How Plants Grow?

For first year agriculture engineers

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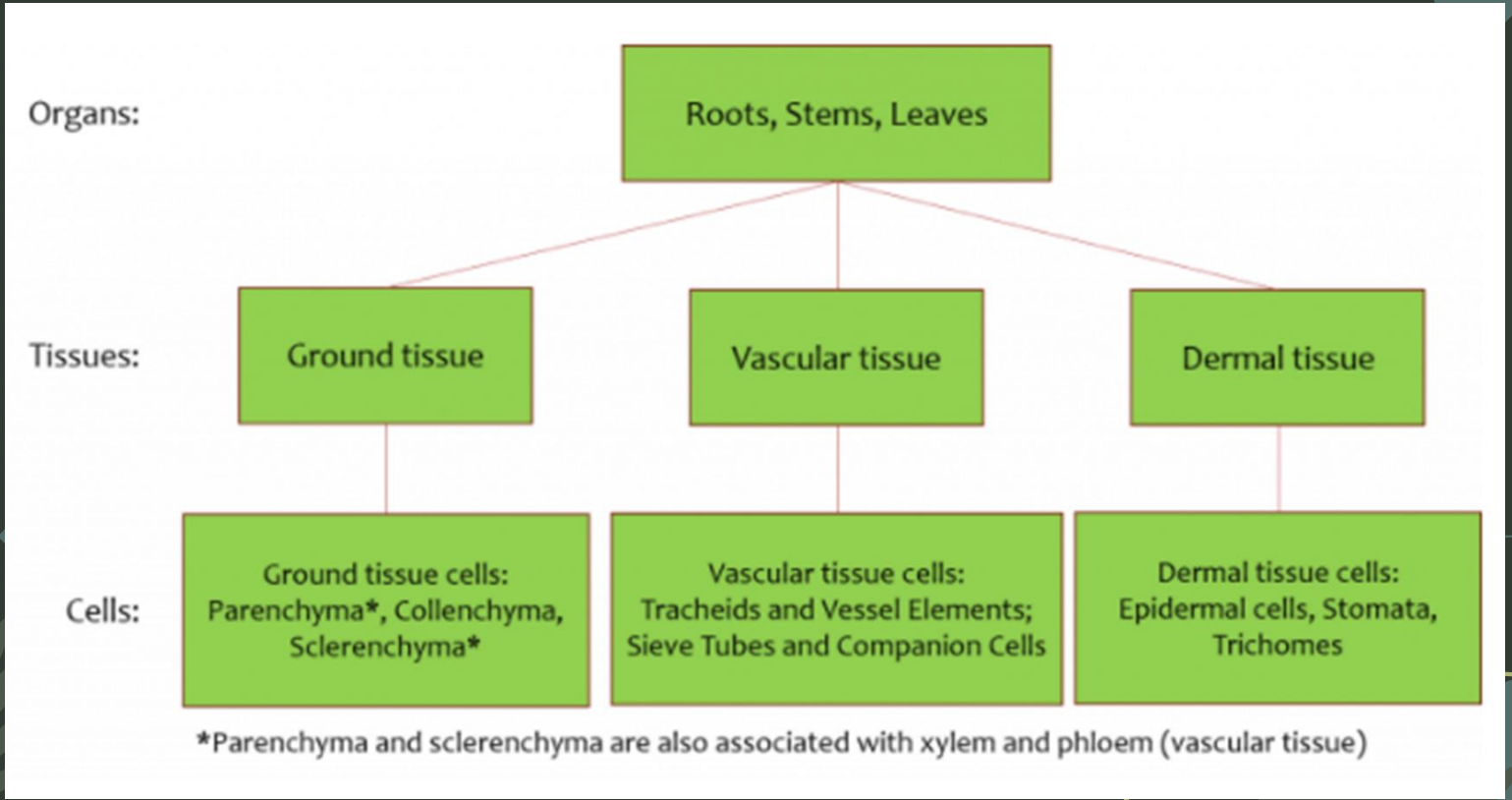
Contents

The plant organization

Like animals, plants are multicellular eukaryotes whose bodies are composed of organs, tissues, and cells with highly specialized functions.

Plant body organization



Plant Organ Systems

The shoot system

The root system

The vegetative (non-reproductive)

The leaves and the stems

The reproductive parts

Flowers and fruits

Roots

01

The shoot system

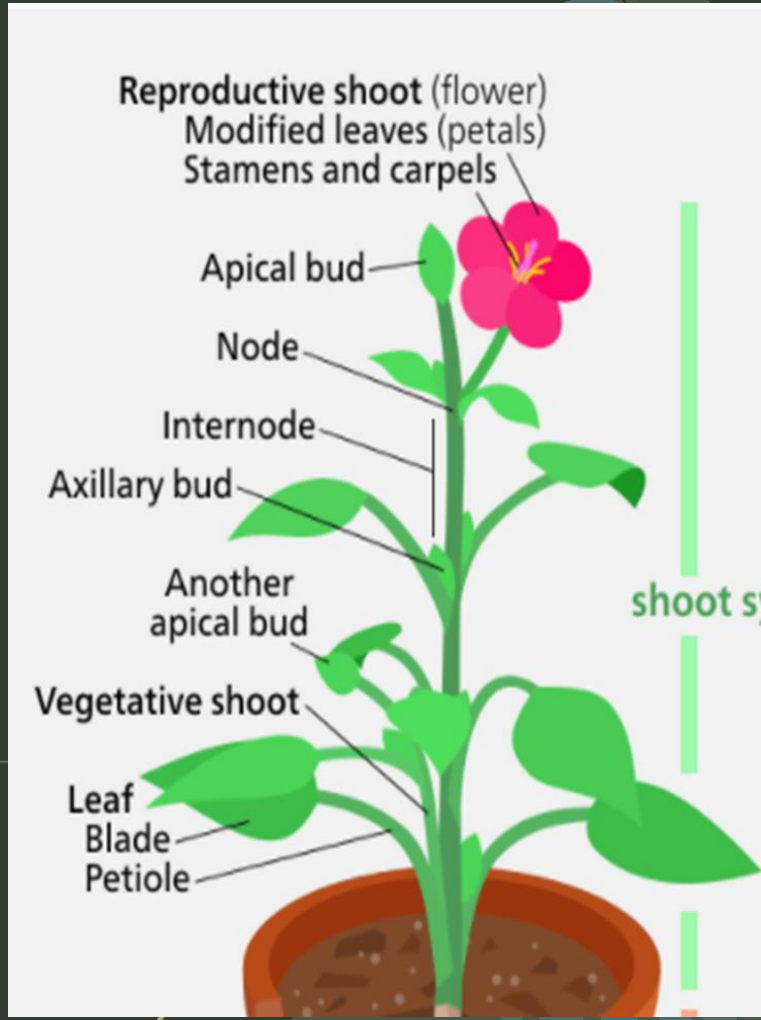
a/ Non-reproductive parts

b/ Reproductive parts

The shoot system

a/ Non-reproductive parts

- **Stems**



The shoot system

Non-reproductive parts

Stems functions

Their main function is to provide support to the plant, holding leaves, flowers and buds.

Connect the roots to the leaves.

Transporting absorbed water and minerals from the roots to the rest of the plant.

Transporting sugars from the leaves (the site of photosynthesis) to desired locations throughout the plant.

The shoot system

Non-reproductive parts

Stems

They may range in length from a few millimeters to hundreds of meters, and also vary in diameter, depending on the plant type.

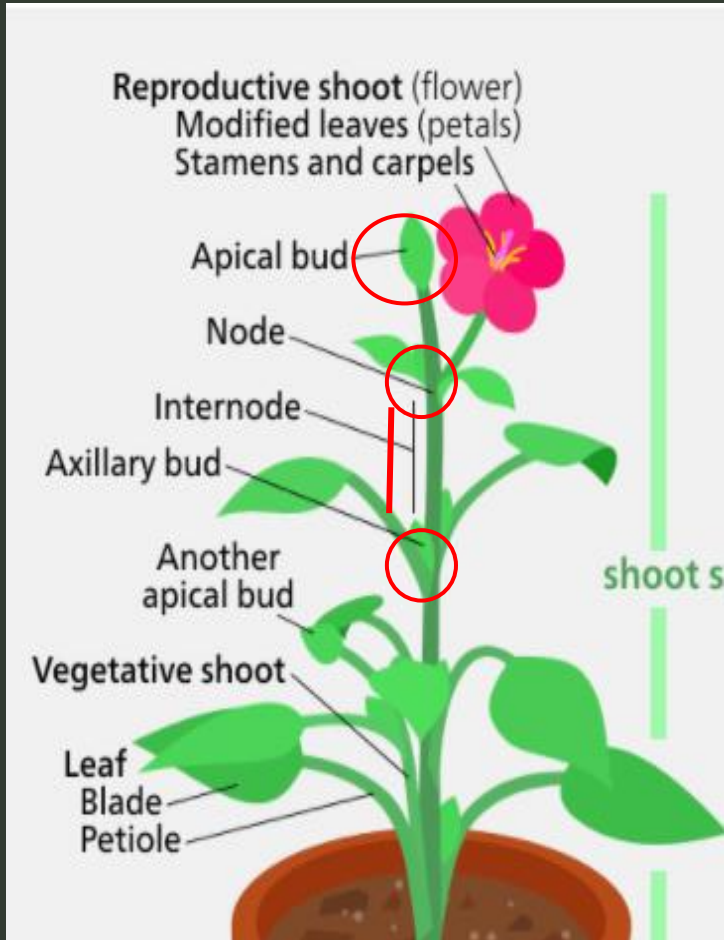
Stems are usually above ground, although the stems of some plants, such as the potato, also grow underground

The shoot system

Non-reproductive parts

The stems structures

- Nodes, which are points of attachment for leaves and flowers,
- Internodes, are the regions of stem between two nodes,
- The apical bud, which is located at the tip of the shoot and contains the apical meristem.
- Axillary buds, which may present where a leaf meets a stem, and are sites where branches or flowers may be produced.



