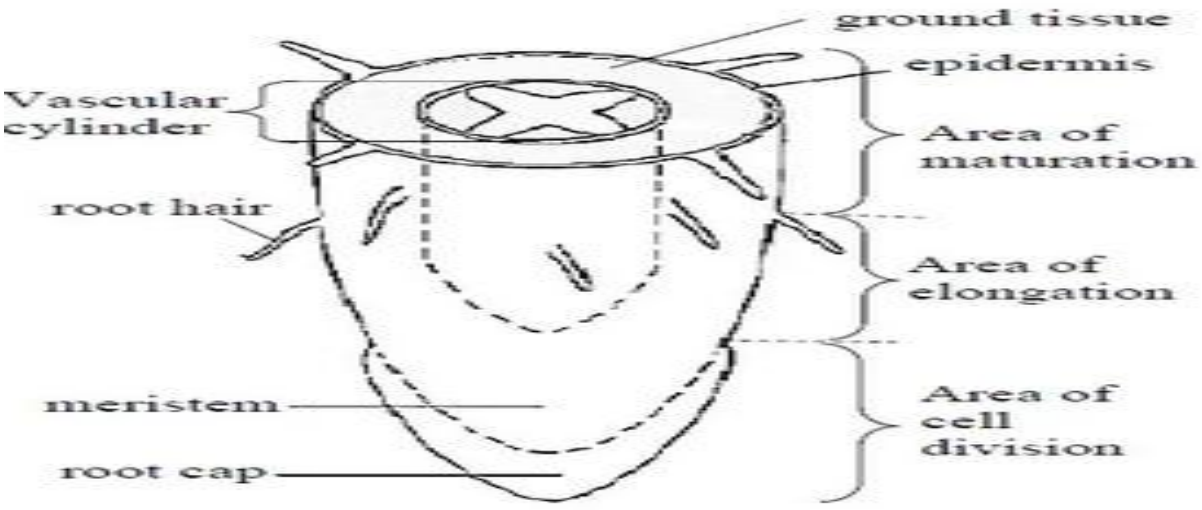
outgrowth of a single epidermal cell, and might contain its nucleus, as shown in the cross section. Root hairs increase the surface area that is in contact with the soil, which facilitates the absorption of water and minerals.

Inside the epidermis is a region called the **cortex (G)**. The cortex is composed primarily of **cortex parenchyma cells (H)**, which are thin-walled cells that take up mineral ions after they have passed through the epidermis. The cells may also be modified to store water or starch. Notice that many **air spaces (I)** exist between the parenchyma cells; they facilitate the free exchange of ions, fluids, and gases. The cortex is the largest area of the young root.

The central core of the root is occupied by a complex group of tissues known collectively as the **vascular cylinder (L)**. The outermost tissue of the vascular cylinder is the **endodermis (J)**, which is a single layer of cells that completely encloses the rest of the vascular tissue. Parts of the cell walls of these endodermal cells are impregnated with a waxy material that regulates the flow of water and minerals from the cortex to the inner tissues of the vascular cylinder. This material forms a collar that is called the **Casparian strip (K)**.

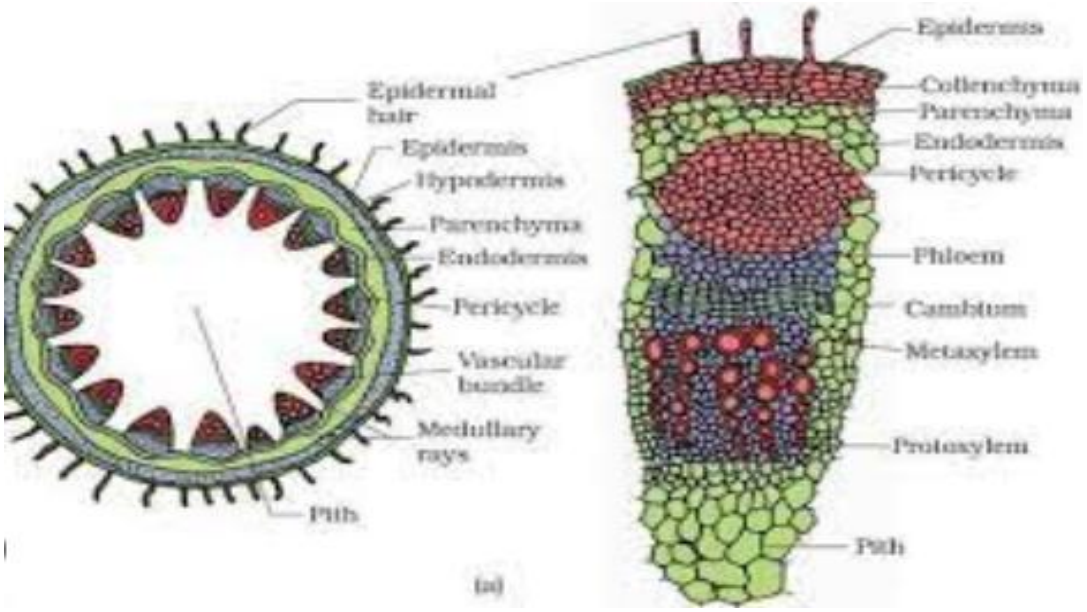
Inside the endodermis is the **pericycle (M)**, which is made up of a layer of parenchyma cells that undergo cell division to produce lateral roots. Cells of the pericycle are also responsible for the secondary growth of roots, which causes an increase in root diameter.

