SNS COLLEGE OF TECHNOLOGY

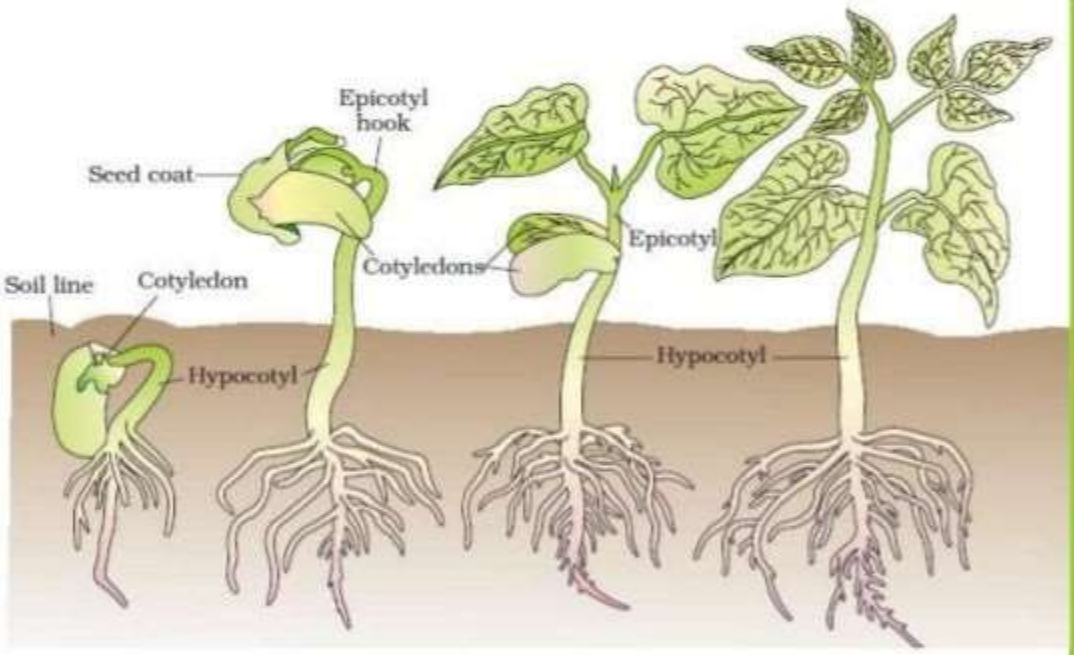
(AN AUTONOMOUS INSTITUTION) COIMBATORE-35

IV YEAR / VII SEMESTER

19GET277-BIOLOGY FOR ENGINEERS

INTRODUCTION

- All cells of a plant develops from the zygote.
- Zygote produces a number of cells which organize into tissues and organs.
- Development is the sum of two processes: growth and differentiation.
- During the process of development, a complex body organisation is formed that produces roots, leaves, branches, flowers, fruits, and seeds, and eventually they die.



GROWTH

- Growth may be defined as an irreversible permanent increase in size in size, volume or mass of a cell or organ or whole organism.
- Growth is one of the fundamental characteristics of a living being.
- It is accompanied by metabolic processes i.e. anabolic and catabolic process, that occur at the expense of energy.
- Example:- expansion of a leaf, elongation of stem etc.