Non-reproductive parts

Types of stems

Based on their location with respect to the ground, there are three types of stems:

Underground stem

Aerial stem

Subaerial stem.

Non-reproductive parts

Types of stems

Underground stems

These stems remain at the ground level and produce aerial shoots that rise above the soil.

Their roots are superficially present.
These stems are meant for storage of food.

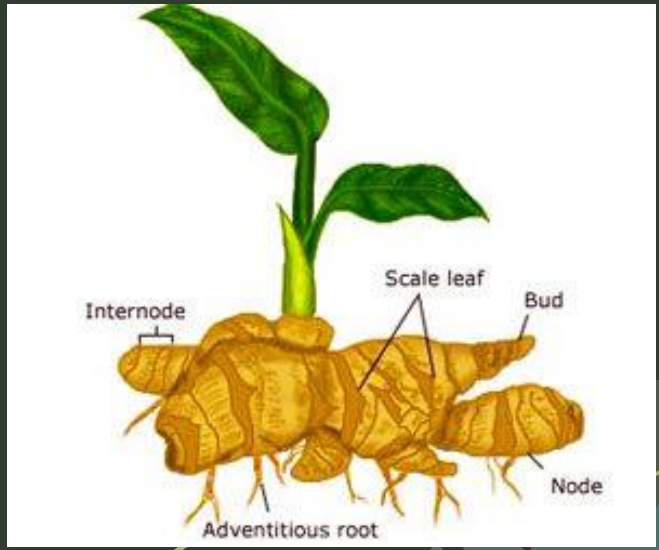
Non-reproductive parts

Types of stems

Types of underground stems

1- Rhizome

Horizontal thickened underground plants stem, capable of producing the shoot and root systems of a new plant.



Non-reproductive parts

Types of stems

Types of underground stems

1- Rhizome

Primroses

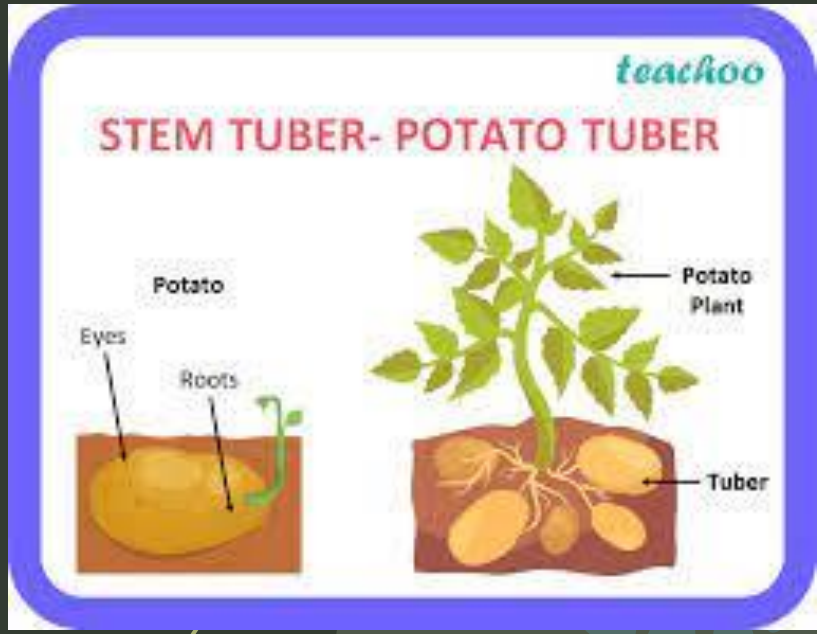
Non-reproductive parts

Types of stems

Types of underground stems

2- Tuber

is a horizontal underground stem that becomes enlarged at its growing due to the accumulation of stored food



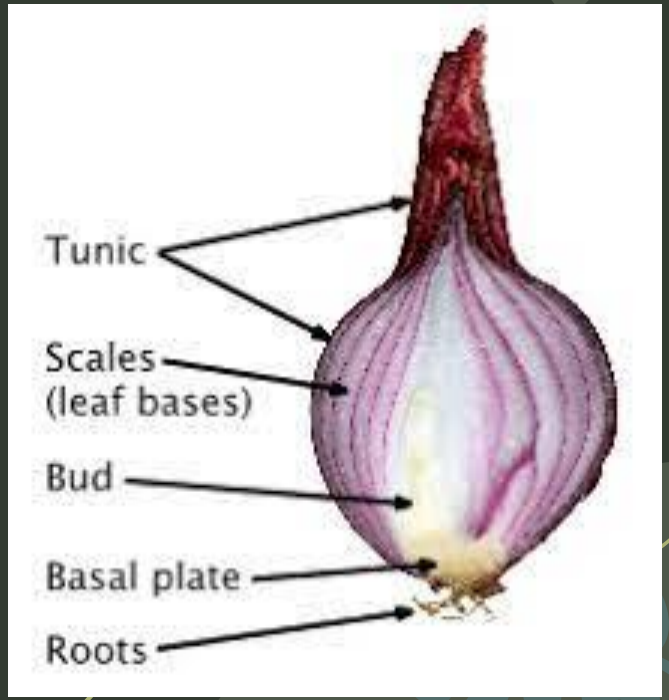
Non-reproductive parts

Types of stems

Types of underground stems

3-Bulb

It is a short underground stem with a fleshy base with leafy scales.

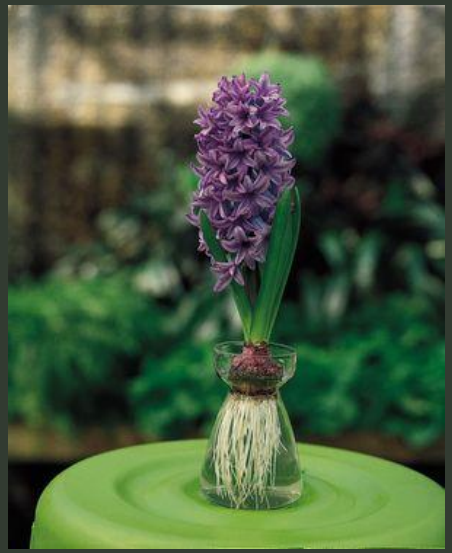


Non-reproductive parts

Types of stems

Types of underground stems

3-Bulb



Hyacinth

Tulip

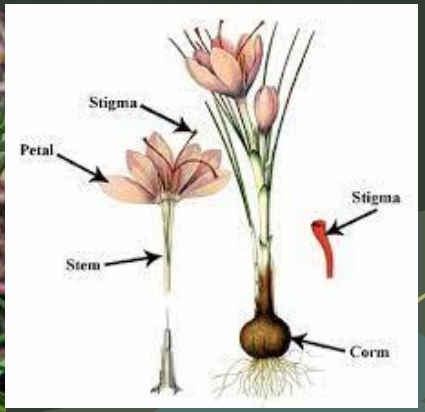
Non-reproductive parts

Types of stems

Types of underground stems

4- Corm

Vertical, fleshy, underground stem that acts as a food-storage structure to enable the plant to survive adverse conditions



Saffron crocus

Non-reproductive parts

Types of stems

Types of underground stems

4- Corm

Alocasia

Gladiolas

Non-reproductive parts

Types of stems

Subaerial stems

These types of stems are present on the ground or partially underground. They are present mostly in plants, which are short-lived and have a weak and herbaceous stem.

Example: Grasses, Mint, Strawberry, pineapple

Non-reproductive parts

Types of stems

Subaerial stems

Rose

Jasmine

Mentha

Non-reproductive parts

Types of stems

Aerial stems

These stems are found above the ground and perform varied functions.

