PLANT GROWTH REGULATOR / PHYTOHORMONE / PLANT HORMONE

* Small
* Simple compound.
* Diversity in chemical composition

GROWTH

→ PROMOTE → PROMOTORS. : Cell div^{N}, cell elongation, flowering, seed germ^{n}, FRUITING,
TROPHIC GROWTH (SHOOT BEND TOWARDS LIGHT : PHOTOTROPHISM)
PATTERN FORMATION. (ROOT, STEM, LEAF FORMATION,
TO RELOCATE PARTICULAR CELL IN PARTICULAR LOCATION.
↓
PERFORM PARTICULAR FUNCTION.
eg : AUXIN
GIBBERELIN
CYTOKININ

→ INHIBIT → INHIBITOR. eg ABSCISSIC ACID (ABA).

→ DORMANCY IN SEED.
↓
NO GERMINATION

→ ABSCISSION
Falling of young leaf / flower

NOTE : ETHYLENE CAN FIT EITHER OF TWO CATEGORY.
↓
maximum activity (INHIBITORY).

AUXIN

EXPERIMENT

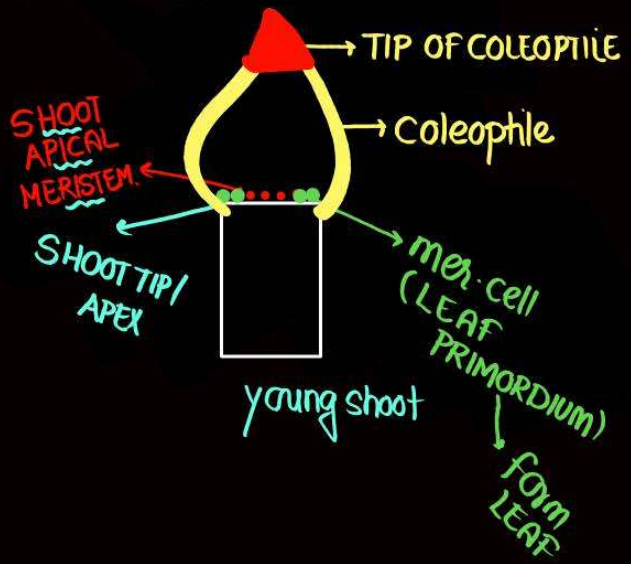
CHARLES DARWIN & FRANCIS DARWIN

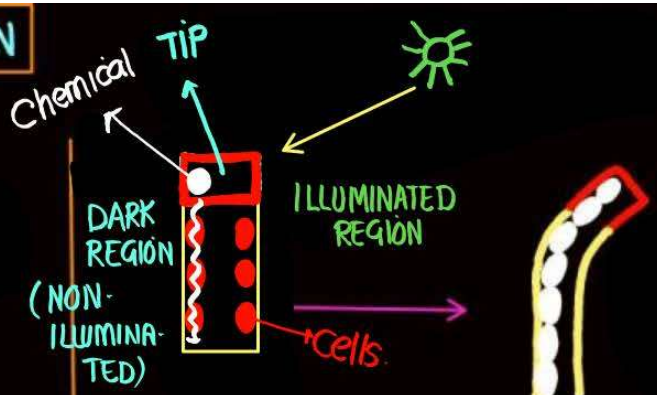
↓

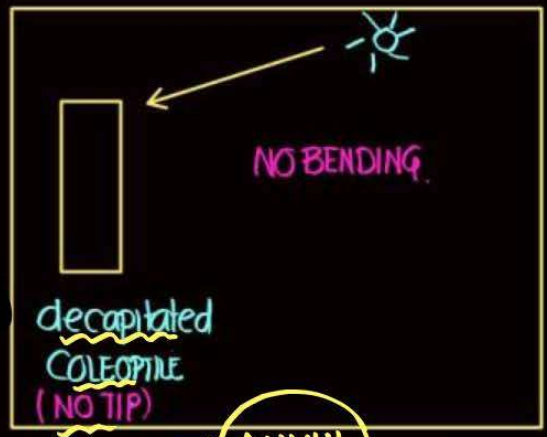
CANARY GRASS / PHALARIS

↓

TAKEN **COLEOPTILE** ← PLUMULE → COVERING (FORM SHOOT).