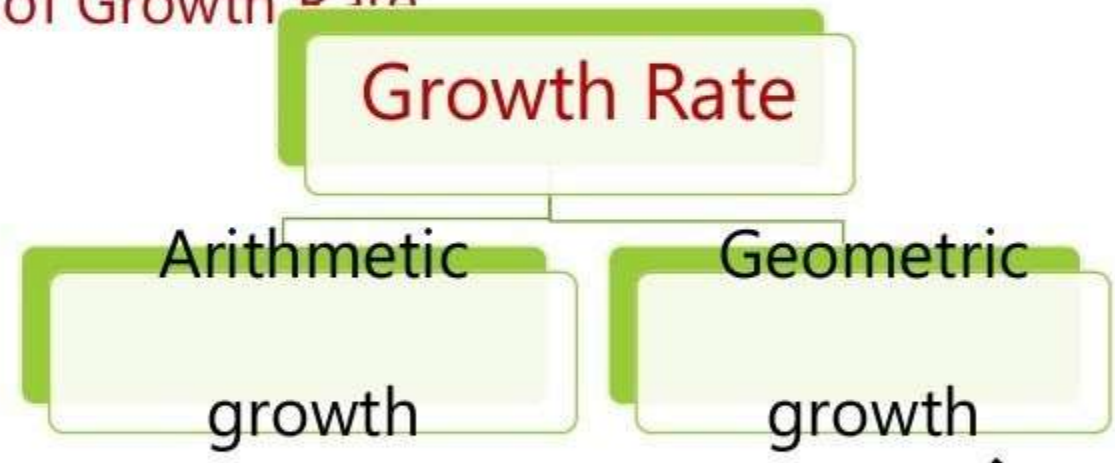
Characteristics of Growth

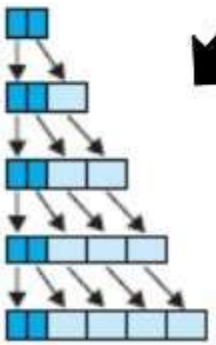
The main characteristics of growth are :-

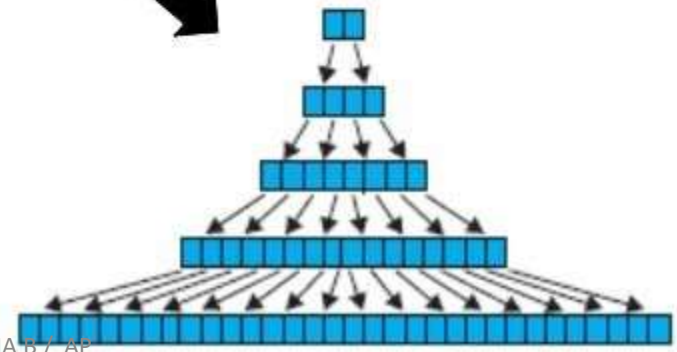
1. Cellular growth
2. Cell division
3. Cell expansion
4. Cellular differentiation

Growth Rates

- Growth rate can be defined as increased growth per unit time.
- The rate of growth can be expressed mathematically.
- Types of Growth Rate







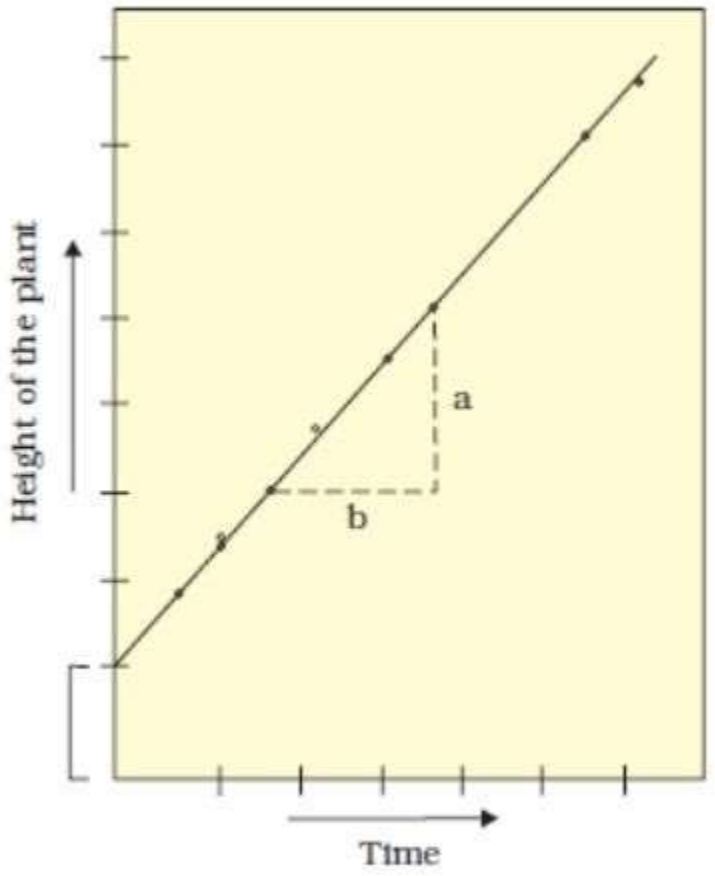
- ***Arithmetic growth*** -
- After mitotic cell division, only one daughter cell continues to divide while others differentiate or mature.
- Example – root elongating at a constant rate.
- Mathematically, it is expressed as

$L_t = L_0 + rt$

L_t = length at time 't'

L_0 = length at time 'zero'

r = growth rate / elongation per unit time



Constant linear growth, a plot of length L against time t

- ***Geometric Growth*** - Initial growth is slow (lag phase), followed by a rapid increase in growth (log/exponential phase), and followed by a phase where growth slows down (stationary phase).
- Example – all cells, tissues and organs show this type of growth
- If one plots the parameter of growth against time, it would be a typical sigmoid or S-curve.