Several important functions are performed by the stems when they are transformed into aerial forms, such as climbing, food storage,

Non-reproductive parts

Types of stems

Aerial stems

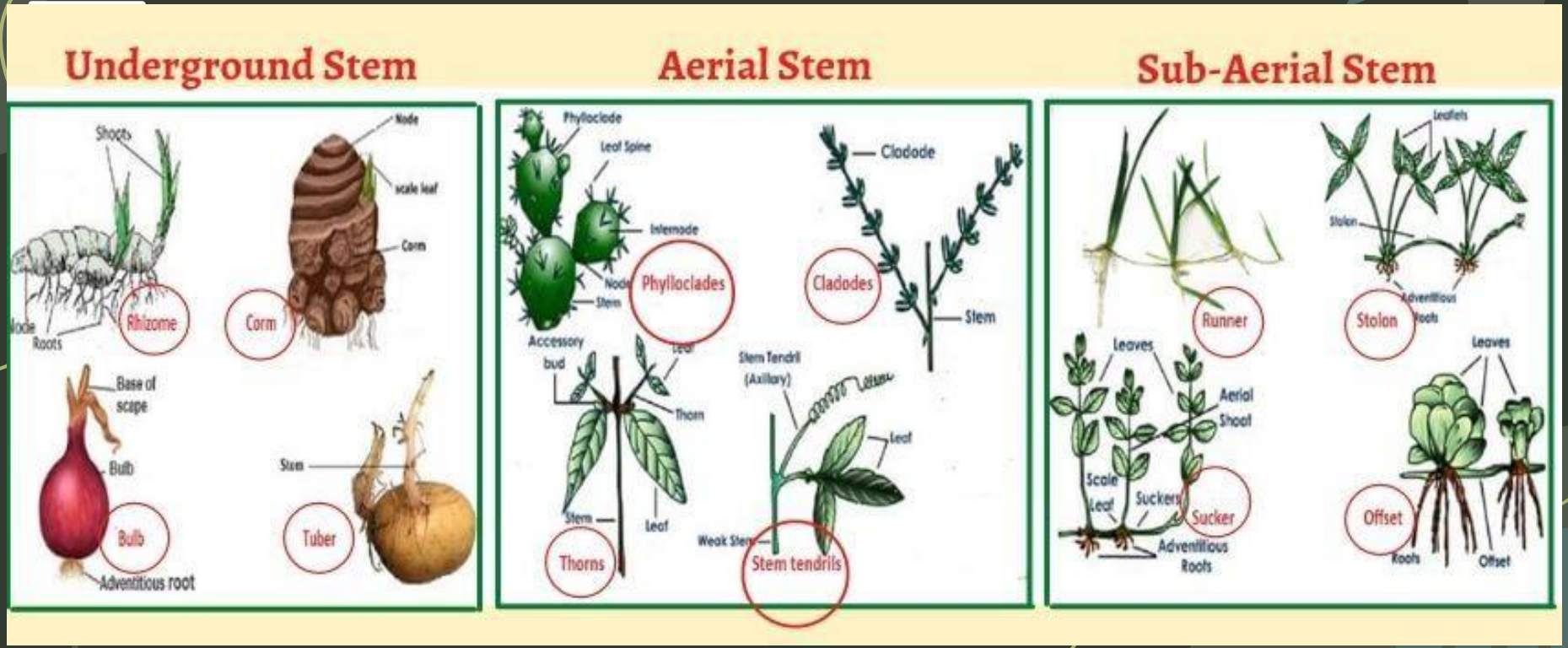
Luffa

Bouganvillea

Opuntia

Non-reproductive parts

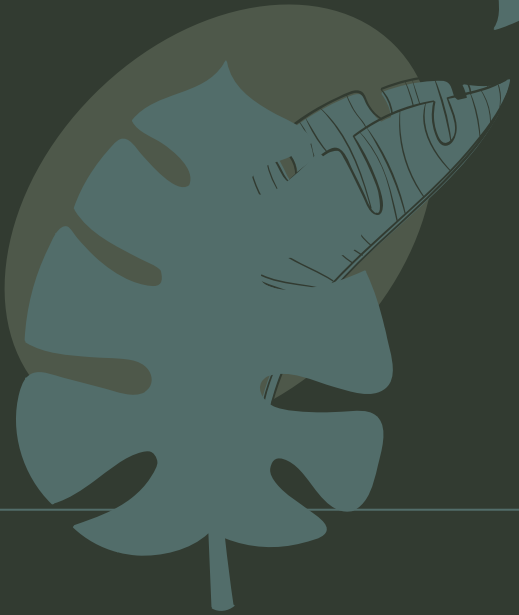
Types of stems



The shoot system

a/ Non-reproductive parts

- **Leaves**

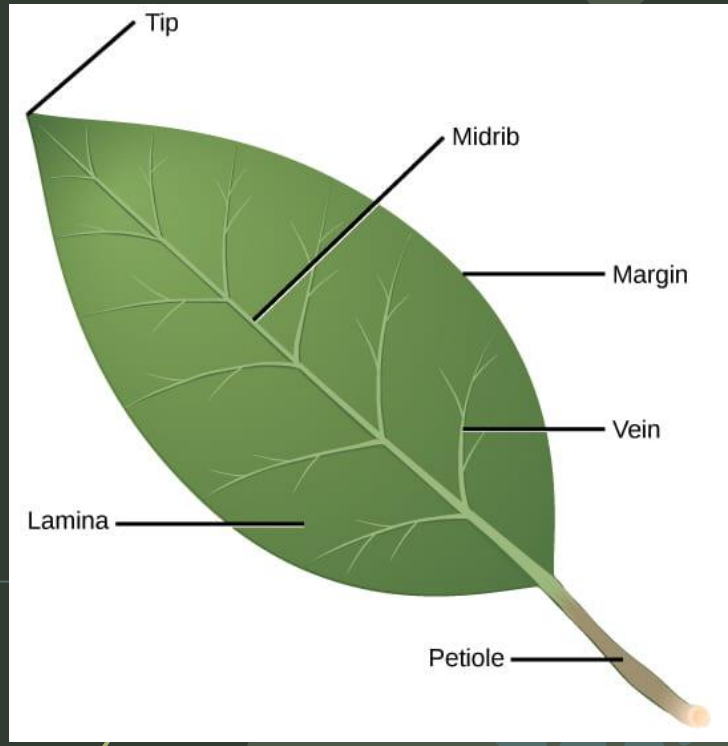


The shoot system

a/ Non-reproductive parts

Leaves

They are the main sites for photosynthesis: the process by which plants synthesize food. Most leaves are usually green, due to the presence of chlorophyll in the leaf cells.



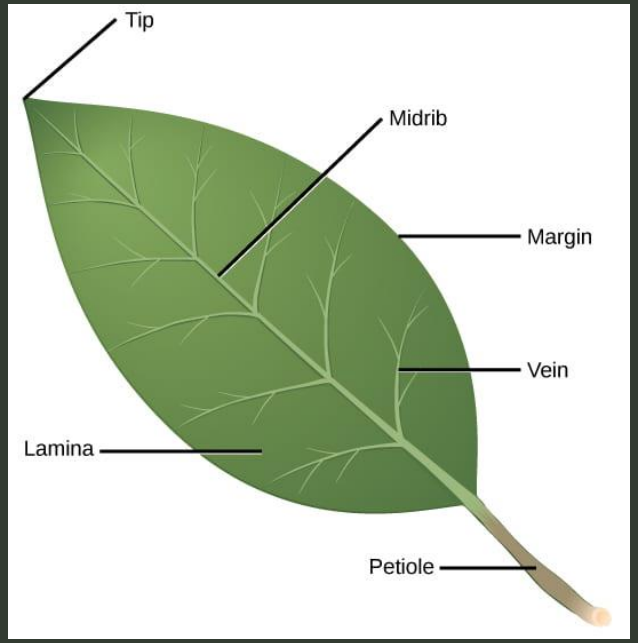
The shoot system

a/ Non-reproductive parts

Leaves structures

Petiole

Which is a structure that attaches the leaf to the stem (the leaves of some plants lack a petiole and attach directly to the stem).



Veins

Which are bundles of vascular tissue that run through the leaf; leaf veins carry water and nutrients, and also provide structural support to the leaf.

