Biology

The study of life. The word "biology" is derived from the Greek words "bios" (meaning life) and "logos" (meaning "study of").

Divisions of Biology

1-Zoology: This division deals with the study of animals.

2- Botany: This division deals with the study of plants.

3-Microbiology: This division deals with the study of microorganisms

Brunches of Biology

1- Morphology: The study of the external feature of the living organisms.
2- Taxonomy: Is the science of identification, nomenclature and classification of plants and animals
3- Anatomy: The study of internal structures of different parts of living organisms.
4- Cell Biology: The study of structures and functions of cell and deals with the behavior of the nucleus during cell division
6- Embryology: Study of the embryo structure and its development.
7- Physiology: This science covered various functional aspects of plants and animals like metabolism, nutrition, growth, movement and respiration etc.
8-Genetics: This science study the mode of transmission of the hereditary characteristics from one generation to the other (the study and behavior of genes in different generations).
9- Paleontology: Study of fossil which are the remains of plants and animals.
10- Evolution: It is the science which deals with the origin of the living beings and their gradual changes.

Scopes of Botany

1-Economic botany: deals with the uses of plant resources. Different types of cereals,Oils, timber, Rubber, Spices, Medicines and Vitamins are obtained from plants or plant parts.

2- Agriculture: Is the industry that furnished our food and many raw materials, such as fibers, wood, cork, rubber, gums, resins, essential oils, many kinds of oils, waxes, animal products, improved methods of farming with irrigation, agronomic techniques and crop management are covered within agriculture.

3- Forestry: Forest wealth is important economically as well as from the point of view of maintaining ecological balance and keeping the environment clean. It provides food and protection of a large number of animals.

4- Horticulture:This field is concerned with the development and propagation of good varieties of fruits, vegetable and ornamental plants.

5- Plant Pathology: This field deals with the plant diseases and their control with the help of chemicals and by using disease resistance varieties.

6-Plant breeding: This field is concerned with the production and development of new high yielding and disease resistant varieties of various crop plants.

7- Pharmacognosy: This branch concerned with used of plants and plant parts in drug industry.

Plants

Plants are living organisms that cover large amounts of the surface of our planet. They come in many shapes, sizes and colors. Most plants have roots, stems and leaves and they either produce flowers or cones for reproduction. Botanists (scientists who study plants) have identified about 391,000 living species of plants across the world.

Special characteristics of plants:

1- Plants are multicellular organisms in the kingdom Plantae.

2- Plant cells are distinguished by their cell walls containing cellulose, chloroplasts and a large central vacuole that holds water and keeps the plant turgid

3- Plants are autotrophs; they produce their own food by photosynthesis, which is the process of making nutrients such as sugars from light energy and carbon dioxide. Photosynthesis occurs in chloroplasts, which contain chlorophyll and carotenoids.

4- Plants develop from embryos, immature sporophytes formed by a fusion of egg and sperm cells, supported by non-reproductive gametophytic tissue.

5- Plants have indeterminate growth. While animals reach a certain size and stop growing, plant cells in their meristematic tissues retain the ability to divide and grow throughout the life of the plant.

6- Plants are sedentary, they different ways to obtain the materials they need for their metabolism.

7- lacking the nervous systems, they use a combination of hormones and sensory ions to take in information

The Important of Plants

1- Plants supply food to nearly all terrestrial organisms on the earth, including humans.

2- They produce oxygen and absorb carbon dioxide (CO_2) during photosynthesis.

3- Plants provide many products for human use, such as vegetable, timber, medicines, dyes, oils, rubber, clothing, spices, perfumes).

4- Plants are the earth's main autotrophs and fixers of carbon and nitrogen.

5- Plants provide the habitat and food upon which almost all other living things.

Plant Habitat: Is the place where a plant lives, it may be classified into:

I. Terrestrial Plant: Plants that are growing on land.

II. Aquatic (Hydrophytes) Plants: Plants that are living in water environment.

Plant Habit: Is the general appearance, growth form of plants, it classifies in to:

I. Herbs are soft stemmed plants with less wood or no wood.

II. Shrubs A shrub is a perennial, woody plant with several main stems arising from the ground level.

III. Climbers An elongated weak stem generally supported by means of climbing devices.

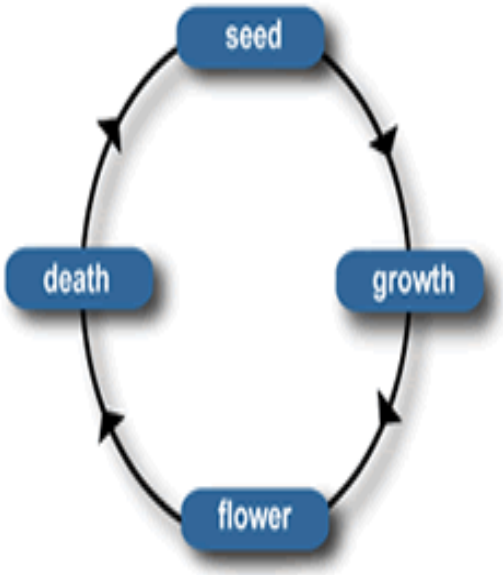
IV. Trees Is a stout, tall, woody plant having one main stem called trunk with many lateral Branches.

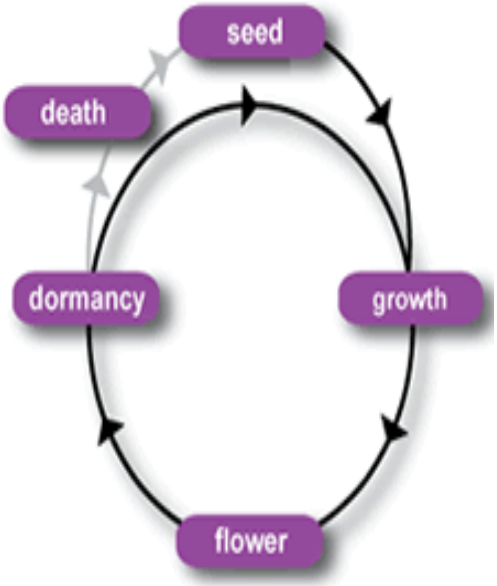
PLANT LIFE CYCLES:

1. Annuals: A plant that completes its life cycle in one growing season or less. Winter and summer annuals. Summer annuals include many plants: Euphorbia and Digitaria. Winter annuals include Poa and Veronica.

2. Biennials: A plant that lives for two seasons, growing vegetatively during the first season and flowering and fruiting during the second season. Carrots, Papaver.