- The exponential growth can be expressed as :

$W_1 = W_0$ ert

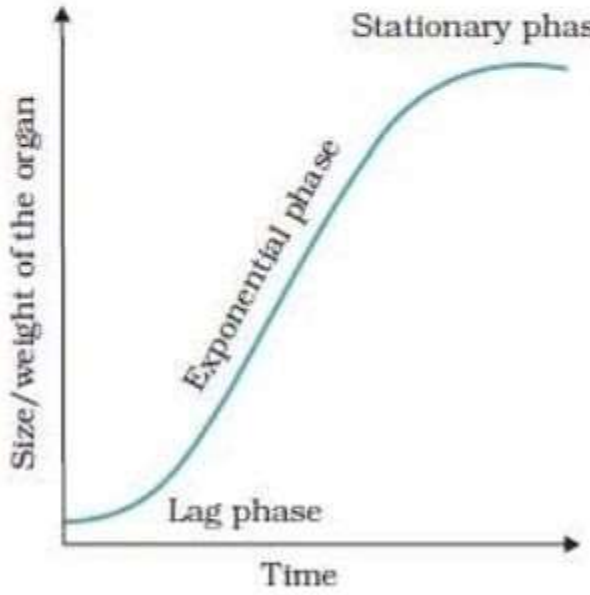
W_1 = final size (weight, height, number etc.)