The shoot system

a/ Non-reproductive parts

Leaves

The thickness, shape, and size of leaves are evolutionarily adapted to specific environments:

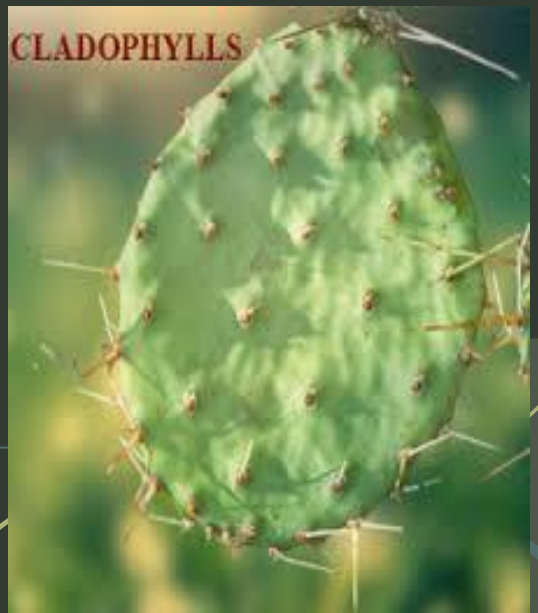
The shoot system

a/ Non-reproductive parts

Leaves

The thickness, shape, and size of leaves are evolutionarily adapted to specific environments:

In hot climates, plants such as cacti have leaves that are reduced to spines, which in combination with their stems, help to conserve water.



The shoot system

a/ Non-reproductive parts

Leaves

The thickness, **shape,** and size of leaves are evolutionarily adapted to specific environments:

Coniferous plant species that thrive in cold environments, like pine, have leaves that are reduced in size and needle-like in appearance. These needle-like leaves have stomata (pits that allow gas exchange) and a smaller surface area; these two attributes both aid in reducing water loss. are adapted to cold, dry environments.

The shoot system

a/ Non-reproductive parts

Leaves

The thickness, shape, and **size** of leaves are evolutionarily adapted to specific environments:

Many aquatic plants have leaves with wide lamina that can float on the surface of the water, and a thick waxy cuticle (waxy covering) on the leaf surface that repels water.

01

The shoot system

a/ Non-reproductive parts

b/ Reproductive parts

The shoot system

b/ Reproductive parts

- **Flowers**

The shoot system

b/ Reproductive parts

Flowers

The largest flower found on earth

Rafflesia Arnoldii

The shoot system

b/ Reproductive parts

Flowers

The smallest flower found on earth

Wolffia

The shoot system

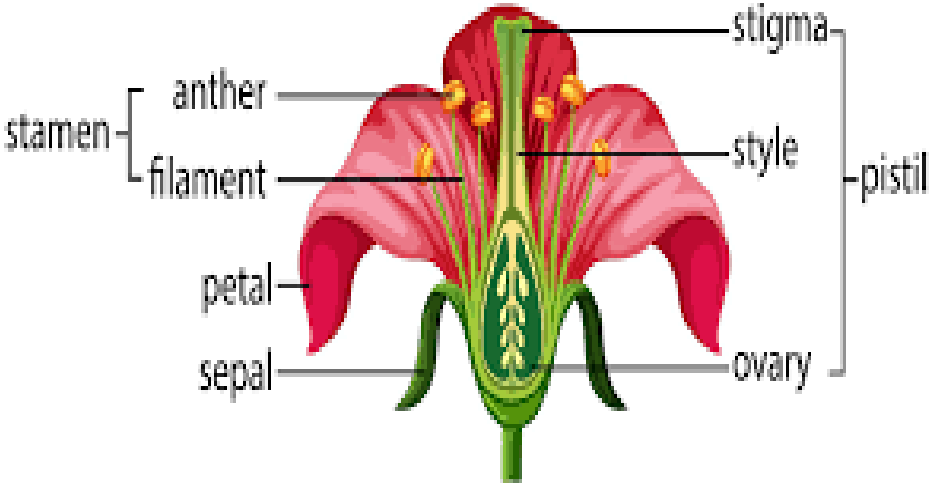
b/ Reproductive parts

Flowers

A flower has four major parts, namely:

1- Petals:

- The colorful part of a flower which attracts insects and butterflies.
-The petals are collectively known as the “**corolla.**”



The shoot system

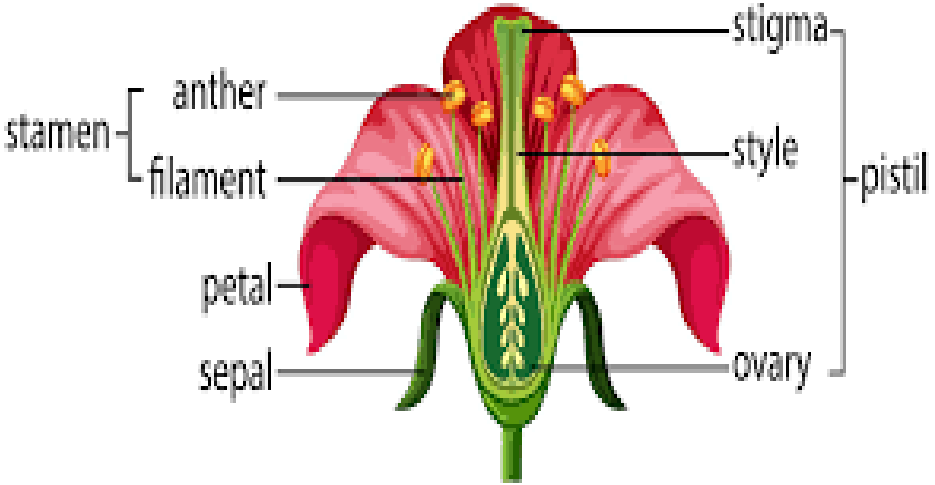
b/ Reproductive parts

Flowers

A flower has four major parts, namely:

2- Sepals:

- Are green leafy parts present under petals and protect the flower buds from damage.
- Collectively, sepals are known as the "**calyx.**"



The shoot system

b/ Reproductive parts

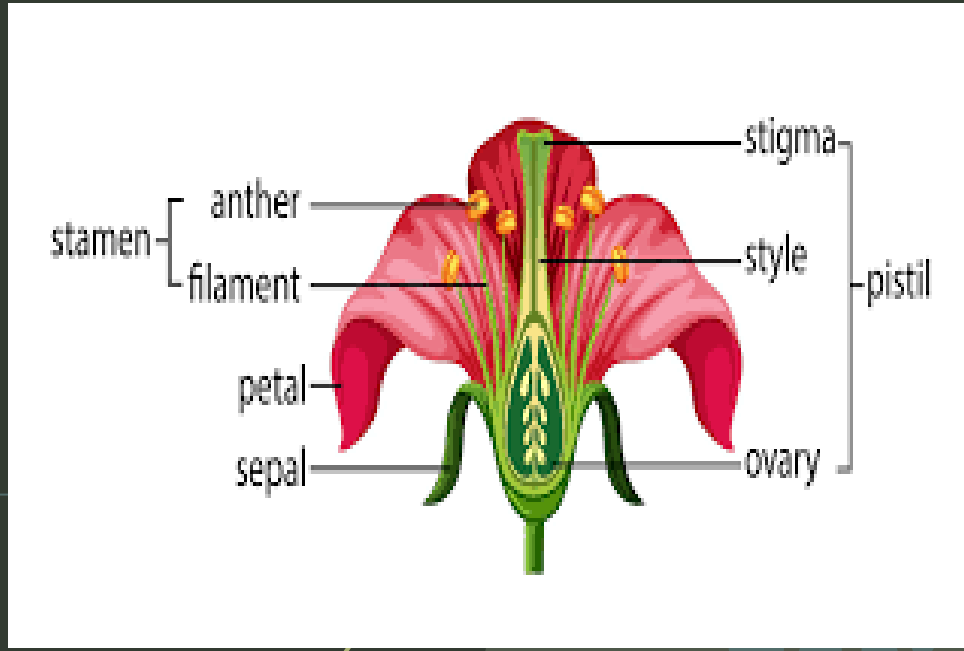
Flowers

A flower has four major parts, namely:

3- Stamens:

-This is **the male part** of the flower.