Some of the tissue that extends from the roots through the stem of the plant to its leaves is called **xylem (N)**. Xylem transports water and dissolved minerals from the soil to distant parts of the plant. Two types of cells, tracheids and vessel elements, make up the xylem, and we will discuss these in a future plate. The job of transporting sugar and other organic compounds in the plant falls to the **phloem (O)**. The phloem transports nutrients produced during photosynthesis (in the leaves) to other parts of the plant.



Longitudinal Zonation of a Root

Internal Structure of Dicot Stems



Internal structure of a typical dicot stem shows following features:

1. Epidermis:

Epidermis is the outermost layer of the stem. It is single layer and lack of chloroplast. Multicellular hairs (trichomes) and stomata are found on epidermis. Outer side of epidermis a layer is present which is made up of cutin is called cuticle.

Epidermis plays a significant role in protection.

2. Cortex:

In dicotyledonous stem cortex divided into three parts:

(a) Hypodermis: It is present just below the epidermis. It provides additional support to epidermis. It is thick multicellular layer. This layer is composed of collenchyma and their cells contain chloroplast. So hypodermis is green and photosynthetic.

(b) General Cortex: This part is composed of parenchyma. Storage of food is the main function of the cortex. Resin canal/ mucilage canal are present in it. The innermost layer of the cortex is called endodermis.

(c) Endodermis: It is single celled thick layer. The cells of endodermis are barrel shaped. These cells accumulate more starch in stem of dicot. Thus it is known as "Starch sheath".

3. Pericycle:

This layer is situated in between the endodermis and vascular bundles. The pericycle of stem is multilayered and made up of sclerenchyma. Sclerenchymatous pericycle is also known as Hard bast Libéria dur

.Note:

- In sunflower stem perieycle is made of alternate bands of parenchymatous and sclerenchymatous cells.
- Pericycle which is present in front of the vascular bundle is made up of sclerenchyma and remaining is composed of parenchyma.
- Part of pericycle which is situated in front of vascular bundle is known as Bundle cap.

4. Vascular Bundle:

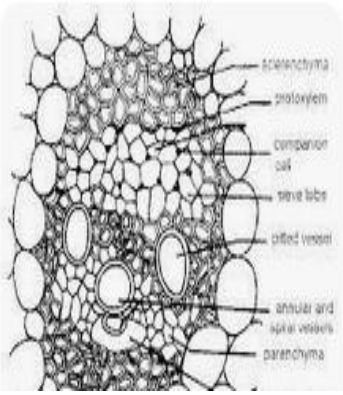
The vascular bundles (wedge shaped) are arranged in a ring. Each vascular bund is conjoint, collateral and open. Each vascular bundle is made of phloem, cambium and xylem. Eustele is present in dicotyledon stems.

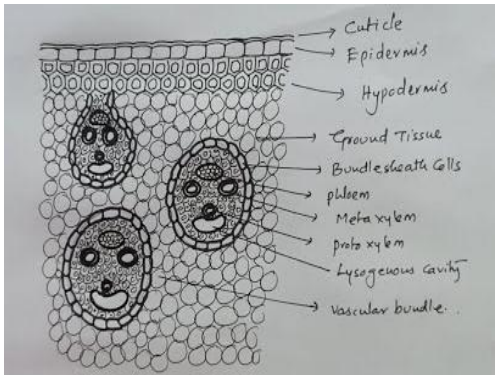
5. Pith:

This is well developed region, spreading from ring of vascular bundle to the centre. The cells of this region mainly made up of parenchyma.

Function of pith: Storage of water and food.

Internal Structure of Monocotyledon Stems





1. Epidermis: Epidermis is the outer most single celled thick layer. It is covered with thick cuticle. Multicellular hairs are absent and stomata are also less.

2. Hypodermis: Hypodermis of monocotyledon's stem is made up of sclerenchyma. It is 2-3 layered monocot stem rigidity is more in hypodermis where as in dicot stem, elasticity is more. It provides mechanical support to plant.

3. Ground tissue: The entire mass of parenchyma cells next to hypodermis and extending to the centre is called ground tissue. There is no differentiation of ground tissue in monocotyledon stem. It means ground tissue is not differentiated into endodermis, cortex, Pericycle etc.

Note: Sometimes in some grasses, wheat etc. the central portion of ground tissue becomes hollow and is called Pith cavity.

4. Vascular Bundle:

- Many vascular bundles are scattered in the ground tissue and V.B. are generally oval shape.
- Vascular bundles lies towards the centre are large in size and-less in number.
- Vascular bundles situated towards the periphery are small in size but more in number.
- Each vascular bundle are conjoint, collateral and closed.
- Vascular bundles surrounded by the layer of sclerenchymatous fibre are known as bundle sheath.
- So vascular bundles are called fibro vascular bundles.

(a) Xylem: In xylem number of vessels is less. In metaxylem there occur two large vessels while in protoxylem there occurs one or two small vessels. Vessels are arranged in V or Y shape. Just beneath protoxylem vessels, there occur a water cavity which is schizolysigenous in origin but major part of water cavity is lysigenous. This cavity is formed by disintegration of the element present below the proto xylem and neighbouring parenchyma.

(b) Phloem: It consists of sieve tube elements and companion cells. Phloem parenchyma is absent.

5. Pith: Pith is undifferentiated in monocotyledon stems. Atactostele is found in monocotyledon. This is highly developed stele.