W_0 = initial size at the beginning of the period

r = growth rate

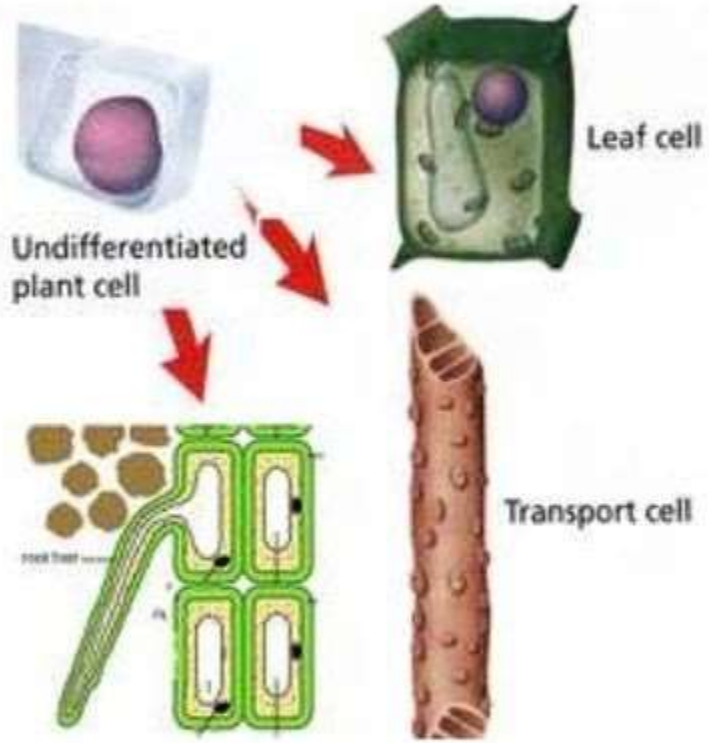
t = time of growth

e = base of natural logarithms



Differentiation, Dedifferentiation & Redifferentiation

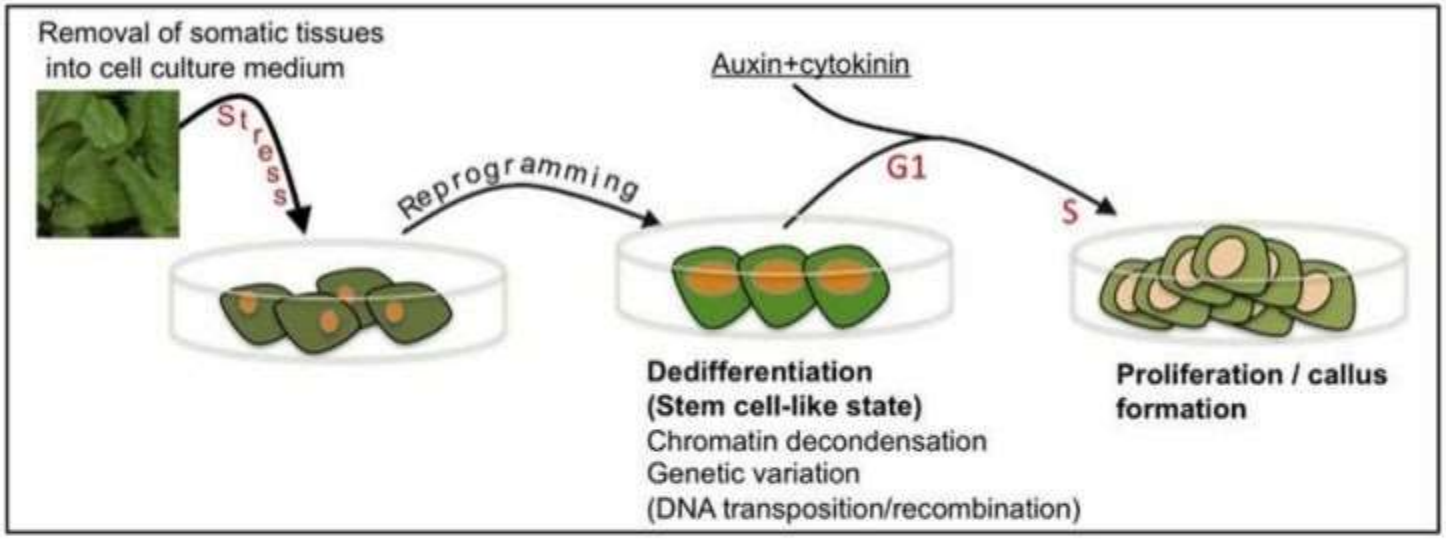
- **Cellular differentiation** is the process by which a less specialized cell becomes a more specialized cell type.
- Cells derived from meristems and cambium differentiate and mature to perform specific functions which is termed as **differentiation**.



DIFFERENTIATION

- Cells undergo structural changes during differentiation.
- Changes take place both in their cell walls and protoplasm.
- Example :- Cells lose their protoplasm during the formation of tracheary elements.
- Plants develop a strong, elastic, lignocellulosic secondary cell walls, to carry water to long distances even under extreme tension.