- Many stamens are collectively known as the “**androecium.**”



The shoot system

b/ Reproductive parts

Flowers

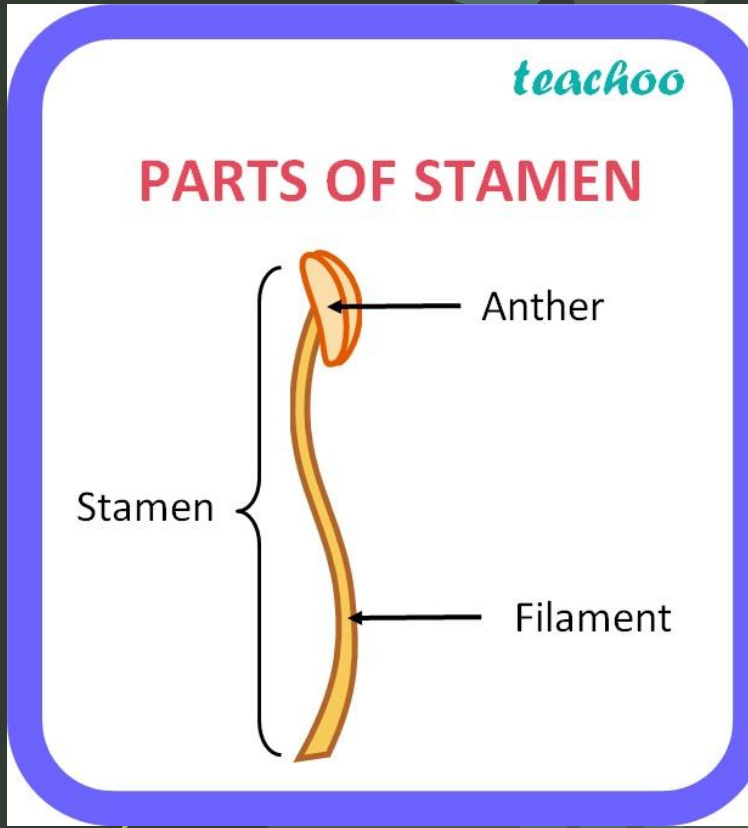
Stamen is structurally divided into two parts:

a- Anther

It is the head of the stamen and is responsible for producing the pollen

b- Filament

The part that is long and slender and attached the anther to the flower



The shoot system

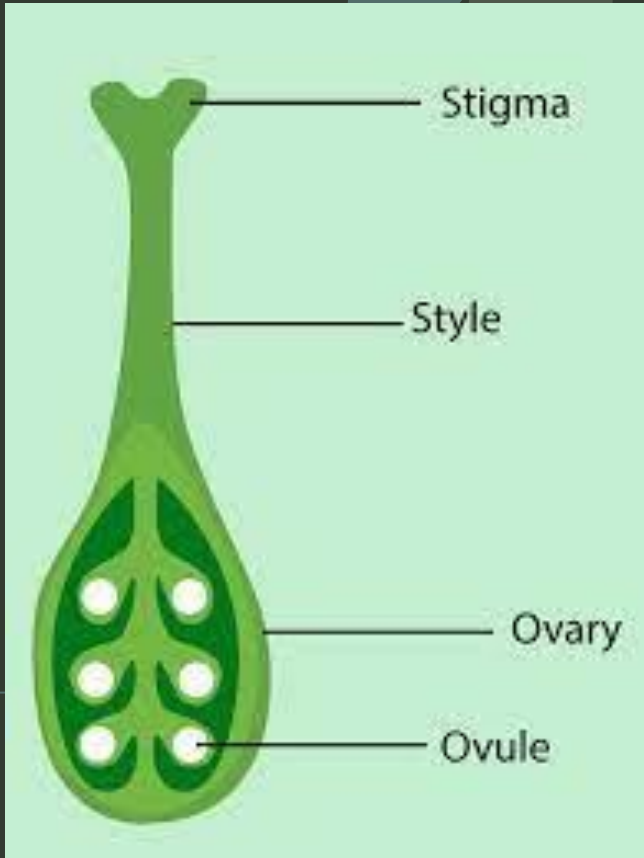
b/ Reproductive parts

Flowers

A flower has four major parts, namely:

4- Pistil:

- This is **the female part** of the flower.
-A collection of pistils is called the "**gynoecium.**"



The shoot system

b/ Reproductive parts

Flowers

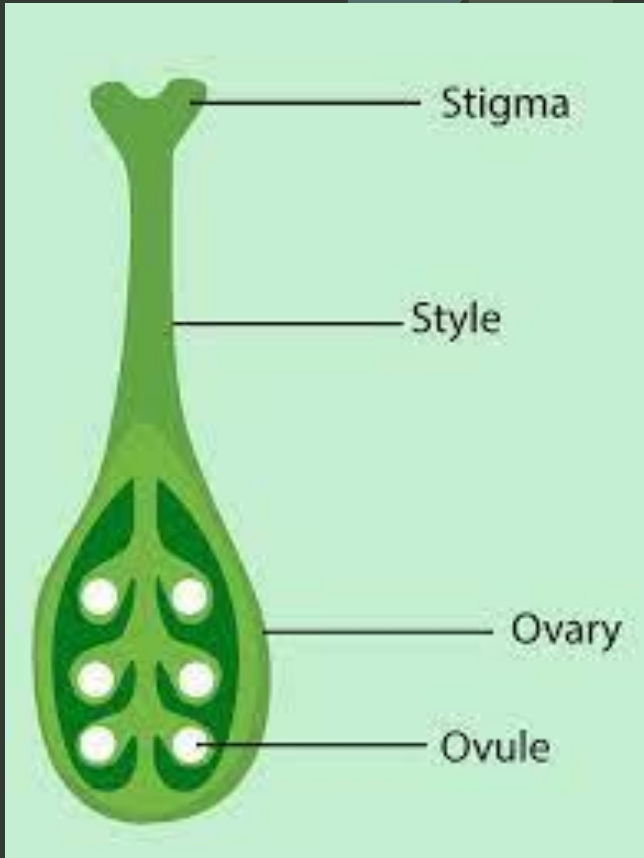
Pistil structurally divided into four parts:

a- Stigma

It forms the head of the pistil.
It contains a sticky substance.
They are responsible to begin fertilization.

b- Style

The style starts to become hollow to enable to take the pollen to the ovaries for fertilization.



The shoot system

b/ Reproductive parts

Flowers

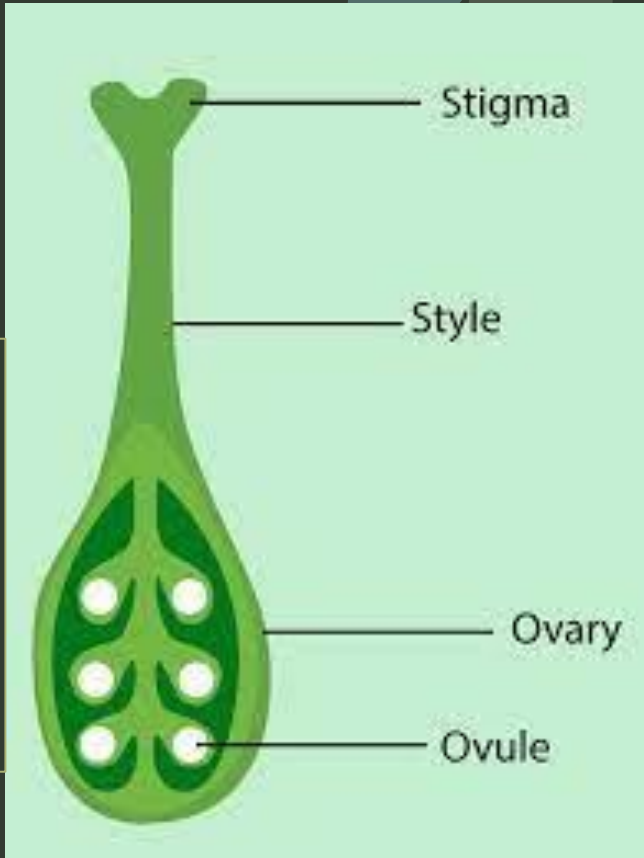
Pistil structurally divided into four parts:

c- Ovary

-They form the base of the pistil.
-The ovary holds the ovules.

d- Ovule

-They are contained in the ovary.
- In a favorable pollination the ovules become the seeds of the fruit.



The shoot system

b/ Reproductive parts

Functions of a Flower

Reproduction so they help in the union of male and female gametes.

After fertilization, the ovary of the flower develops into a fruit containing a seed.

Flowers provide nectar to certain birds and insects, which in turn help in the transfer of pollen from one flower to the other.