3. Perennials: A plant that grows for many years that flowers and set fruits





Living Organisms

Living organisms are divided into three Domains (Super kingdoms):

I. Bacteria: Most of the Prokaryotes
II. Archaea: Prokaryotes of Extreme Environments.
III. Eukarya: Eukaryotes: includes:

A-Kingdom Protista (Protoctista)
B-Kingdom Fungi
C-Kingdom Plantae
D-Kingdom Animalia

Kingdom Plantae

Based on whether plants have a well-differentiated body and the presence or absence of specialized tissues for transport, and the ability to bear seeds Kingdom Plantae (Plant Kingdom) classified into:

1-Division Thallophyta

These are the lowermost plants of the plant kingdom, without a well-differentiated body design, the plant body is not differentiated as roots, stem, and leaves, include Algae.

2-Division Bryophyta

These are small terrestrial plants. They show differentiation in the body design, with stem, leaf-like structures, and root-like structures(rhizoids),they do not have any specialized tissue to conduct water and other substances (Non-Vascular Tissues). They the plant to the other. These plants have naked embryos called spores, include Ferns and Horsetails.

4- Division Phanerogamae

Phanerogams are seed-bearing plants. The plant body is well differentiated with stem, leaves, and roots. There are well differentiated reproductive tissues that produce seeds, have a well-developed vascular system. Depending on whether the seeds produced are naked or whether they are enclosed, phanerogams are further classified into two subdivisions:

A-Gymnosperms

All gymnosperms are woody, perennial, evergreen. Their leaves may be fern-like, scale- like is no fruit formation and the seeds are hence said to be naked, include, or needle shaped, do not produce flowers, they have a well-developed vascular Coniferophyta, Cycadophyta, Ginkgophyta, and Gnetophyta.

B-Angiosperms

are seed-bearing plants. Seeds develop inside tissues that get modified to form the fruit of the plant. Also called the flowering plants, they are found abundantly in nature. These plants are usually terrestrial and they may be annual, biennial or perennial. The vascular system is very well developed with xylem and phloem. Angiosperms also show the feature of double fertilization.

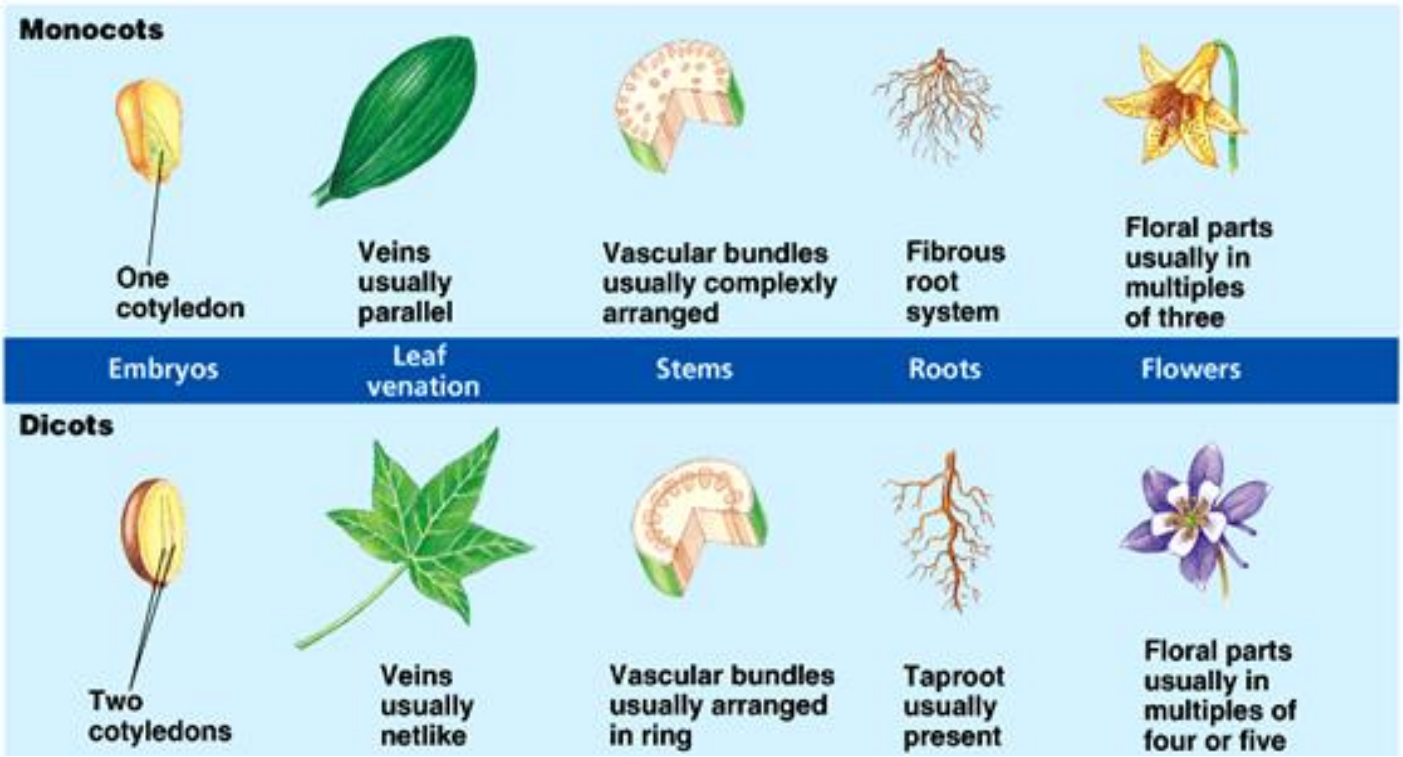
On the basis of the cotyledons (seed leaves) Angiosperms are further divided into:

I- Monocotyledoneae plants:

1-Embryo with a single cotyledon.
2-Flower parts in multiple of three.
3-Major leaf veins parallel.
4-Stem vascular bundles scattered.
5-Roots are adventitious.
6-Secondary growth absent.

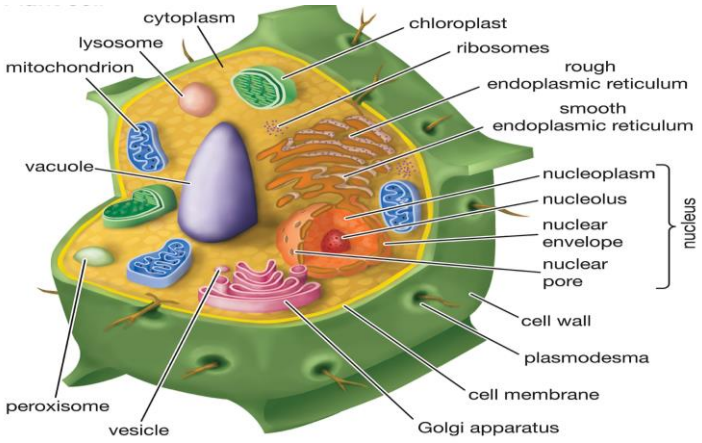
II -Dicotyledoneae plants.