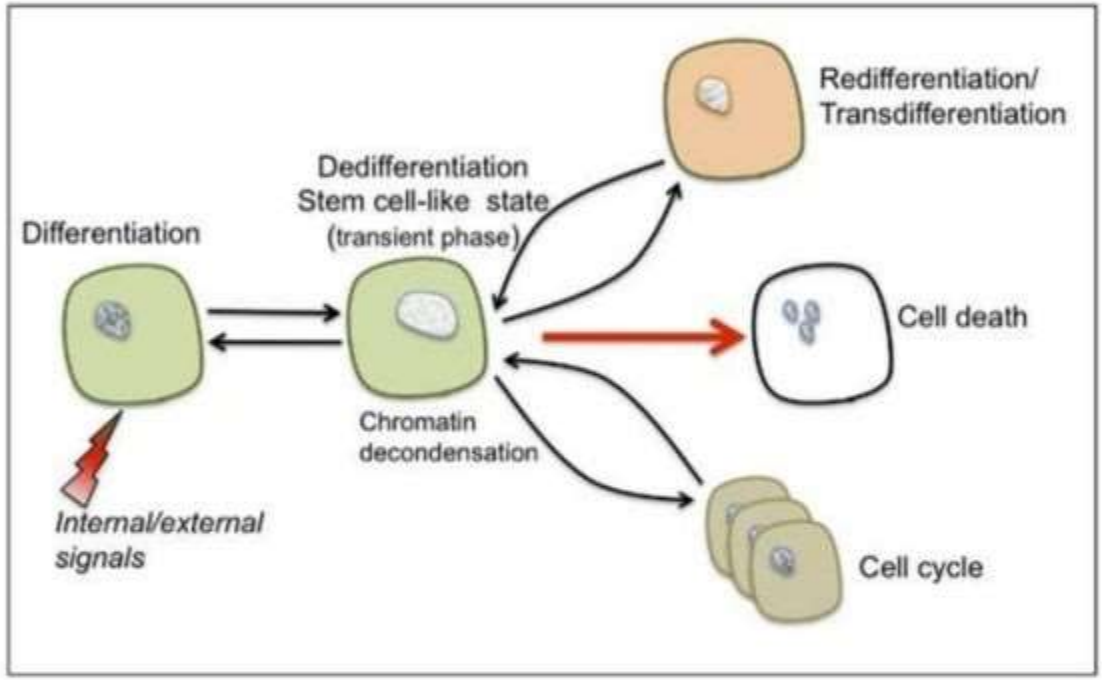
DEDIFFERENTIATION



- Dedifferentiation is an important biological phenomenon whereby cells regress from a specialized function to a simpler state reminiscent of stem cells.
- An undividable differentiated cell sometimes regains the power of division. This process is called dedifferentiation.
- Dedifferentiation is a common process in plants during secondary growth and in wound healing mechanisms.

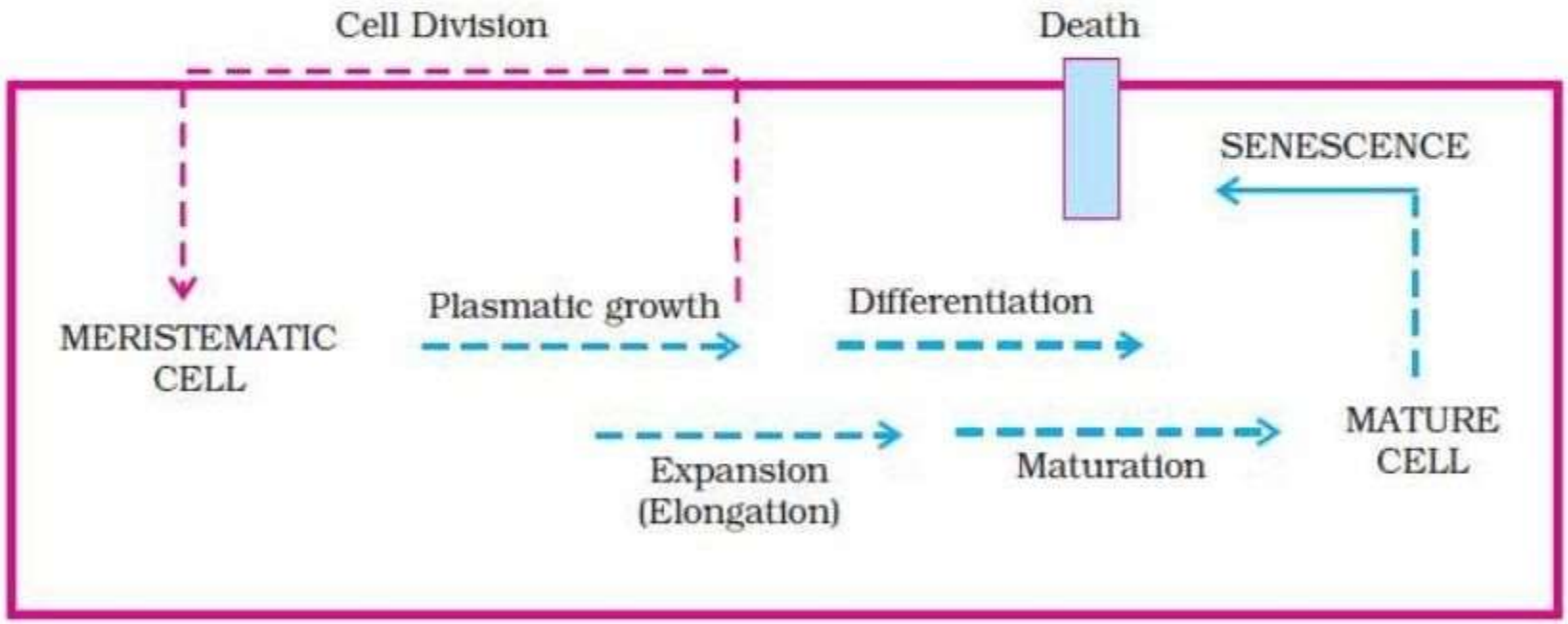
REDIFFERENTIATION

- A dedifferentiated cell can divide and produce new cells.
- New cells produced again loose the power of division and become a part of permanent tissue which is called "redifferentiation'.
- Example:- Formation of tumour cells.