Coleoptile / YOUNG SHOOT

LIGHT (STIMULUS) → FALL ON TIP OF COLEOPTILE/SHOOT → SENSATION (CHEMICAL PRODUCED) → AUXIN

THIS CHEMICAL ACCUMULATED IN DARK/SHADED REGION → CHEMICAL DIFFUSE FROM TIP TO BASE → available for cells in dark Region → cells show more growth

Compare to cells of LIGHTED REGION

↓

BENDING OF SHOOT TOWARDS LIGHT (PHOTOTROPHISM)

F.W WENT: ISOLATE CHEMICAL (AUXIN)

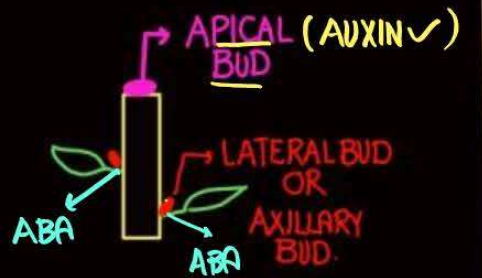
discovery

OAT / AVENA SATIVA

HUMAN URINE: AUXIN ISOLATE.

ROLE OF AUXIN

① APICAL DOMINANCE



⇒ PRESENSE OF APICAL BUD (AUXIN) inhibit germination of Lateral BUD

↓

NO LATERAL BRANCH

↓

NO LEAVES./less in number.

⇒ accumulation of ABA at lateral BUD. (INHIBITOR)

⇒ CYTOKININ SUPPLY INHIBIT AT LATERL BUD.

* If you Remove apical BUD

LATERL BUD → GERMINATE.

→ LATERAL BRANCH → MORE LEAVES.

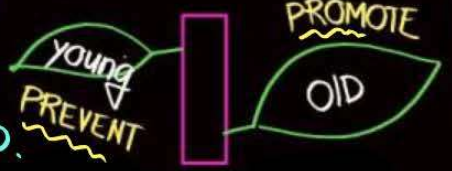
TEA PRODUCTION, HEDGES MAKING

↓

APICAL BUD REMOVE OR AUXIN

② ABSCISSION (PREVENT)

Falling of leaves, flower, FRUIT ETC.



③ FLOWERING IN PINEAPPLE

④ PARTHENOCARPY IN TOMATO.

SHOOT TIP
ROOT TIP

⑤ PROMOTE GROWTH OF LATERAL ROOT ON STEM CUTTING

⑥ NOTE: TYPES OF AUXIN

NATURAL	SYNTHETIC
* Isolate from plant	NAA (Napthalene acetic acid)
IAA (INDOLE-3-ACETIC ACID)	2,4-D (2,4 DICHLORO-PHENOXY ACETIC ACID)
IBA (INDULE-3 BUTYRIC ACID)	

(weed free lawn)
→ weedicide (Remove weed)
→ KILL DICOT
→ BUT NOT KILL MONOCOT.

⑦ XYLEM DIFFERENTIATION

HIGH AUXIN → XYLEM

⑧ CELL DIVISION (TISSUE CULTURE)

INDOLE DERIVATIVE

TRYTOPHAN → AUXIN SYNTHESIS

⑨ AGRICULTURE & HORTICULTURE

→ VEGETABLES
→ FLOWER
→ ORNAMENTAL

GA

★ Japanese farmer → RICE PLANT
Tall, Thin, yellow.

★ KUROSAWA: RICE PLANT → INFECTION → FUNGUS
GIBBERELA (BAKANE DISEASE / FOOLISH SEEDLING DISEASE).

CHEMICAL ISOLATE → GIBBERELIN GA_3 → SYNTHETIC → COMMERCIAL LEVEL.

more than 100 GA: study
GA_1, GA_2, GA_3 . . . . . .
GA_1 → Bean plant
NATURAL

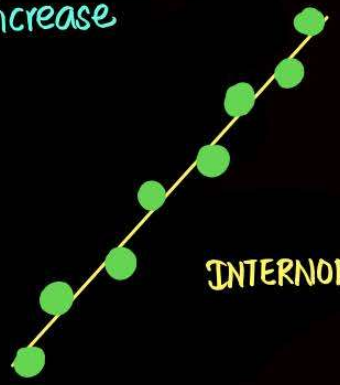
ROLE

GRAPES, APPLE: shape, size increase

GA →

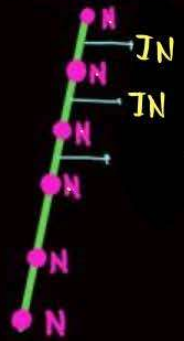
Stalk of fruit → Length (less)