1-Embryo with two cotyledons.
2-Flower parts in multiple of four or five.
3-Major leaf veins reticulate.
4-Stem vascular bundles in a ring.
5- Tap root system is present.
6-Secondary growth present.



Plant cell

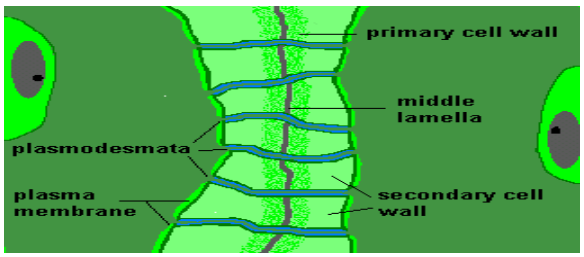
Plant cells: are the basic unit of life in organisms of the kingdom Plantae. They are eukaryotic cells with specialized structures called organelles that carry out different functions.



Plant cell organelles

1- Cell Wall

It is a rigid layer which is composed of cellulose, glycoproteins, lignin, pectin and hemicellulose. It is located outside the cell membrane. It consists of three layers, primary, secondary and the middle lamella. The primary function of the cell wall is to protect and provide structural support to the cell. The plant cell wall is also involved in protecting the cell against mechanical stress and to provide form to the cell. It also filters the molecules passing in and out of the cell.



2- Cell membrane (cell surface, plasma membrane)

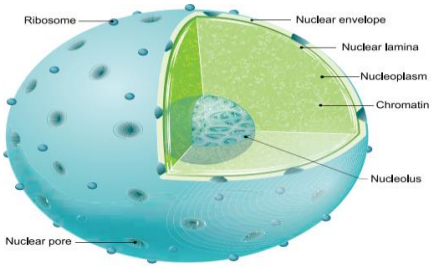
It is the semi-permeable membrane that is present within the cell wall. It is composed of a thin layer of protein and fat. The cell membrane plays an important role in regulating the entry and exit of specific substances within the cell. It keeps toxins from entering inside, while nutrients and essential minerals are transported across.

3- Cytoplasm

It is the semifluid gelatinous substance that fills the cell, made up of eighty percent water usually clear and colorless. It is the main arena of various activities of a cell.

4-Nucleus

It is the largest among all cell organelles, may be spherical or ellipsoidal, consist of **Nuclear envelope**, **Nuclear pores**, **Nucleoplasm, Nucleolus and Chromatin).** Its function is controlling all the cellular activities and storing the genetic or hereditary information.

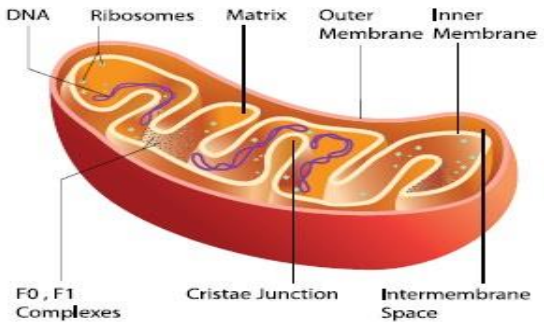


5-Vacuoles

are large, bounded by a single unit membrane called **Tonoplast**. The vacuoles contain **cell sap**, which is a solution of sugars, amino acids, mineral salts, waste chemical, it accumulates products like tannins. The major function of plant vacuole is to maintain water pressure known as turgor pressure, which maintains the plant structure, stores salts, minerals, nutrients, proteins, pigments and remove the wastes.

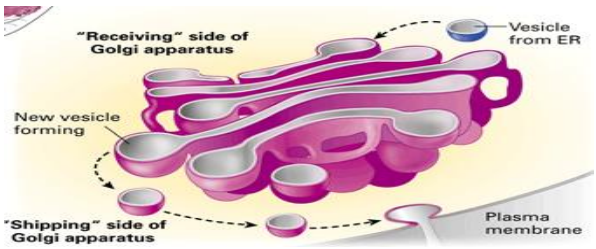
6- Mitochondria

They are the double-membraned organelles found in the cytoplasm of all eukaryotic cells. They provide energy by breaking down carbohydrate and sugar molecules, hence they are also referred to as the "Powerhouse of the cell."



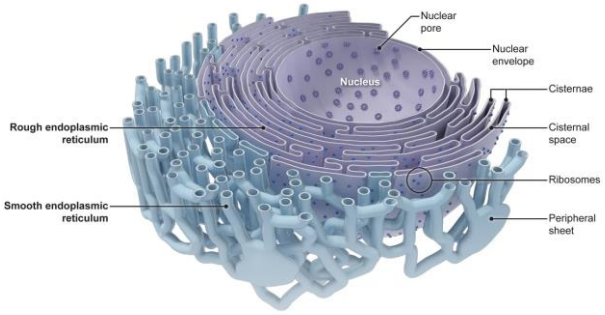
7- Golgi Body(apparatus)

is found in all plant cells and is the term given to groups of flattened disc-like structures located close to the endoplasmic reticulum. The Golgi apparatus receives proteins and lipids (fats) from the rough endoplasmic reticulum.



8-Endoplasmic Reticulum

is associated with nuclear membrane and cell surface membrane. It forms a network in cytoplasm and gives mechanical support to the cell. When ribosomes are present in the outer surface of the membrane it is called (**Rough endoplasmic reticulum (RER)** which involved in protein synthesis**,** when the ribosomes are absent it is called (**Smooth Endoplasmic reticulum (SER)** which are the sites of lipid synthesis.



9- Plastids

They are membrane-bound organelles that have their own DNA and are necessary to store starch, carry out the process of photosynthesis and used in the synthesis of many molecules, which form the building blocks of the cell. Have 3 types

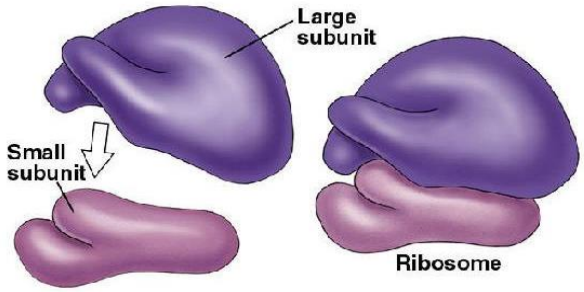
a-Leucoplasts: storage of protein, lipid and starch

b-Chloroplasts: photosynthesis process

c-Chromoplasts: provide color to all fruits and flowers**.**

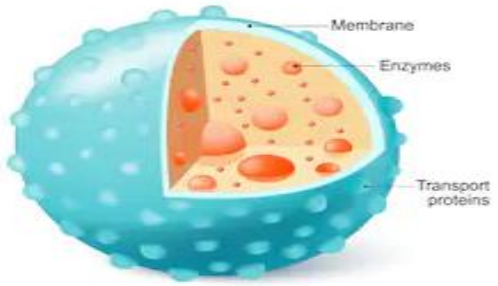
10-Ribosomes

They are the smallest membrane-bound organelles which comprise RNA and protein, consist of two subunits (**Large** and **Small** subunits), can be found floating within the **Cytoplasm** or attached to the **Rough endoplasmic reticulum** or **Nuclear envelope**. They are the sites for protein synthesis



11- Lysosomes (suicidal bags)

are membrane-bound organelles and the area within the membrane is called the lumen, which contains the hydrolytic enzymes, formed when small pieces of Golgi body are pinched off from its tubules. The function of lysosomes is digestion and removal of waste, food particles and foreign bodies in the cell.