DEVELOPMENT

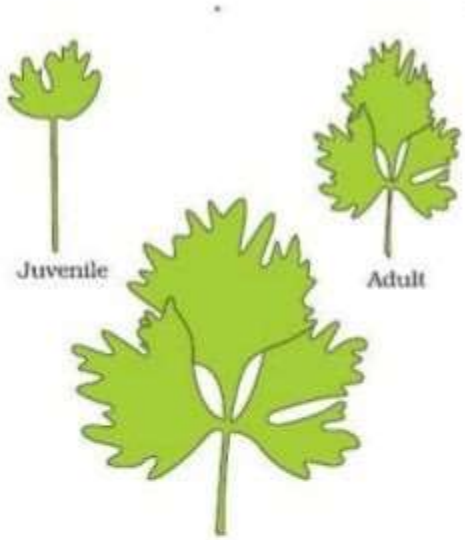
- Development is a term that includes all changes that an organism goes through during its life cycle from germination of the seed to senescence.



Sequence of the developmental process in a plant cell

Plasticity & Heterophylly

- **Plasticity –** The ability of plant to follow different pathways and produce different structures in response to environment and phases of life.
- In cotton & coriander plants, the leaves of the juvenile plant are different in shape from those in mature plants.
- Heterophylly - The phenomenon of appearance of different forms of leaves on the same plant is called heterophylly.
- e.g., heterophylly in cotton coriander and larkspur

