QUICK REVISION NOTES
For NEET
BIOLOGY CLASS 11

Plant Growth and Development

Growth: It is a quantitative parameter and refers to an irreversible increase in size or weight of a cell, tissue or organ. Plants are capable of growing throughout their life due to meristematic tissues present in certain parts.

Growth can be measured by an increase in cell number, length, area, volume and dry or wet weight.

Primary Growth: Apical meristems of roots and shoots is responsible for primary growth.

Secondary Growth: Secondary growth is due to lateral meristems, e.g. vascular and cork cambium. The plant increases in the girth due to secondary growth.

Phases of Growth: There are three phases of growth:

1. **Meristematic (formative phase)** growth is shown by apices of roots and shoots. The meristematic growth is facilitated by a thin cellulosic cell wall, along with many plasmodesmata connections.
2. **Elongation (phase of enlargement)** is characterised by deposition in the cell wall and increased vacuolation.
3. **Maturation** is characterised by cell wall thickening and lignification. Cells attain maturity and their maximal size and undergo protoplasmic modifications.

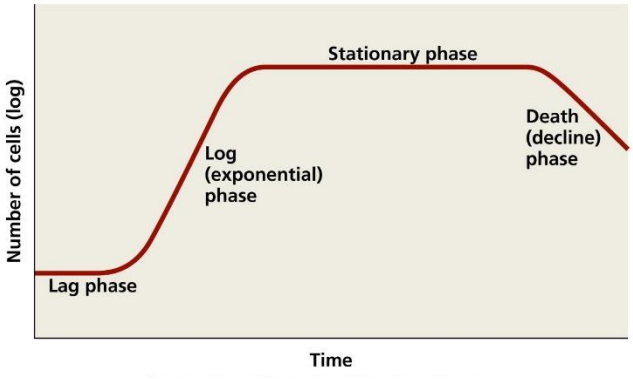
Growth Rate is the increased growth in unit time. Growth can show either arithmetic or geometric progression.

Growth Ring

A layer of wood formed in a plant during a single period of growth. Growth rings are visible as concentric circles of varying width when a tree is cut crosswise. They represent layers of cells produced by the tissue known as vascular cambium. ♦ Most growth rings reflect a full year's growth and are called annual rings. But abrupt changes in the environment, especially in the availability of water, can cause a plant to produce more than one growth ring in a year

Growth Curve

It is an 'S' shaped curve obtained when we plot growth against time. It is also called 'sigmoid 'curve. This curve mainly shows four phases of growth- 1.initial slow growth (Lag phase), 2. the rapid period of growth (log phase/grand period of growth/exponential phase) where maximum growth is seen in a short period and 3. The diminishing phase where growth will be slow and 4. Stationary / steady phase where finally growth stops.



Conditions of Growth: Essential elements required for growth are:

- **Water** is essential and also required for enzymatic activity. Turgidity helps in growth
- **Oxygen** is required for respiration and metabolism of organic compounds to release energy required for growth
- **Macro and micronutrients** are required as an energy source and for the synthesis of protoplasm

In addition to these, optimum temperature, salinity, light, etc. environmental factors also affect growth

Differentiation: Meristematic cells differentiate and undergo structural changes to perform specific functions, e.g. tracheary elements develop lignocellulosic cell walls, which is strong, elastic and required for the transport of water to long-distance, peripheral meristematic cells develop into the epidermis and cells present apically differentiate into the root cap.

Dedifferentiation: When living differentiated cells regain their ability to divide and differentiate, the process is called dedifferentiation. E.g. parenchyma cells again differentiate into the cork and interfascicular cambium.

The dedifferentiated cells again lose their capacity to divide, i.e. **redifferentiation.**

Development: Development refers to growth as well as differentiation. The development includes all the phases of the lifecycle from seed germination to senescence.

Development is controlled by various intrinsic and extrinsic factors:

Intrinsic Factors: These include genetic as well as hormonal control

Extrinsic Factors: Environmental factors like oxygen, temperature, water, nutrients, etc.

Plants form different types of structures in response to various environmental conditions. This is termed as **plasticity.**

Heterophylly refers to the different shapes of leaves present at different stages of life or in different environmental conditions. E.g. In coriander, cotton and larkspur, leaves are of different shapes at juvenile and mature stages. In buttercup, leaves of terrestrial and aquatic habitats are different.

Plant Hormones?

Plants need sunlight, water, oxygen, minerals for their growth and development. These are external factors. Apart from these, there are some intrinsic factors that regulate the growth and development of plants. These are called plant hormones or **"Phytohormones".**

- Plant hormones are chemical compounds present in very low concentration in plants. They are derivatives of indole (auxins), terpenes (Gibberellins), adenine (Cytokinins), carotenoids (Abscisic acid) and gases (Ethylene).
- These hormones are produced in almost all parts of the plant and are transmitted to various parts of the plant.
- They may act synergistically or individually. Roles of different hormones can be complementary or antagonistic.
- Hormones play an important role in the processes like vernalisation, phototropism, seed germination, dormancy etc. along with extrinsic factors.
- Synthetic plant hormones are exogenously applied for controlled crop production

Charles Darwin first observed the phototropism in the coleoptiles of canary grass and F.W. Went first isolated auxin from the coleoptiles of oat seedlings.