12- Microbodies

Single membrane cell organelles with 2 types:

A- **Peroxisomes:** Kind of microbody, contains oxidative enzymes and responsible for breaking down the very long chain fatty acid molecules into smaller parts, also are responsible of photorespiration.

B- **Glyoxysomes**: They too oxidize long chain fatty acids and form Acetyl CoA (intermediate to form sugar for growth) and has a role in nitrogen metabolism

Plant Tissues

Plant Tissues: is a collection of similar cells performing an organized function for the plant. Each plant tissue is specialized for a unique purpose, and can be combined with other tissues to create organs such as leaves, flowers, stems and roots.

Plant tissues functions

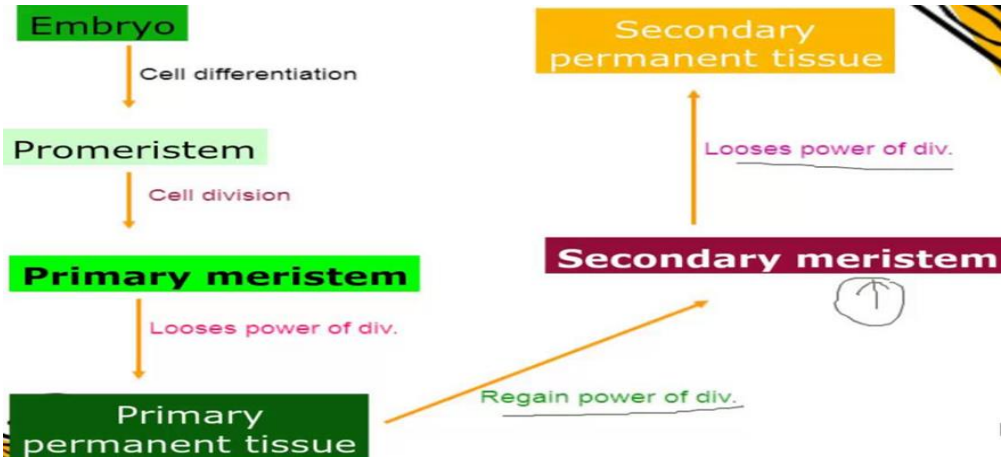
1-Help provide mechanical strength to organs.
2-They help in providing the elasticity and flexibility to the organs.
3-The xylem and phloem tissues help in transportation of material throughout the plants
4-They divide to produce new cells and help in the growth of the plants.
5-They help in various cellular metabolisms like photosynthesis, respiration.

Classification of Plant Tissues

1-Meristematic Tissue: consist of a group of cells that have the ability to divide, living, have thin-walled with very small and few vacuoles, the protoplasm of the cells is very dense. They possess a single, large and prominent nucleus. Meristematic tissues give rise to permanent tissues.

Meristematic tissues have three types depending on the origin:

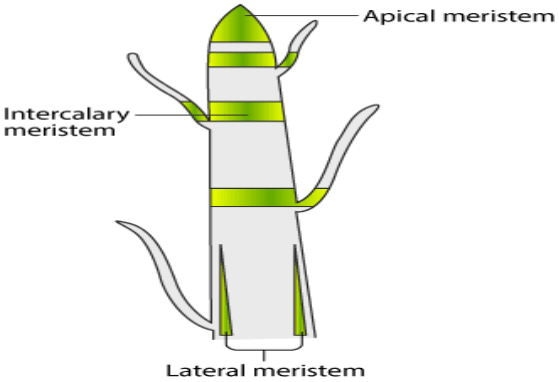
a-Promeristem: The earliest and youngest meristematic tissue, originates from the embryo found in the root and the shoot tips.
b-Primary Meristem: It arises from the Promeristem. Cells divide actively, present below the Promeristem and forms the permanent tissue.
c-Secondary Meristem: It originates from the primary meristem, formed the permanent tissue.



Meristematic Tissue on the Basis of Position

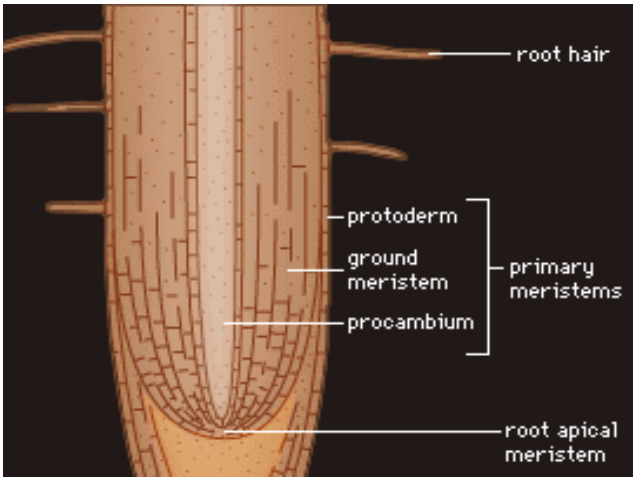
1. Apical Meristem: located at the growing apices of main and lateral shoots and roots. responsible for length growth of an organ. Example root and shoot apical meristem.
2. Intercalary Meristem: are usually present at the base of node, internode or at the base of the leaf. They are responsible for growth of leaves and internodes**.**

3. Lateral Meristem: occurs on the sides both in stem and root, divide mainly in one plane and cause the organ to increase in diameter and girth.



Meristematic Tissue on the Basis of Function

a-Protoderm: It is the outermost plant tissue and forms the epidermis. It protects the plants from any mechanical shocks.
b-Procambium: It is the innermost tissue and gives rise to xylem and phloem. It helps in the transport of water and nutrients to different parts of the plant.
c-Ground Meristem: The cells are large with thick walls. It forms the cortex, pericycle and pith.



2- Permanent Tissue.: are derived from the meristematic tissues and have lost their ability to divide. They have attained their mature form, classified into:

A-Dermal Tissue (Protective Tissue)
B-Vascular Tissue (Conducting Tissue)
C-Ground Tissue (Supporting Tissue)
D-Secretory Tissue

A-Dermal Tissue: is the outer protective covering, consists of the **Epidermis** and the **Periderm**.