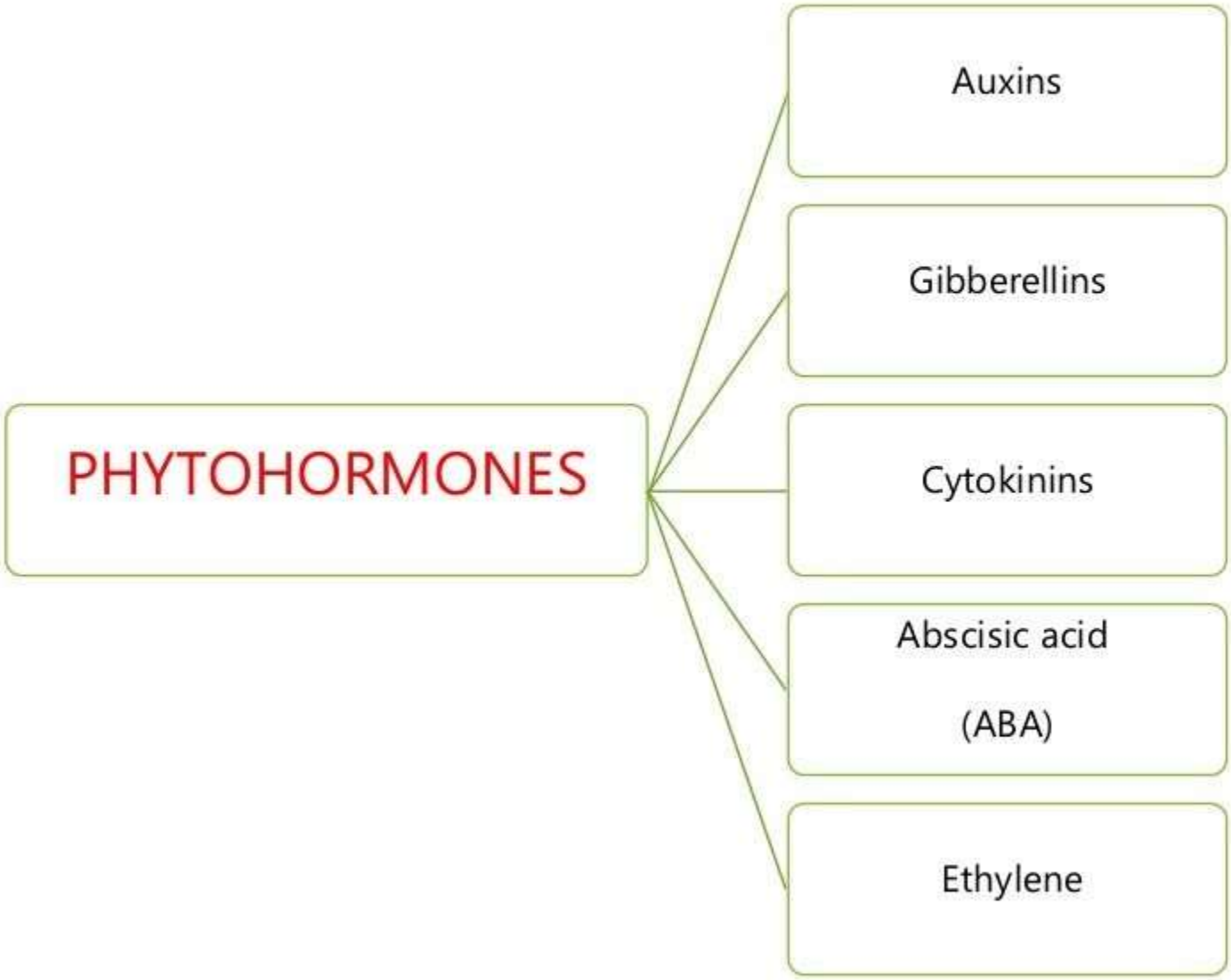


Heterophylly in larkspur (Terrestrial Habitat)

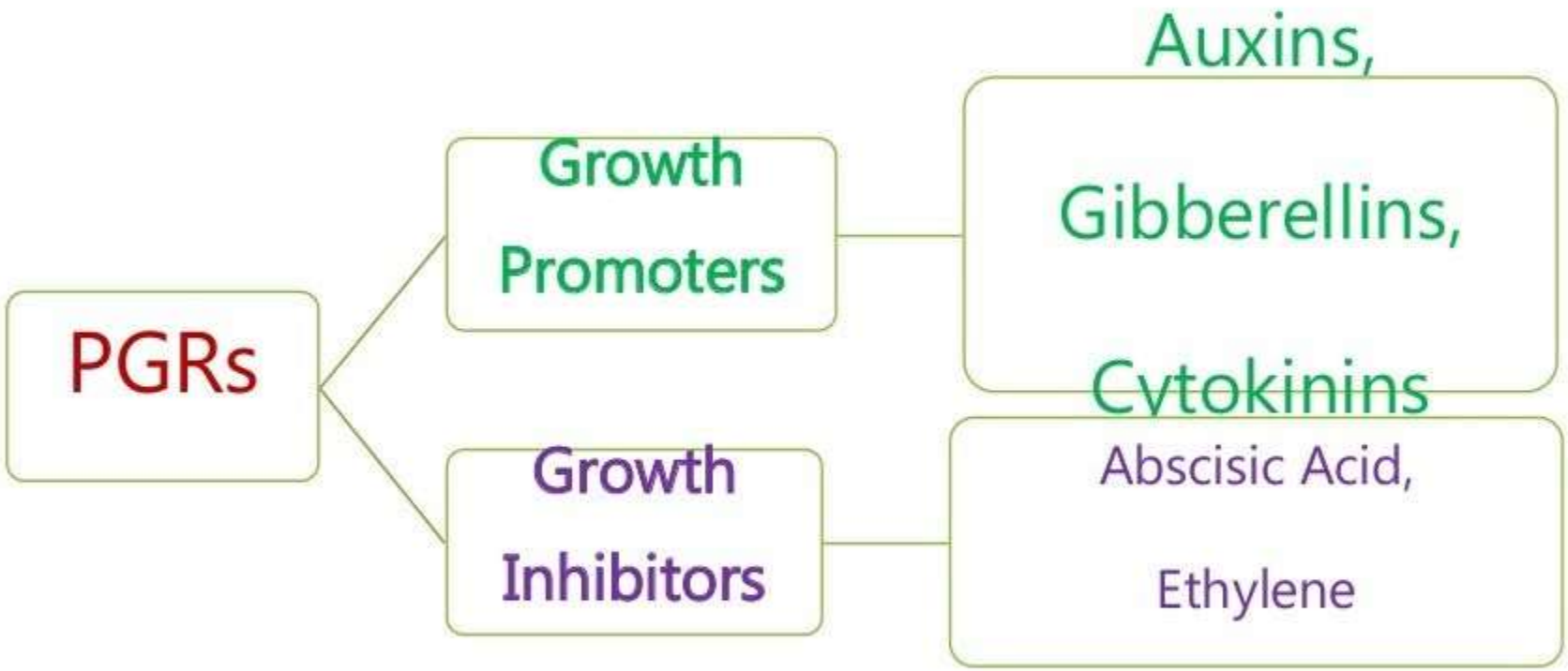
Heterophylly in buttercup (Water Habitat)

PLANT GROWTH REGULATORS

- Plant growth regulators (Phytohormones) are chemical substances that influence the growth and differentiation of plant cells, tissues and organs.
- Plant growth regulators function as chemical messengers for intercellular communication .
- They work together coordinating the growth and development of cells.
- They could be indole compounds (indole-3-acetic acid, IAA); adenine derivatives (N6-furfurylamino purine, kinetin), derivatives of carotenoids (abscisic acid, ABA); terpenes (gibberellic acid, GA3) or gases (ethylene, C_2H_4).


