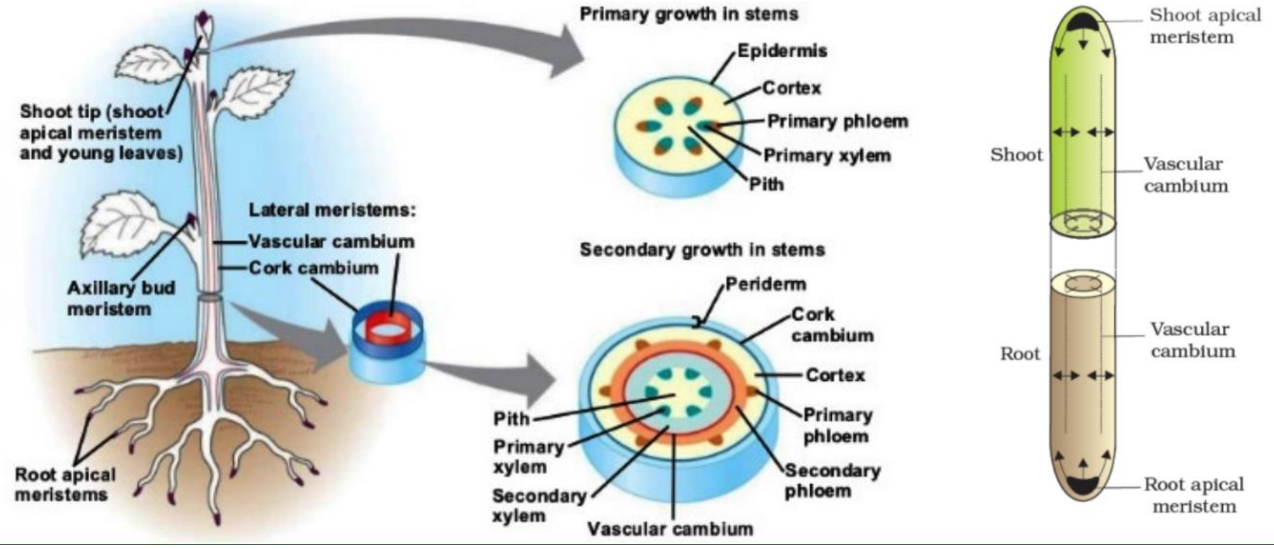
PLANT GROWTH & DEVELOPMENT

- All plants cells are descendants of the zygote. Root, stem, leaves, flowers, fruits and seeds arise in orderly manner in plants.
- Plants complete their vegetative phase (Juvenile) to move into reproductive phase in which flower and fruits are formed for continuation of life cycle of plant.
- **Development** is the sum of two processes **growth** and **differentiation**. Intrinsic and extrinsic factors control the process of growth and development in plants.
- **Growth** is irreversible/permanent increase in dry weight, size, mass or volume of cell, organ or organism. It is internal or intrinsic in living beings. Result of anabolism.
- In plants growth is accomplished by cell division, increase in cell number and cell enlargement. So, growth is a quantitative phenomenon which can be measured in relation to time.
- **Plant growth continues** throughout the life due to presence of **Meristematic tissue (dividing capacity)** present at the certain region of plant.
- The growth in which new cells are always being added to plant body due to meristem is called **open form of growth**.



- **Primary growth** (increase in length):-
  - **i) Apical Meristem:** Present at Root and shoot apex causes elongation of plant along their axis.
  - **ii) Intercalary meristem -**Located at base of internodes produce buds and new branches in plants.
- **Secondary meristem** (Increase in Grith):
  - **iii) Lateral Meristem** – vascular cambium & cork cambium increases grith of plant.

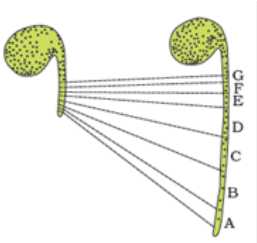
Growth is measurable

- At cellular level, growth is increase in protoplasm (difficult to measure).

Parameter of Growth (Increase in):

i) Fresh weight ii) Length iii) Dry weight iv) Volume v) Area vi) Cell number

- **Cell Number**- Apical meristem of Maize root produces more than 17,500 new cells per hour.
- **Cell Size**- Watermelon cells increase in size by 3,50,000 times.
- **Length**- Growth of Pollen Tube
- **Surface Area**- Growth in dorsi-ventral leaf.



