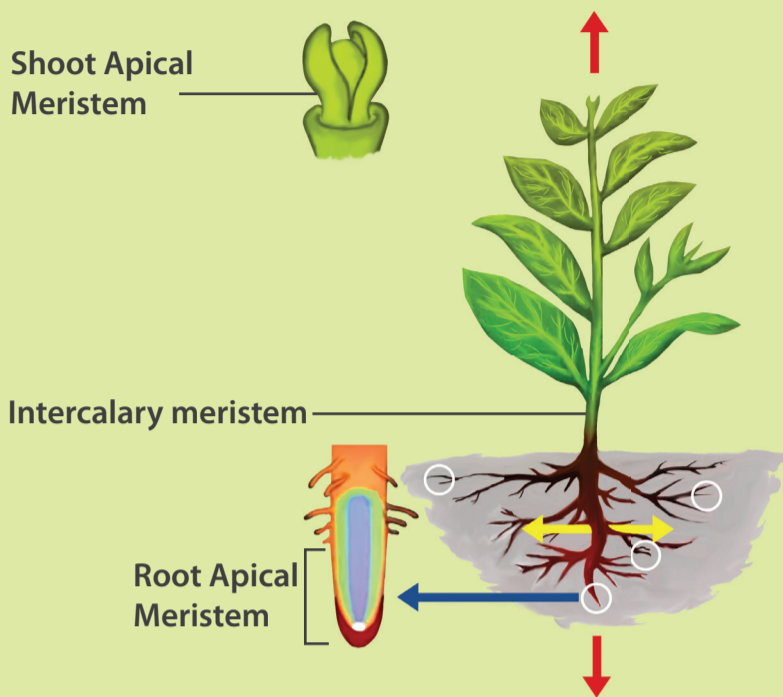


Phases of Plant Growth

Growth: Irreversible increase in size of an organ or its part, or even of an individual cell

Plant growth is indeterminate

- Meristematic cells can divide & self-propagate
- Shoot & root apical meristems help in increase of length
- Intercalary meristem help in growth of width – secondary growth



Phases of Growth

- **Meristematic phase:** Constant division of cells in shoot & roots
- **Elongation phase:** Cell enlargement, increased vacuole formation & new cell wall deposition
- **Maturation phase:** Protoplasm & cell wall thickening has attained maximum growth

Rate of Growth

- **Arithmetic growth:** Cell differentiation follows mitotic division

$$L_t = L_0 + rt$$

(where, L_t is the length at time 't', L_0 is the length at time 'zero', r is the growth rate)

- **Geometric growth:** Follow the 'lag', 'log' & 'stationary' phase format to obtain sinusoidal curve

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

(where W_1 is final size, W_0 is initial size, e is base of natural logarithm, r is the growth rate and t is the time of growth)

Growth rate can be absolute or relative

Plant growth is measurable

- Assessing the cellular growth in protoplasm is hard
- Growth is measured in terms of increase in cell number, area, volume, length, etc.

Types of Differentiation

- **Differentiation:** It is when cells stop dividing & start maturing & take up specialized function.
- **Dedifferentiation:** Differentiated cells that have lost their ability to divide gain back their ability under certain conditions.
- **Redifferentiation:** Dedifferentiated cells divide and once again produce cells that can no longer divide but mature to perform specific functions.

Conditions for Growth

- Water
- Oxygen (O_2)
- Nutrients
- Light
- Temperature

Plant Development

Changes that occur throughout the life cycle that are affected by intrinsic & extrinsic factors



Plant Growth Regulators

Growth regulators: Small, simple chemicals produced naturally by plants that regulate growth & development of the plant.

Characteristics

Can have diverse chemical composition such as gases (ethylene), terpenes (gibberellic acid) or carotenoid derivatives (abscisic acid)

Promote cell division, cell enlargement, flowering, fruiting and seed formation

Inhibit growth and promote dormancy and abscission in plants

Types

Plant Growth Promoters

Plant Growth Inhibitors

Auxins

Discoverer: Charles Darwin & his son, Francis Darwin
Types:

- Indole-3-acetic acid (IAA)
- Indole butyric acid (IBA)
- Naphthalene acetic acid (NAA)
- 2,4-dichlorophenoxyacetic (2, 4-D)

IAA & IBA are natural auxins & other two are synthetic auxins
Effects:

- Promote flowering
- Initiate rooting in stem cut
- Prevent early fall of leaves & fruits
- Promote abscission of old fruits & leaves
- Help in cell division & control differentiation of xylem

Gibberellins

Discoverer: E. Kurosawa
Types:

- Over 100 varieties
- All are acidic & denoted as $GA_1, GA_2, etc.$

Effects:

- Increase axis length
- Delay senescence in fruits
- Help fruits (e.g. apples) elongate & improve their shape

Applications:

- Brewing industry uses GA_3 to speed malting process
- Increase sugarcane yield by lengthening the stem
- Hasten maturity period in young conifers & promote early seed production
- Promote bolting in beet & cabbage

Cytokinins

Discoverer: F. Skoog and his co-workers
Types:

- Natural – Zeatin
- Synthetic cytokinin

Effects:

- Aid in formation of new leaves & chloroplast
- Promote lateral shoot growth & adventitious shoot formation
- Help overcome apical dominance
- Delay leaf senescence by promoting mobilisation of nutrients

Abscisic Acid

Discoverer: Three independent researchers
Effects:

- Regulates abscission and dormancy
- Inhibits plant growth, metabolism and seed germination
- Increases stress tolerance
- Helps in seed development & maturation
- Induces seed dormancy & help withstand critical growth factors

Ethylene

Discoverer: Group of cousins
Effects:

- Hastens fruit ripening
- Affects horizontal growth of seedlings & swelling of the axis in dicot seedlings
- Promotes abscission and senescence
- Enhances respiration rate during ripening of fruits (respiratory climactic)
- Increases root growth & root hair formation

Applications:

- Breaks dormancy of seed & bud
- Promotes sprouting
- Boosts rapid petiole elongation
- Initiates flowering and synchronize fruit-set