PHYTOHORMONES
Auxins
Gibberellins
Cytokinins
Abscisic acid
(ABA)
Ethylene

Classification of PGRs



AUXINS

- Auxins were discovered by Charles Darwin and Francis Darwin.
- F.W. Went isolated auxins from the tips of coleoptiles of oat seedlings.
- Went developed *Avena* curvature test for bioassay of auxins.

Synthetic Auxins

- IAA - Indole Acetic Acid
- IBA – Indole Butyric Acid
- NAA - Naphthalene Acetic Acid
- 2, 4-D - 2, 4-dichlorophenoxyacetic

Physiological Effects of Auxins

- promote apical dominance
- initiate rooting in stem cuttings
- promote flowering e.g. in pineapples
- prevent fruit and leaf drop at early stages
- promote the abscission of older mature leaves and fruits
- induce parthenocarpy, e.g., in tomatoes
- used as herbicides
- controls xylem differentiation and helps in cell division

GIBBERELLINS

- E. Kurosawa, a Japanese scientist, identified gibbereilins present in a fungal pathogen Gibberella fujikuroi.
- Gibbereilins were isolated from infected rice seedlings when treated with sterile filtrates of fungus.
- Physiological Effects of Gibberelins
- Elongation of intact stems
- Dwarf shoots
- Bolting in rosette plants (e.g., Henbane, Cabbage)
- Overcome the natural dormancy of buds, tubers, seeds etc.
- Seed Germination
- Induce parthenocarpy or development of seedless fruits
- Promote flowering in long day plants
- Vernalization

CYTOKININS

- Skoog and Miller discovered cytokinins.
- Skoog and Miller crystallised the cytokinesis promoting active substance named it kinetin from corn-kernels and coconut milk.

Physiological Effects of Cytokinins

- induce cell-division
- delay the senescence of leaves and other organs
- promotes lateral bud
- increases cell expansion in dicot cotyledons and in leaves
- promotes chloroplast development and chlorophyll synthesis

ETHYLENE

- Cousins confirmed the release of a volatile substance from ripened oranges that hastened the ripening of stored unripened bananas.
- The volatile substance was identified as ethylene.

Physiological Effects of Cytokinins

- promotes senescence and abscission
- inhibits elongation of stems and roots
- Induce fruit ripening
- breaks seed and bud dormancy
- initiates germination in peanut seeds
- sprouting of potato tubers
- promotes root growth and root hair formation
- initiate flowering and for synchronising fruit-set in pineapples

ABSCISIC ACID

- 1963, Frederick T. Addicott and his co-workers identified Abscisic acid.
- ABA was isolated from several abscission-accelerating substances from cotton plants.
- ABA is called stress hormone.

Physiological Effects of Cytokinins

- acts as a general plant growth inhibitor
- induces seed and bud dormancy
- inhibits seed germination
- stimulates the closure of stomata
- plays an important role in seed development, maturation and dormancy

PHOTOPERIODISM

- Photoperiodism is a response of plants to the relative lengths of light and dark periods.
- Some plants require periodic exposure to light to induce flowering.
- Duration of dark period is equally important for flowering.

➢ *Long Day Plants* – Plants that require exposure to light for a period exceeding critical duration to induce flowering.

Example: Pea (*Pisum sativum*), Barley (*Hordeum vulgare*), Wheat (*Triticum aestivum*)

➢ *Short Day Plants* – Plants that require exposure to light for a period less than this critical period to induce flowering.

Example: Rice, Jowar, Cotton

➢ *Day Neutral Plants* – Plants where there is no correlation between exposure to light duration and induction of flowering.

Example: cucumber, rose, and tomato

VERNALISATION

- Vernalisation is the phenomenon of induction of flowering in plants by exposure to low temperature.
- It prevents precocious reproductive development late in the growing season, and enables the plant to have sufficient time to reach maturity.
- Example – Biennial plants
- These are monocarpic plants that flower and then die in second season.
- Examples :- sugar beet, cabbage, carrot, etc.