Plant Growth Regulators (PGRs): They are chemical compounds and found naturally in plants. They are also synthesised commercially and used in agricultural practices. They are known as plant hormones or phytohormones.

- They are derivatives of adenine (kinetin), carotenoids (ABA), terpenes (GA_3) and indole compounds (auxins). Ethylene is a gaseous hormone
- They are present in a very low concentration and act as chemical signals between cells
- Environmental factors influence gene expression and hormone production
- Plant hormones may show different effects at different stages and at different concentrations
- Plant hormones act by signal transduction, i.e. an external signal is converted to internal signal and which in turn causes one or more cellular responses
- According to their actions, they can be classified into two categories:
    1. Plant growth promoters, which induce cell division, elongation, differentiation and the formation of flowers, fruits and seeds, e.g. auxins, gibberellins, cytokinins
    2. Plant growth inhibitors are linked to dormancy, abscission and various stress responses, e.g. Abscisic acid (ABA)
    3. Ethylene, the gaseous hormone has inhibitory as well as growth-promoting effects
- Brassinosteroids also have been discovered to work as a phytohormone
- Different plant hormones may work antagonistically or complimentary (synergistically) to each other. There are many events that get affected by more than one phytohormones, such as apical dominance, dormancy, abscission, senescence, etc.

Important Discoveries of Phytohormones (PGRs)

- Charles Darwin and his son Francis showed that there was some substance at the tip of coleoptile of canary grass, which is transmittable and responsible for the phototropism, i.e. bending towards the light
- Auxin was first isolated from human urine
- F.W. Went isolated Auxin from the coleoptiles of oat
- E. Kurosawa discovered that foolish seedling or ‘bakanae’ disease of rice seedlings was due to the presence of gibberellic acid in the fungus *Gibberella fujikuroi*
- Skoog discovered that callus proliferation in the internodal region takes place, only if auxin was supplemented with coconut milk or DNA, yeast or vascular tissue extract
- Miller et al later identified and crystallised cytokinin and termed as kinetin from herring sperm DNA.
- H.H. Cousins discovered the presence of a gaseous substance in ripened oranges, which hastened the ripening of bananas

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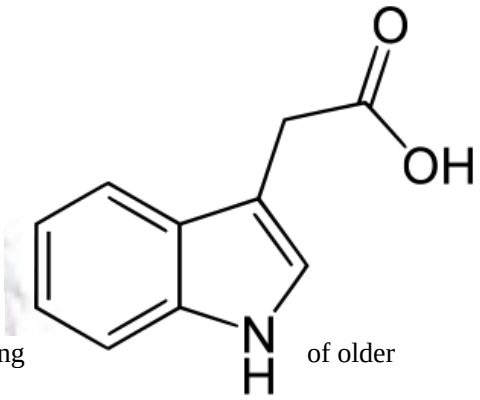
Physiological Effects of PGRs

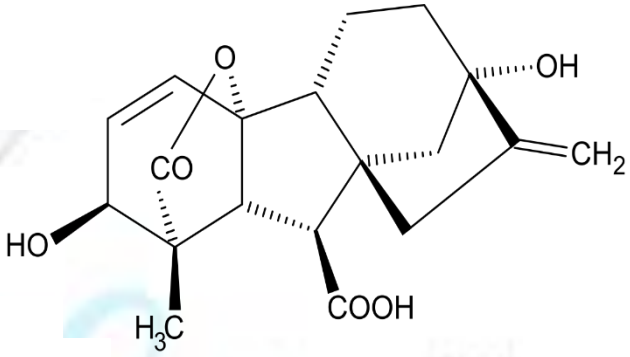
Auxins: Produced in root and shoot apices. It gets transported to various parts. The transport of auxin is polar or unidirectional. Natural auxins- IAA (Indole acetic acid) and IBA (Indole butyric acid), synthetic auxins- 2,4-D (2, 4-Dichlorophenoxyacetic acid), NAA (naphthalene acetic acid).



Effects of auxins:

- Apical Dominance
- Induces cell differentiation in xylem
- Induce parthenocarpy, i.e. formation of seedless fruits, e.g. Tomatoes
- Promote flowering, e.g. Pineapples
- Delay abscission of young leaves and fruits, whereas, promote falling of older leaves and fruits
- Root initiation in stem cuttings for vegetative propagation
- 2, 4-D is widely used as herbicides to kill dicot weeds

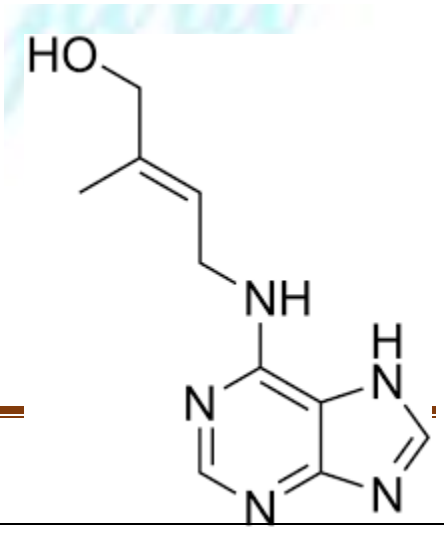
Gibberellins: More than 100s of gibberellins are found. GA_3 (Gibberellic acid) is one of the first and the most common gibberellins. All the gibberellins are acidic.