Epidermis: is a single layer of closely packed cells, the epidermis on above ground organs (leaves and stems) is involved with gas exchange, while the epidermis on below ground organs (roots) is involved with water and ion uptake

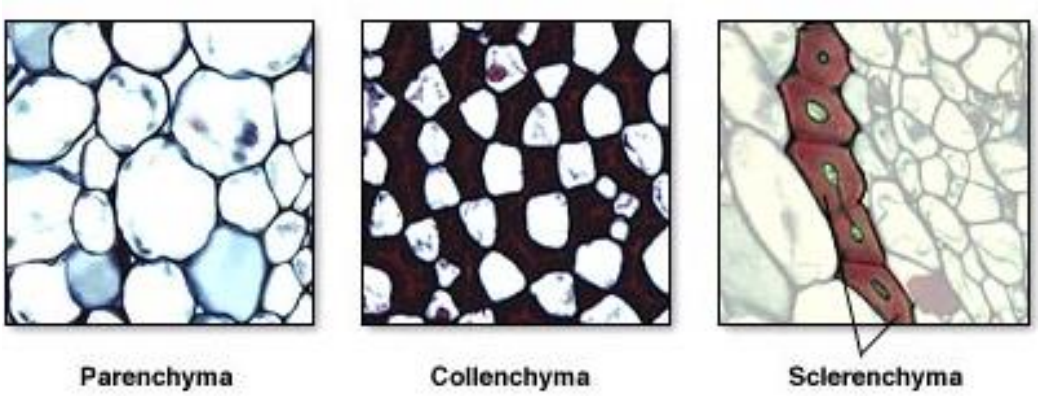
Periderm(bark): replaces the epidermis in plants that undergo secondary growth (woody plants). The periderm consists of **cork**, **cork cambium** and **secondary cortex**

B-Ground tissue: makes up much of the interior of a plant and carries out basic metabolic function, the ground tissue of the leaf (called mesophyll) uses the energy in sunlight to synthesize sugars in a process known as photosynthesis, in the stem (called pith and cortex) develops support cells to hold the young plant upright, while in the root (also called cortex) often stores energy- rich carbohydrates, consists of three simple tissues:

Parenchyma: is a living ground tissue that makes up the bulk of the primary plant body and takes part in several tasks such as photosynthesis, storage and regeneration. It stores nutrients, carbohydrates and water. The parenchyma is capable of healing wounds and regenerating parts of the plant.

Collenchyma: is living ground tissue that offers flexible support for primary growth. The collenchyma is specialized for supporting the plants primary growth regions and therefore makes the plant stronger. The cell wall is thickened and provide a measure of flexibility which allows the plant to withstand windy conditions.

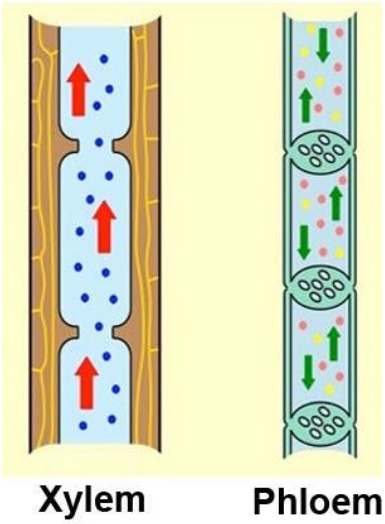
Sclerenchyma: is a ground tissue whose mature cells are dead. Its cell walls are composed of cellulose and lignin. Sclerenchyma supports mature plants and protects seeds. This ground tissue has an extra material that provides added strength and rigidity to the cells.

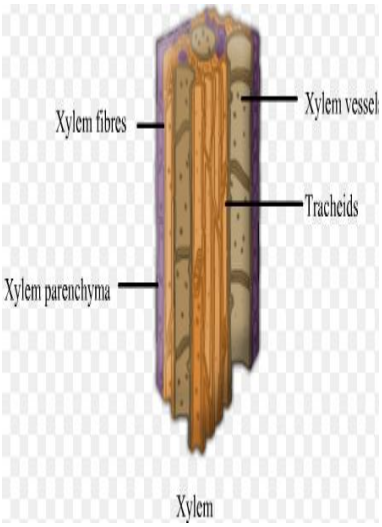


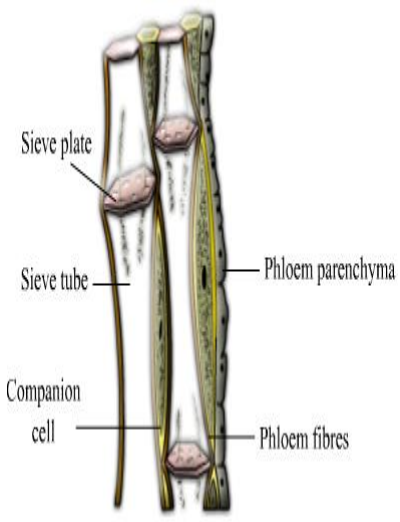
C-Vascular tissue: is a complex conducting tissue, formed of more than one cell type, found in vascular plants. The primary components of vascular tissue are the xylem and phloem

Xylem: is a specialized type of vascular tissue created in vascular plants to transport water and nutrients from the roots of a plant to the tips of the leaves. The xylem is created from hollow, dead cells. It consists of tracheids, vessels, xylem parenchyma and xylem fibres. Tracheids and vessels are hollow tube-like structures that help in conducting water and minerals. The xylem conducts only in one direction. The xylem parenchyma is responsible for storing the prepared food and assists in the conduction of water. Xylem fibres are supportive in function.

Phloem- It consists of four of elements: sieve tubes, companion cells, phloem fibres and the phloem parenchyma. Unlike the xylem, phloem conducts in both directions. It is responsible for transporting food from the leaves to the other parts of the plant. Phloem contains living tissues except for fibres that are dead tissues.







D-Secretory Tissue: cells secreted many substances which released from the cytoplasm of the cell, have two types:

1-External secretory tissue: cells found in the external surface of the plant, develop from the epidermis layer, have many types**:**

A-Glandular Hairs: are the hair-like structure present on the epidermis of leaves. They may be unicellular or multicellular. The cells secrete substances which are stored in cell cavities.

B-Nectaries: are special glands which secrete sugary substance called nectar or honey. They are present on floral parts and on vegetative parts. The nectaries present on floral parts are called floral nectaries while the nectaries present on vegetative parts (Petiole, pedicel and stem) are called extra floral nectaries. The cells secrete nectar directly at their surface which attracts the insects which help in pollination.

C-Digestive Glands: are special glands which secrete digestive enzymes. They are present in insectivorous plant. The enzymes digest the proteins of trapped insects.

D- Hydathodes (water stomata): Modified pores which found on the margin of the leaves, exudes drops of water, the secretion of the water as a drop from the leaves is called Guttation.