Formative/ Meristematic phase	Phase of Elongation/Enlargement	Phase of Maturation
➢ It occurs at root/shoot apex. ➢ Cells have rich protoplasm and large nuclei. ➢ Cell wall are primary, thin & cellulosic with abundant plasmodesmata. ➢ The rate of respiration is high & cell undergo mitosis.	➢ Present just next to meristematic zone. ➢ Cell enlargement, large vacuole, and new cell wall deposition. ➢ Maximum elongation in conducting tissues and fibres.	➢ Away from meristematic, next to elongation zone. ➢ Undergo structural & physiological differentiation. ➢ Cells attain their maximum size, wall thickening & protoplasmic modifications.

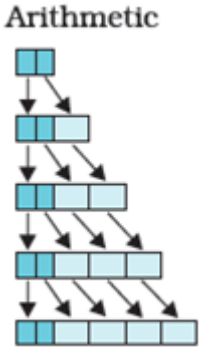
Growth Rate

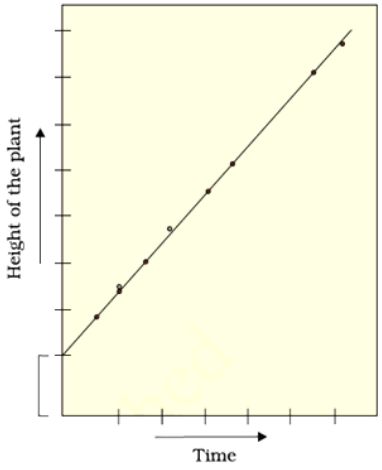
Increase in growth per unit time is called growth rate. Growth rate may be arithmetic or geometrical.

Arithmetic Growth- Rate is constant & increase in growth occurs in arithmetic progression- 2,4,6,8 ……. Found in root and shoot elongation.
In this following mitotic division only one daughter cell continues to divide while other differentiates and mature.

$$L_t = L_0 + rt$$

L_t = Length after time
L_0 = length at beginning
r = growth rate
t = time.

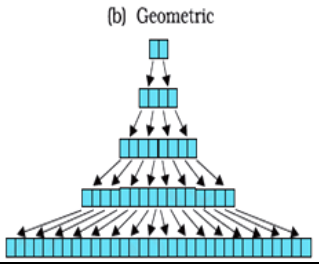


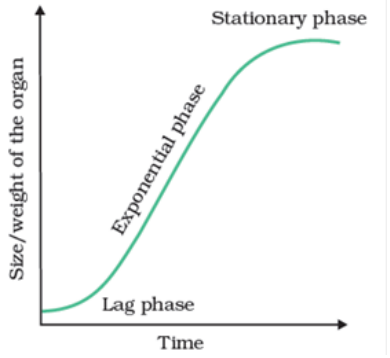


Geometric Growth- Here initial growth is slow & increase rapidly thereafter.
Every cell divides that result into exponential growth.
Common in unicellular organisms when growing in nutrient rich medium.
Characteristic of living organism growing in a natural environment.
Sigmoid growth curve consists of fast dividing exponential phase and stationary phase.

$$W_1 = W_0 e^{rt}$$

W_1 = Final size
W_0 = initial size,
r = growth rate
t = time of growth
e = base of logarithms (2.71828).





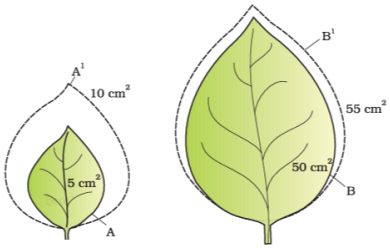
Quantitative comparison between the growth of living system :

1. **Absolute growth rate:** Measurement and comparison of total growth per unit time.
   Eg: Absolute rate = Final growth - initial growth.

Case A	Case B
$10cm^2 – 5cm^2 = 5cm^2$	$55cm^2 – 50cm^2 = 5cm^2$

2. **Relative growth rate-** The growth of given system per unit time expressed on a common basis. Relative Rate= $\frac{\text{Final – Initial}}{\text{Initial}}$

Case A	Case B
$\frac{10cm^2 – 5cm^2}{5cm^2} = 1cm^2$ or 100%	$\frac{55cm^2 – 50cm^2}{50cm^2} = \frac{1cm^2}{10}$ or 10%



Condition for growth

- **Water** -For cell enlargement and maintaining turgidity. Medium for enzymatic activities & protoplasm formation
- **Temperature:** Require optimal temperature for maximum growth.
- **Oxygen:** To release metabolic energy for growth.
- **Nutrients:** Macro & Micro nutrients needed as a source of energy.
- **Light & Gravity:** Affect certain phases of growth.