The shoot system

b/ Reproductive parts

- **Fruits**

The shoot system

b/ Reproductive parts

Fruits

Fruits are typically composed of fertilized, mature **ovules (seeds)** along with the **ovary wall.**

The shoot system

b/ Reproductive parts

Fruits

Fruit structure:

A typical fruit consists of two main components:

Pericarp

Seed

The shoot system

b/ Reproductive parts

Fruits

Fruit structure:

Pericarp

The wall of the ovary,

It surrounds the seeds and develops into different layers

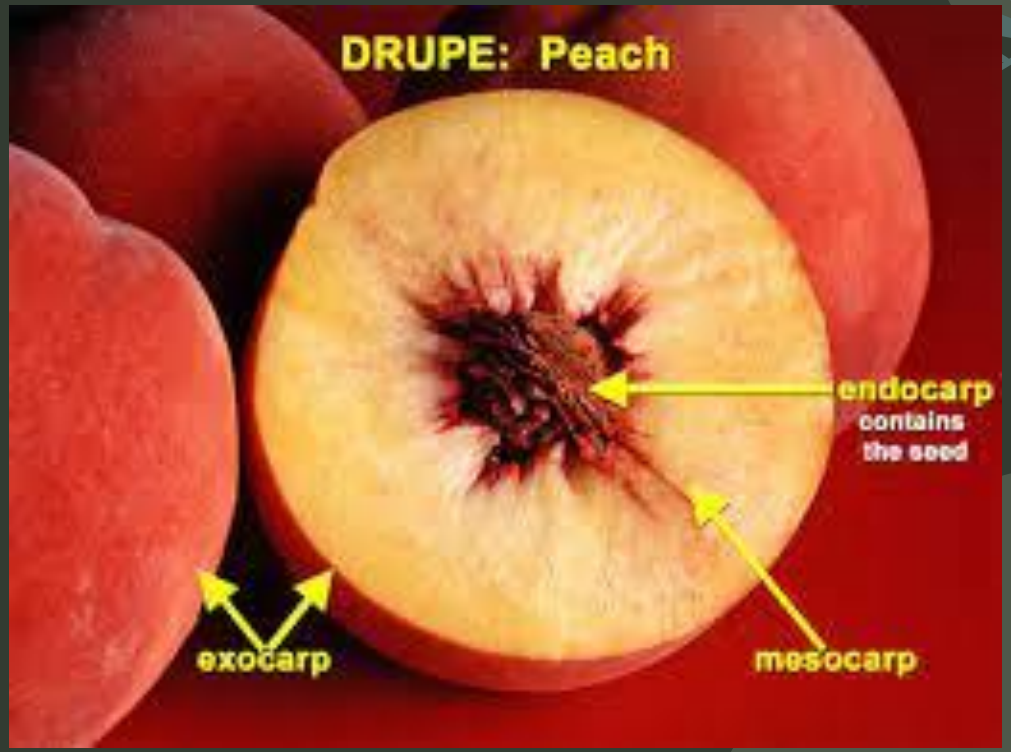
It can vary greatly in texture, thickness, and function.

The shoot system

Pericarp

Exocarp (outer layer):

- commonly referred to as **the skin or peel**. In some fruits, like apples, it is smooth and edible, while in others, like oranges or bananas, it is tough and usually not eaten.

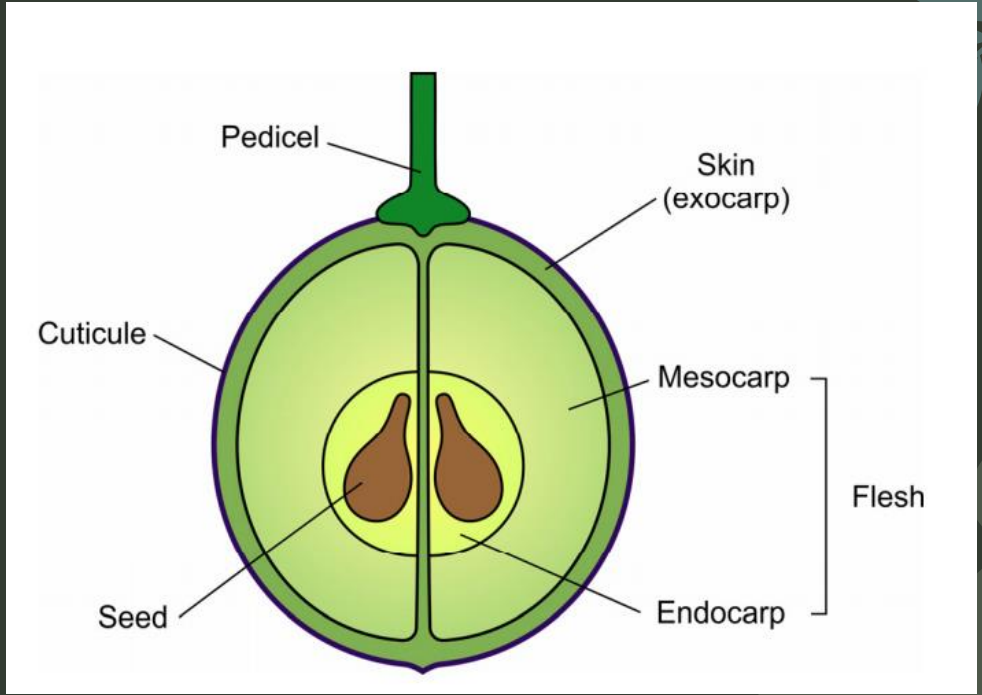


The shoot system

Pericarp

Mesocarp (middle layer)

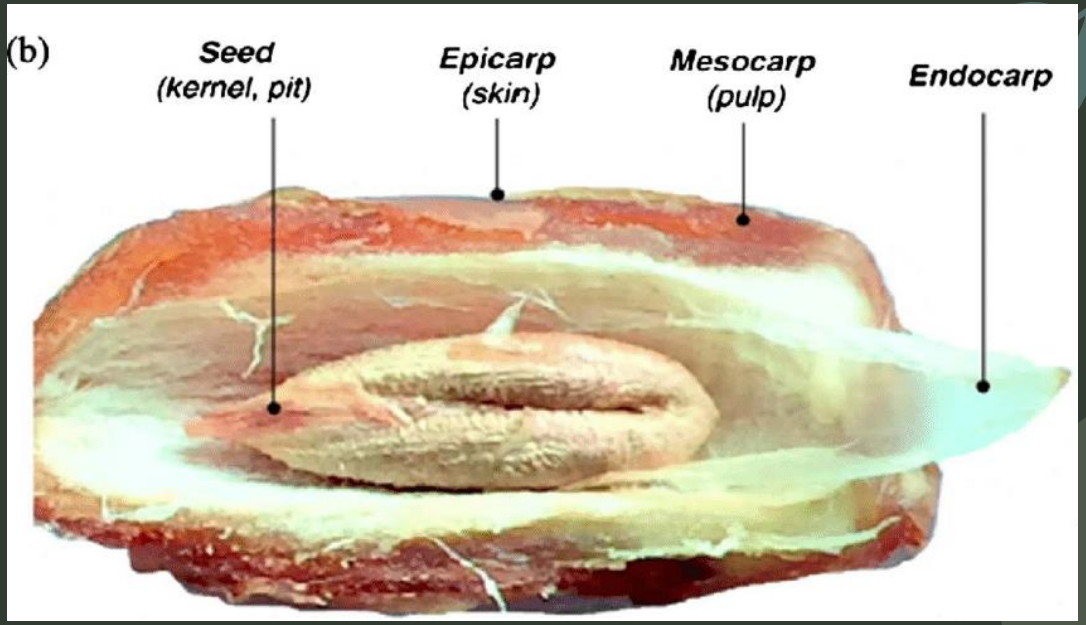
- This is **the fleshy, thick, or fibrous** layer that we often consume.
- For example, in peaches and mangoes, the mesocarp is juicy and sweet.



The shoot system
Pericarp

Endocarp (inner layer)

- The layer closest to the seed(s)
- In some fruits, the endocarp can be **hard and stony** (such as the pit in cherries or peaches), while in others, it can be **thin and papery like dates**

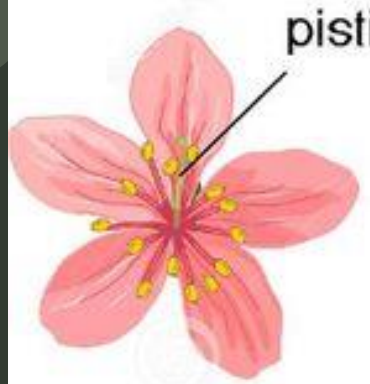


Types of Fruits

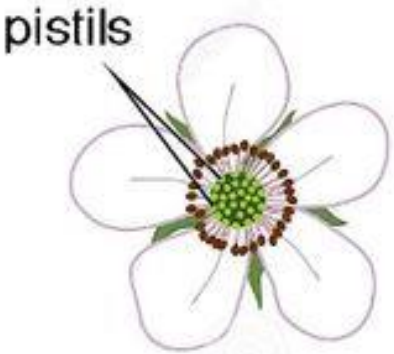
Fruits are classified as:

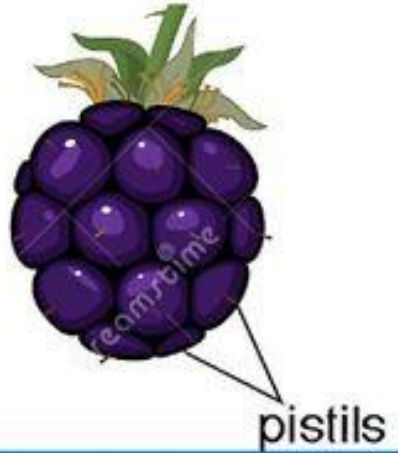
Simple	Aggregate	Multiple
Develop from a single ovary. They include fleshy fruits such as cherries and peaches, apples, and tomatoes.	**Develops from a single flower with many ovaries,** such as with strawberries, raspberries and blackberries.	**Develops Fruits from many flowers packed together,**
They can be dry. Their wall is either papery or leathery and hard, such as peanuts and walnuts	The flower is a simple flower with one corolla, one calyx and one stem, but it has many pistils or ovaries.	such as pineapple