E- Salt Glands: are found mostly on leaves or stem of plants that grow on dry saline soils (Halophyte plants).

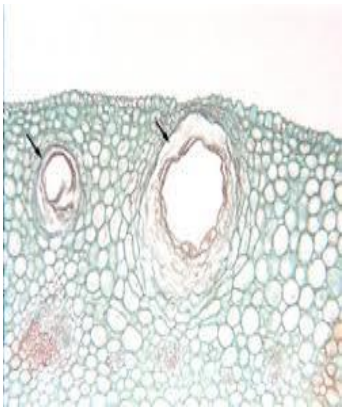
A B C D E

2-Internal secretory tissue: It is responsible for pouring these substances into ducts or cavities that are inside the plant. These cavities storage of substances resulting from the metabolism are: lysigenous cavity, schizogenous cavity and laticifers cavity

a-Lysigenous cavity: Are formed by cavities coming from cells groups which are loaded of secretory products and whose protoplasm membranes have been destroyed gradually, found in fruits and young stems of citrus.

b-Schizogenous cavity: Are the cells or epithelial located inside the parenchyma tissue or inside other tissues. According to its contents, are distinguished ducts or cavities with lipids (essential oils), resins and gums.

c-Laticifers cavity: They originate from the seed´s embryo. They are living cells with cytoplasm and cell membrane and grow indefinitely. The cells that surround them leave in these vessels the metabolic waste substances. This mixture storage, generally milky white, other colors rarely, form an emulsion which are active ingredients as protein, carbohydrates, enzymes, tannins, rubber, hormones and alkaloids and is called **latex.**



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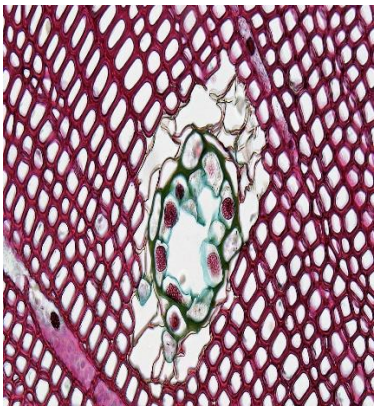

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c

EXTERNAL PLANT PARTS

The study of various external features of the organism is known as morphology. Plant morphology also known as external morphology deals with the study of shape, size and structure of plants and their parts (roots, stems, leaves, flowers, fruits and seeds).

-Plant Morphology can be studied under two broad categories:

A. Vegetative morphology – It includes shoot system and root system

B. Reproductive morphology – It includes Flower/inflorescence, Fruit and Seed

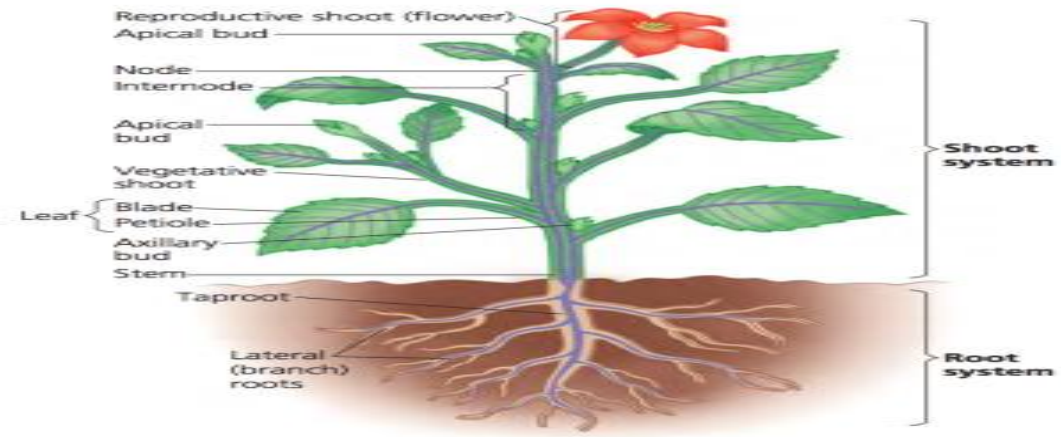


Figure 1. Principal Parts of a Vascular Plant

A. Vegetative morphology

Vegetative morphology deals with the study of shape, size and structure of plants and their parts roots, stems and leaves.

1-Root System

The root is the descending portion of the plant axis, non-green, cylindrical descending axis of the plant that usually grows into the soil. It develops from the radicle which is the first structure that comes out when a seed is placed in the soil.

Root Functions

- Absorbing water and minerals from the soil
- Storing food for future use
- Anchoring the plant firmly to the soil and providing support
- Developing new plants from the roots of the old plant (vegetative reproduction)

Regions of Root

Root tip is covered by a dome shaped parenchymatous cells called **root cap.** It protects the meristematic cells in the apex (Protection Zone). A few millimeters above the root cap three distinct zones have been classified based on their meristematic activity:

I-Protection Zone

II-Meristematic Zone

III-Zone of Elongation

IV-Zone of Maturation (Differentiation Zone)

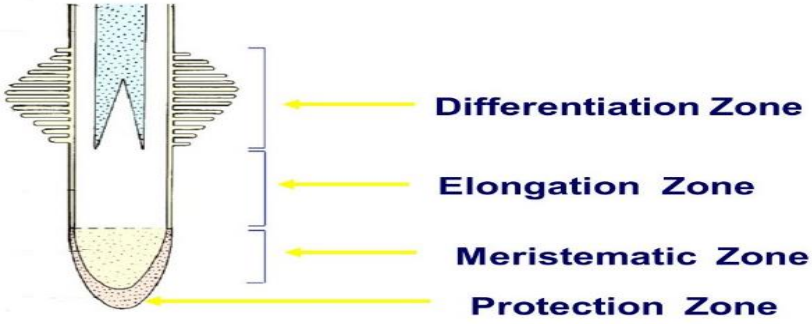


Figure.2 Root Zones

Table: Root zones

Feature	1. Meristematic Zone (Region of cell division)	2. Zone of Elongation	3. Zone of Maturation
Position	It lies just above the root cap	It lies just above the meristematic zone	It lies above the zone of elongation.
Types of cells	Meristematic cells, actively divide and continuously increase in number	Elongated cells	Mature differentiated cells
Functions	This is the main growing tip of the root	The cells increase the length and cause enlargement of the root.	The cells differentiate into various tissues like epidermis, cortex and vascular bundles. It also produces root hairs which absorb water and minerals from the soil

Root hairs /are epidermal cells that occur in a small zone behind the root's growing tip. They increase the absorptive capacity of the root.