Effects of gibberellins:

- Cell elongation
- Delay in senescence
- Stimulate malting process
- Internode elongation
- Promote maturation and seed germination

Cytokinins: There are many naturally occurring cytokinins, e.g. zeatin. They influence cytokinesis and are produced in the rapidly dividing cells, e.g. growing buds, young fruits and root apices



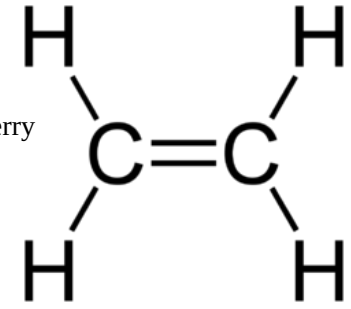
Effects of cytokinins:

- Cell division
- Inhibition of apical dominance, i.e. promote lateral shoot growth

- Delay of leaf senescence
- Embryo development
- Seed germination
- Promote nutrient metabolism
- Formation of chloroplasts in leaves
- Adventitious shoot formation

Ethylene: It is a gaseous hormone. Produced by ripened fruits and tissues undergoing senescence. **Ethephon** is the most widely used compound

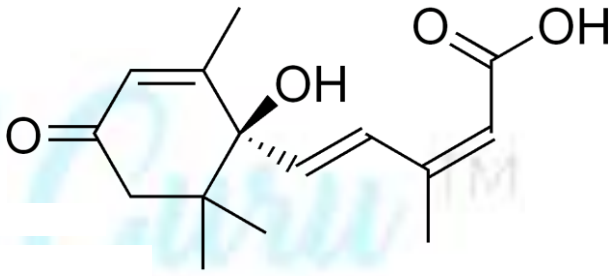
Effects of Ethylene:



- Fruit ripening, e.g. tomatoes, apples,
- Senescence and abscission of leaves, flowers and fruits, e.g. cotton, walnut, cherry
- Maintenance of apical hook on seedlings
- Breaks seed and bud dormancy and initiates seed germination, e.g. peanut seeds, potato tubers
- Root initiation
- Internode and petiole elongation in water plants
- Promotes flowering and femaleness, e.g. cucumbers, mangoes

Abscisic Acid (ABA): It is known as the stress hormone. It acts as an inhibitor of plant growth. It is produced in all the cells containing plastids. It is an antagonist of Gas

Effects of ABA:



- Seed dormancy
- Closure of stomata and tolerance to various stresses
- Seed development and maturation

Brassinosteroids: They are produced in seeds, fruits, leaves and flower buds. E.g. brassinolide

Effects of brassinosteroids:

- Light-mediated gene expression
- Cell division and cell elongation
- Seed germination
- Vascular development

PGRs provide intrinsic control but they, along with genetic and extrinsic or environmental factors, influence plant growth and development, e.g. tropic movements (phototropism, geotropism), photoperiodism, vernalisation, seed dormancy and germination, etc.

Photoperiodism: It refers to the effect of duration of light on plant growth and development, especially flowering. Flowering plants are classified into the following categories, based on their flowering pattern in response to light:

1. **Short day plants:** Flowering is initiated on the exposure of light for a shorter duration
2. **Long day plants:** Flowering is initiated on the exposure of light for a longer duration
3. **Day-neutral plants:** Flowering does not depend on the duration of light exposure

Parthenocarpy

Parthenocarpy is the production of fruits without the fertilisation of ovules. Fruits like banana and figs are developed without fertilisation and do not produce any viable seeds."

Pineapple, banana, cucumber, grape, watermelon, orange, grapefruit, pear, fig are some examples of Parthenocarpy. These develop without fertilization and are often seedless.

Vernalisation: It is a temperature-dependent phenomenon. Flowering is promoted by a period of cold temperature. Seeds are cooled during germination to accelerate flowering.

- Wheat, rye, barley, etc. food crops are grown twice in a year. Spring varieties are planted in spring and harvested at the end of the growing season. Winter varieties are planted in autumn and harvested in mid-summer. Winter varieties will not flower within the growing season if planted in spring.
- Biennial plants need a period of low temperature to flower in subsequent months, e.g. cabbage, sugarbeet, carrots

Seed Dormancy: Seed dormancy is controlled endogenously. Seeds do not germinate even in favourable external conditions. Seed dormancy is caused by various factors:

- Hard and impermeable seed coat
- Chemical inhibitors, e.g. ABA, para-ascorbic acids, phenolic acids, etc.
- Immature embryo

The seed coat is broken by natural abrasions such as microbial action and digestive tract enzymes in animals, which eat seeds. This can also be induced artificially by knives, vigorous shaking and sandpaper.

The effect of hormones can be overcome by cold temperatures, nitrates and gibberellic acids.