Simple fruit

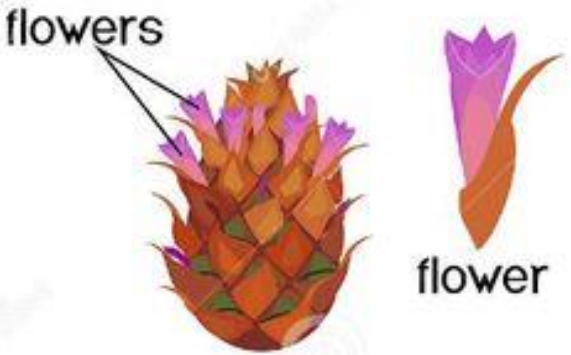


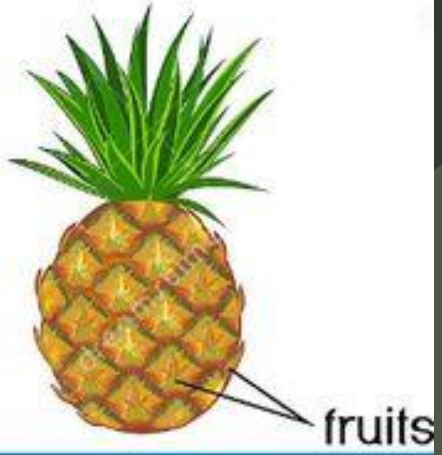
Aggregate fruit





Multiple fruit





The shoot system

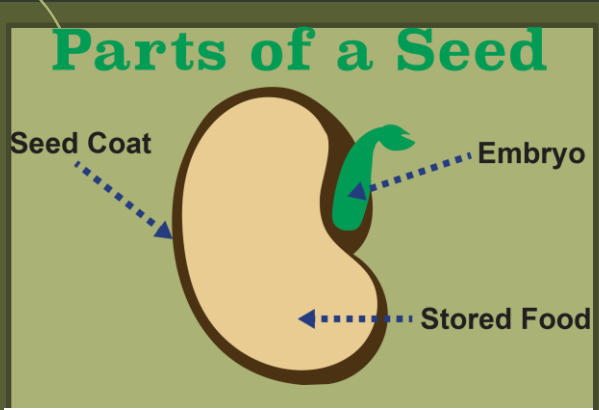
b/ Reproductive parts

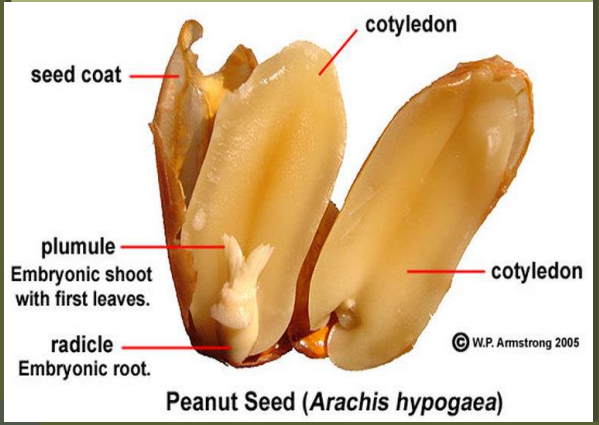
Seeds

A seed

- Give rise to a new plant.
- They may be of different shapes, colors and sizes.
- They are in a dormant condition until they receive adequate sunlight, water, and soil.
- The growth of the plant from a seed is known as **germination.**

Seeds



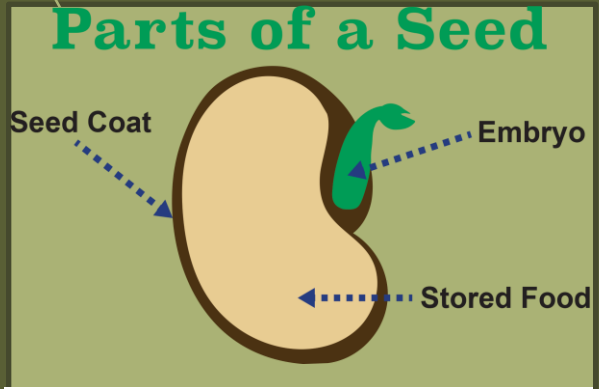


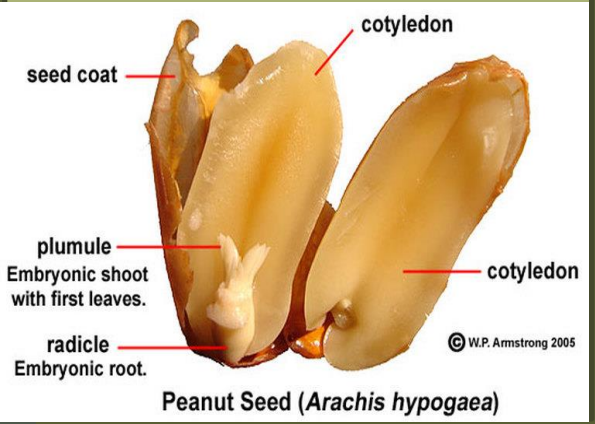
A seed has three parts:

a- The seed coat

A hard outer covering, protects the seed from disease and insects. It also prevents water from entering the seed and initiating germination before the proper time.

Seeds



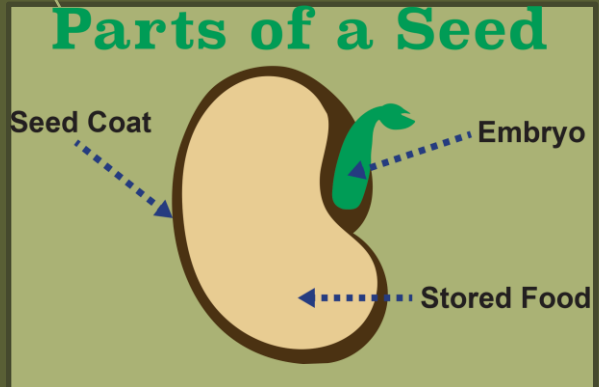


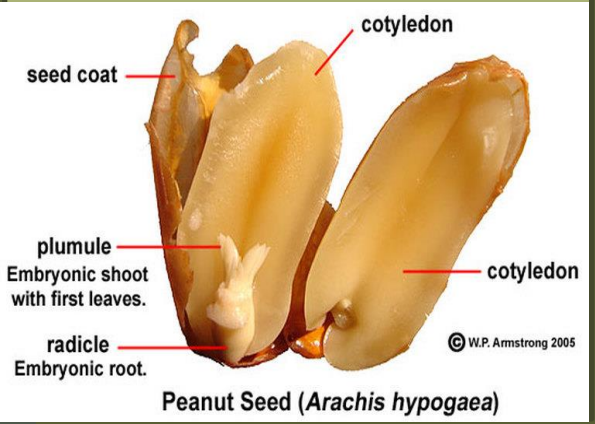
A seed has three parts:

b- Endosperm

It contains the nutrients stored in it. It provides nutrients to the seed in the form of starch, carbohydrates and proteins to support the embryo during germination. It is located below the seed coat.

Seeds





A seed has three parts:

c- The embryo

It is the most important part of a seed. It is diploid, developed from the fertilized egg.
It is a miniature plant in an arrested state of development. It will begin to grow when conditions are favorable.

02

The root system

Roots

The root system

The roots of seeded plants typically occur below ground, and have three major functions:

Anchoring the plant to the soil.

Absorbing water and minerals and transporting them to the shoot system.

Storing the products of photosynthesis.

The root system

The Roots

The root system is classified into two types:

a- Tap Root System

b- Fibrous Root System

The root system

a- Tap Root System

A taproot system comprises main one thick, cylindrical main root, that grows down vertically known as the primary root, and many small roots that branch out from the primary root are termed as secondary and tertiary roots.

Tap roots penetrate deep into the soil and are advantageous for plants growing in dry soils.

This type of root system is typically deeply established and difficult to remove.

The root system

a- Tap Root System types

1- Conical

The primary root begins to expand from the base of the stem and progressively shrinks towards the root's tip.

This sort of root has one swollen end and one tapering end and looks like a cone.

Throughout its length, there are several thread-like secondary and tertiary roots. Example – Carrot.