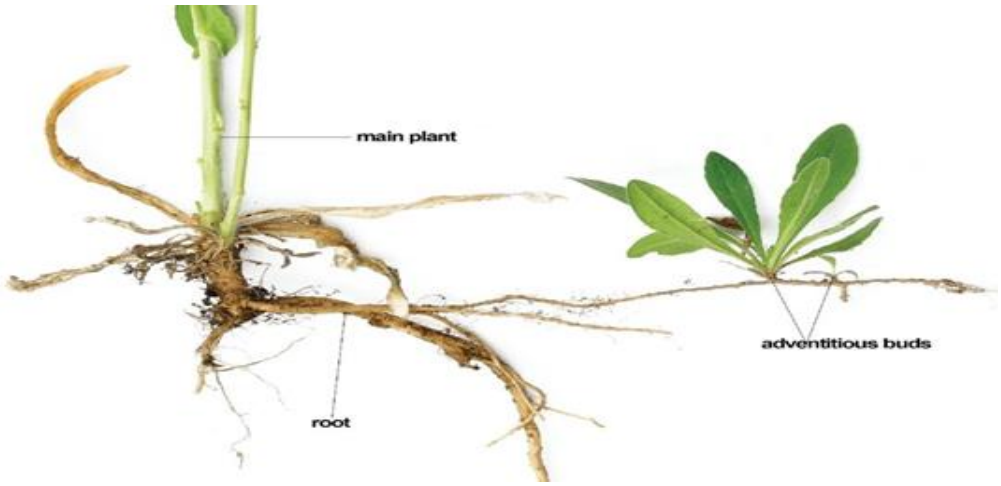
Types of root

I. Tap root system

Primary root is the direct prolongation of the radicle. When the primary root persists and continues to grow as in dicotyledons, it forms the main root of the plant and is called the **tap root.** Lateral roots along with its branches together called as **secondary roots**.

II. Adventitious root system

Root developing from any part of the plant other than radicle is called **adventitious** root. It may develop from the base of the stem or nodes or internodes.



Internal Root structure:

a) Epidermis: Outer layer of cells ("skin"). Protection.

b) Root Hair: An extension of specialized root epidermal cells increasing surface area for absorption of water & minerals.

c) Cortex: Region between epidermis & vascular cylinder. Supports plant parts & stores food.

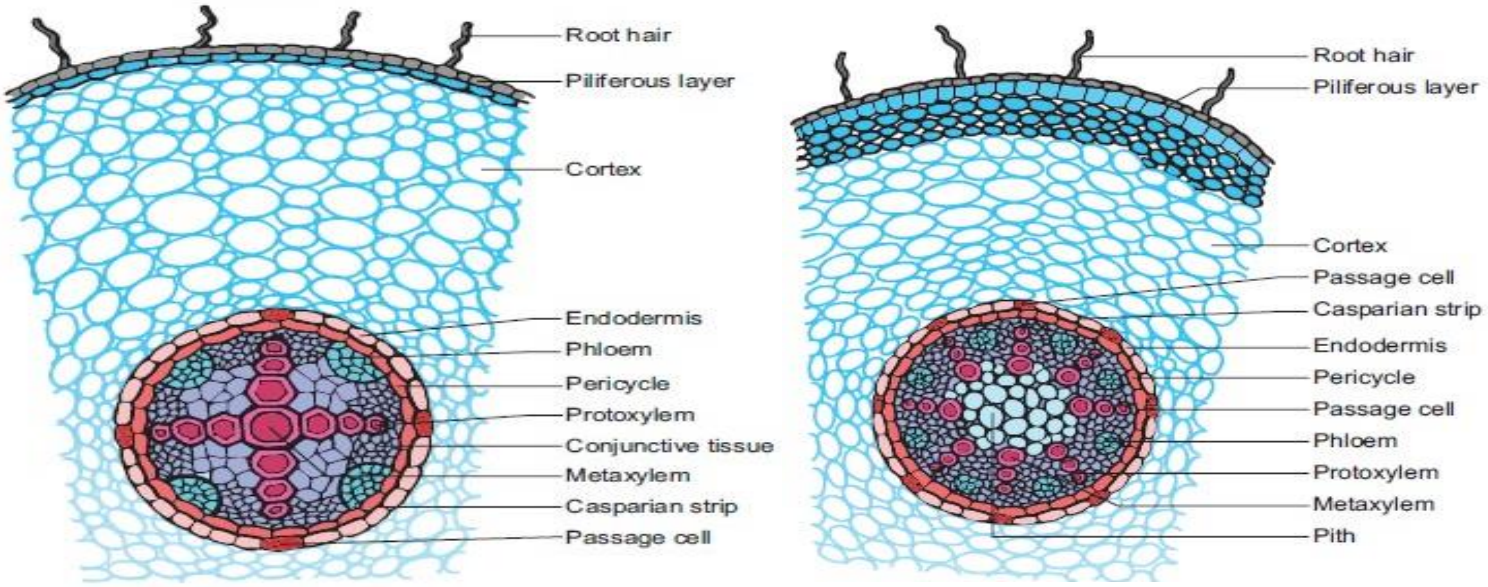
d) Endodermis: Layer of cells just outside vascular cylinder.

e) Pericycle: Cylindrical layer of cells inside endodermis. Origin of cork & secondary (side) roots.

f) Xylem: Living (outer) vascular system carrying water & minerals throughout plant.

g) Phloem: Living (inner) vascular system carrying dissolved sugars and organic compounds throughout plant.

h) Pith: Parenchyma cells found in the centre of the root region.



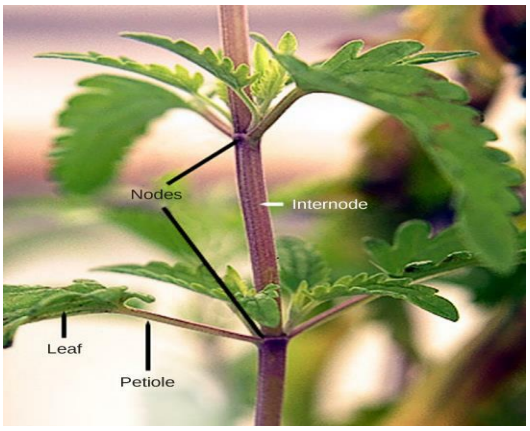
Dicot. Root **Monocot. Root**

Figure 3. Internal structure of Monocot and Dicot Root

EXTERNAL PLANT PARTS

2-Shoot system

Stem: A stem is one of a vascular plant's main structural axes, ascends and bears branches, leaves, flowers, and fruits. It grows from the plumule of a seed's embryo. Nodes are the parts of the stem where leaves are born, whereas internodes are the parts between two nodes. When young, the stem is usually green, but as it matures, it becomes woody and dark brown.



Stem Functions

1- Provides support to the other parts of plant.

2- Transports water and mineral from the root and food prepared by leaves to the other parts.

3- Allows the leaves to arrange in a way that are able to receive direct sunlight in order to perform photosynthesis and gas exchange.

4-Stems bear flowers and fruits in a position that facilitates the processes of pollination, fertilization, and dispersion of seeds.

5- Some stems undergo modification to store food and water.

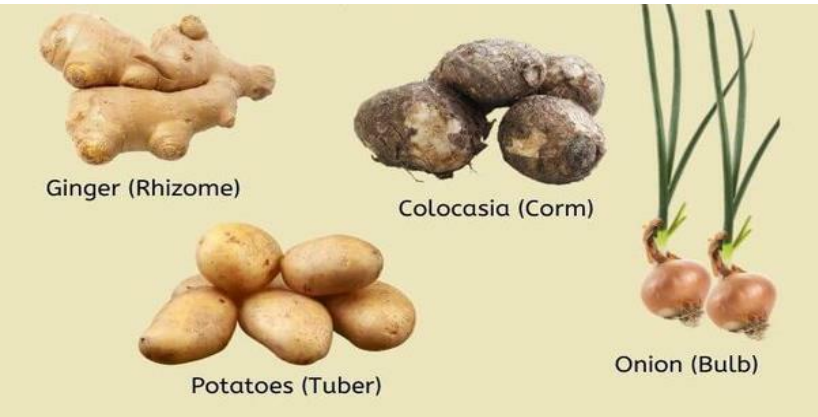
6- Few green stems contain chloroplasts and are capable of carrying out photosynthesis as well.

7- Some stems are modified to carry out vegetative propagation which is a form of asexual reproduction seen in plants.

Types of Stems

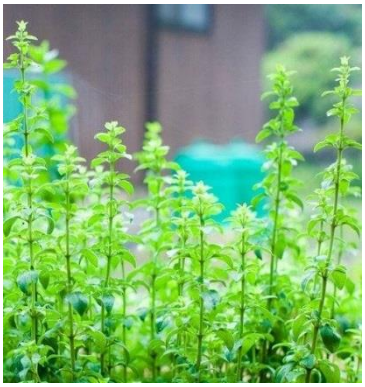
1-Underground stems

These stems remain at the ground level and produce aerial shoots that rise above the soil, they are meant for storage of food and vegetative propagation.



2-Aerial Stems

These stems grows horizontally above the ground and perform varied functions.



3- Aquatic Stems

This type of stem found in the Hydrophyte plants that are found in the water.



Stem Anatomy

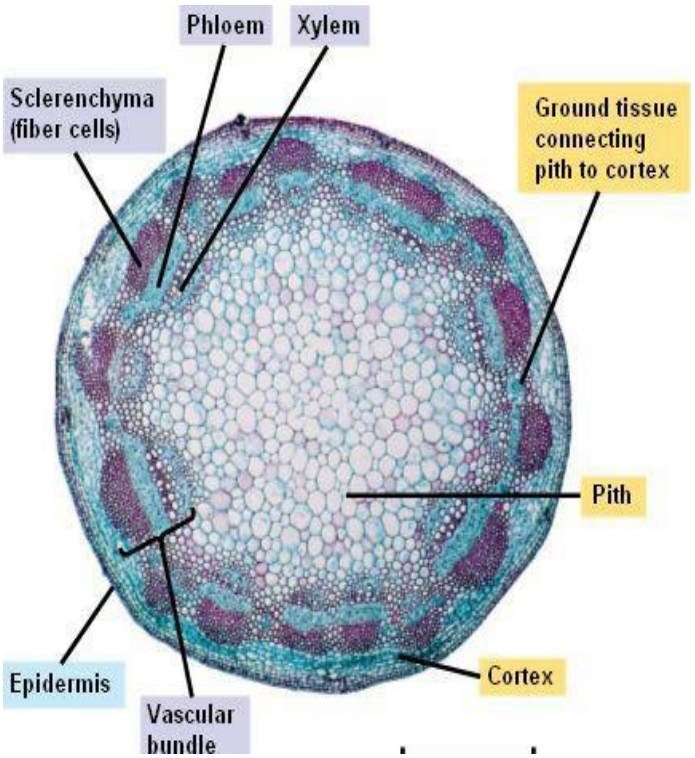
The stem in monocotyledon and dicotyledon consist of:

a- Dermal Tissue: consist of epidermis tissue which is the outer layer of the plant that protects it against the environment.

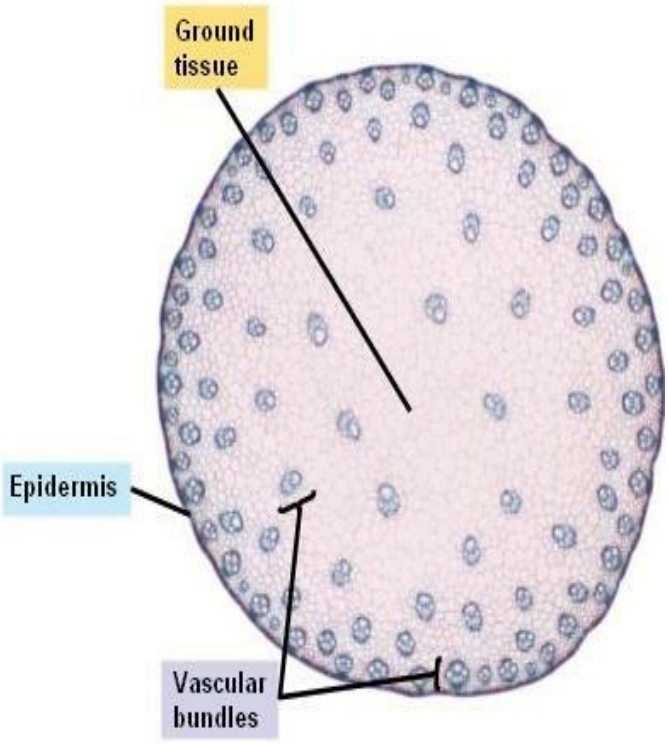
b-Ground tissues: consist of cortex (Parenchyma, Collenchyma and Sclerenchyma).

c- Vascular bundles: consist of xylem and phloem tissues

d- Pith: found in the center of the stem.



Dicotyledon Stem



Monocotyledon Stem

Bud:

Is meristematic tissue which occurs on the tip of a branch or at a stem node at the axil of a leaf where it will develop into a new shoot or flower.

Types of Bud

1- Terminal (Apical) buds: are located at the apex of a stem and the branches. They are responsible for the growth in length of the axis.

2- Lateral (axillary) buds are located on the sides of a stem and usually arise where a leaf meets a stem, grow into branches

3- Adventitious buds arise at sites other than the terminal or axil, such as roots, stem internode, edge of a leaf blade.

4- Flower bud: a bud from which only a flower or flowers develop.

Terminal & Lateral bud

Adventitious buds

Flower bud