The root system

a- Tap Root System types

2- Napiform

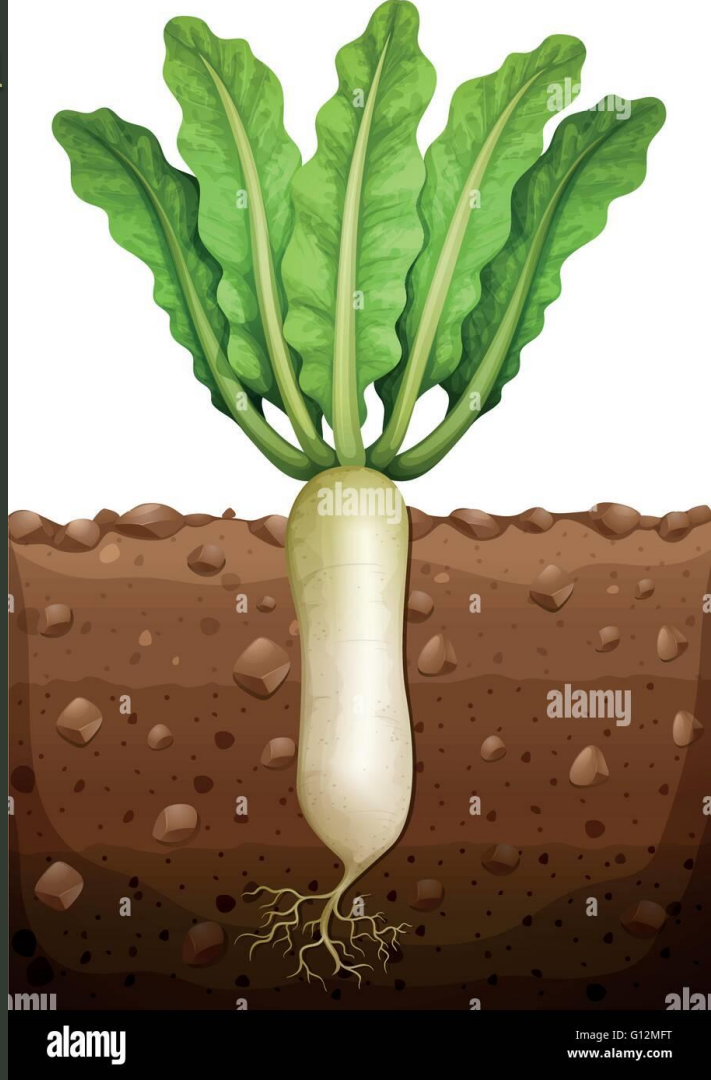
This fleshy root is thick at the stem's base and resembles a sphere. The taproot swells from the stem's base and tapers suddenly. Example – Turnip, Beetroot.

The root system

a- Tap Root System types

3- Fusiform

This type of taproot is tapered at both ends and is wider in the middle. It resembles a spindle, thickest in the center and narrowest at the ends. Example – Radish.



The root system

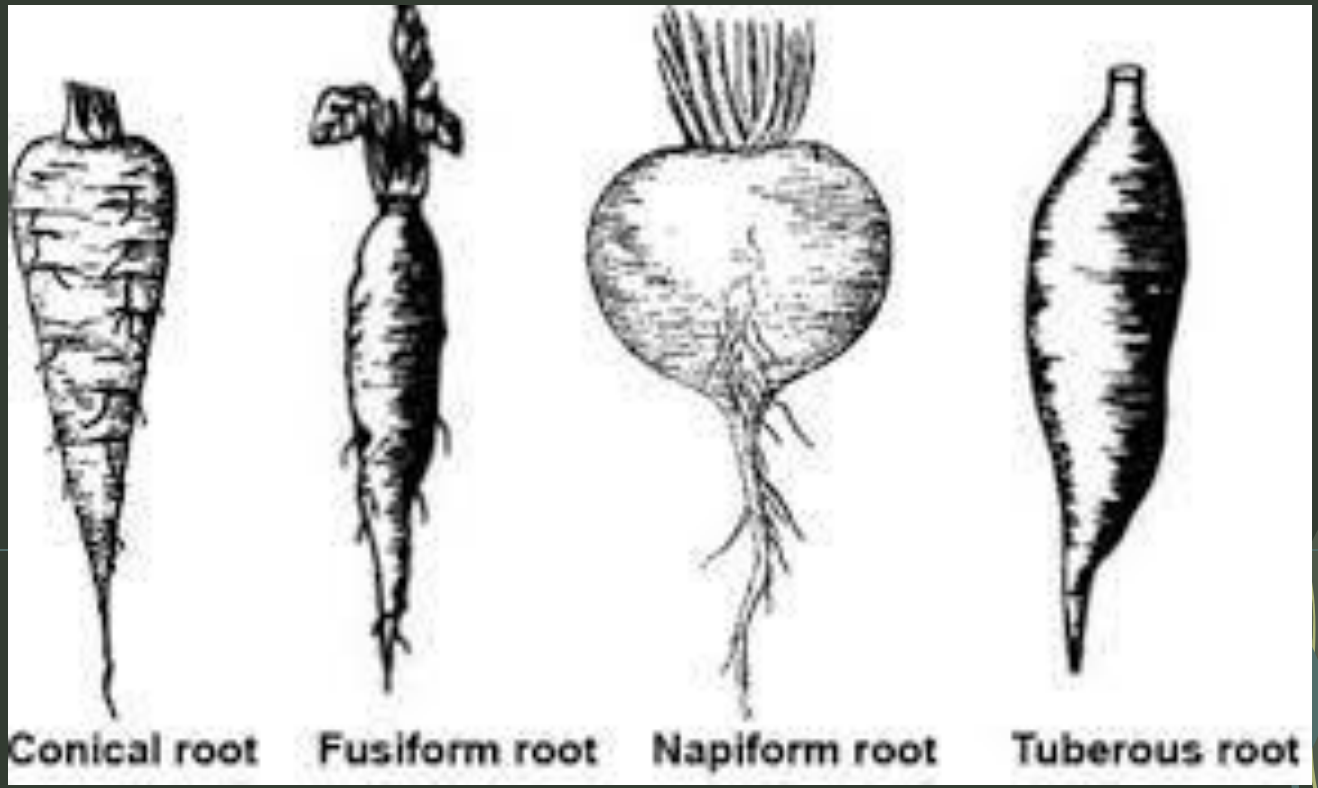
a- Tap Root System types

4- Tuberous

Root is a fleshy root that has been enlarged and adapted to store food. These are termed the storage taproots and do not take on any certain form or shape. Example: Mirabilis jalapa

The root system

a- Tap Root System types



The root system

The Roots

The root system is classified into two types:

a- Tap Root System

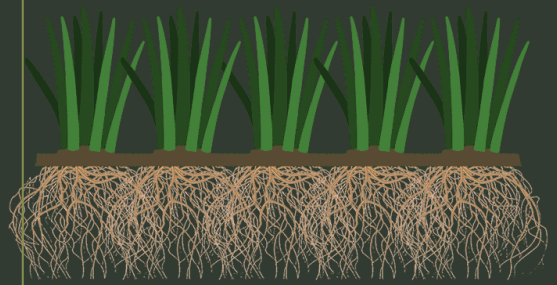
b- Fibrous Root System

The root system

b- Fibrous Root System

It is normally formed by thin, moderately branching roots developing from the stem

They usually stay close to the soil surface, which allows them to access water and nutrients from the topsoil.

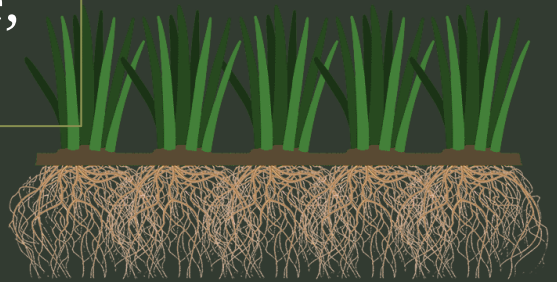


The root system

b- Fibrous Root System

are located closer to the surface and have a dense network of roots.

Examples of fibrous root systems include coconut palm, banana, wheat, rice, and grasses



The root system

Advantages of Fibrous Root System

shallow nature helps prevent soil erosion by holding the soil in place,

Due to their wide reach, fibrous roots are efficient at absorbing water and nutrients from the topsoil.

Fibrous roots can regrow rapidly, making them resilient to physical damage and grazing by animals.

The root system

Difference Between Tap Root and Fibrous Root

Tap Root	Fibrous Root
• It helps in the absorption of minerals. • It penetrates deep into the soil. • It comprises one large long root.	• It helps in the absorption of water from the soil. • It is shallow and doesn't penetrate as deeply. • It does not comprise one large long root.