INTERNODE SHORT



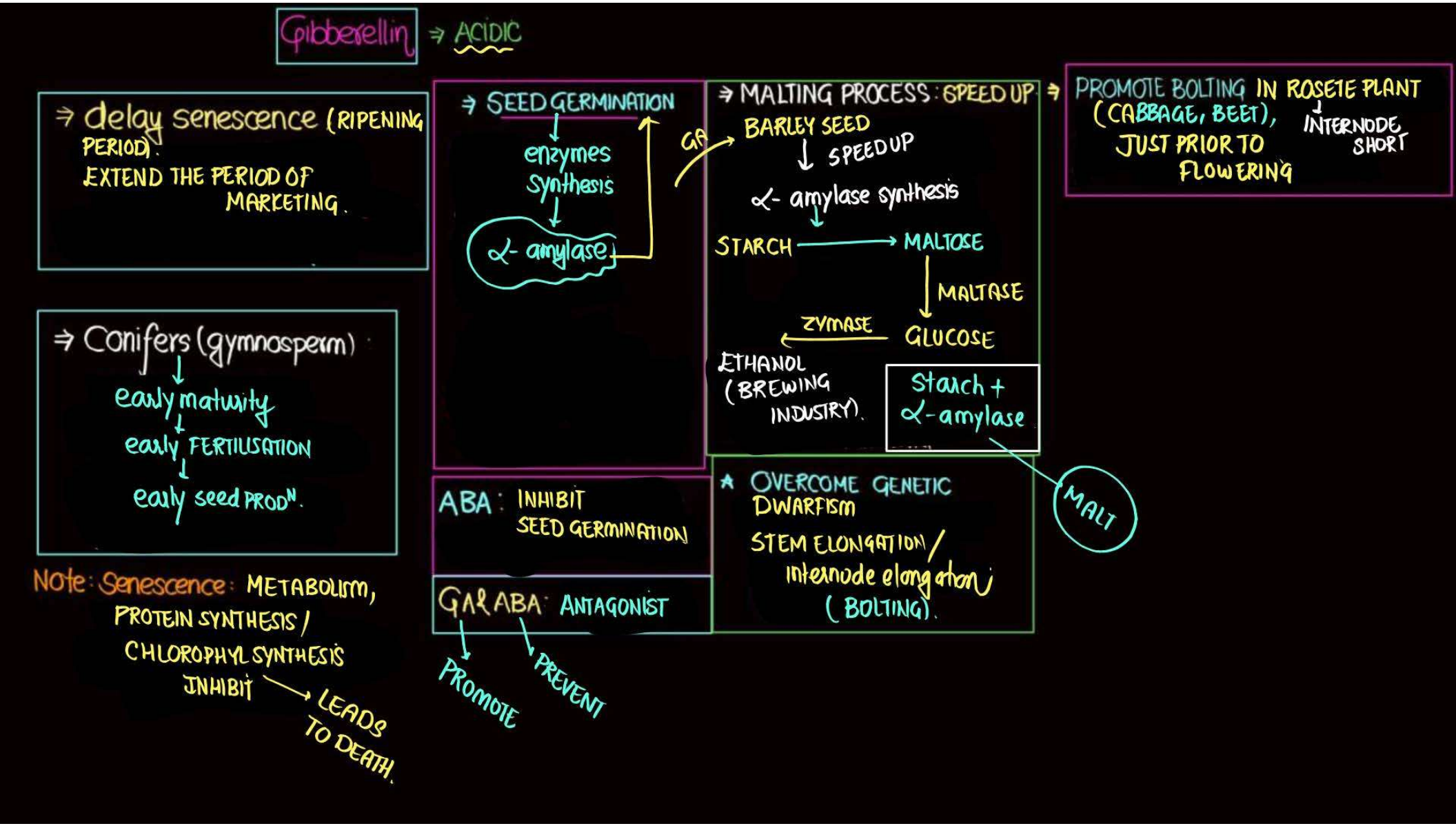
INTERNODE LONG.

LENGTH OF SUGARCANE



GA →
Length increase
INTERNODE ELONGATION

SUGAR PRODN INCREASE
20 TONNES PER ACRE.


Gibberellin ⇒ ACIDIC
⇒ delay senescence (RIPENING PERIOD).
EXTEND THE PERIOD OF MARKETING.
⇒ Conifers (gymnosperm)
early maturity
early FERTILISATION
early seed PROD^N.
Note: Senescence: METABOLISM, PROTEIN SYNTHESIS / CHLOROPHYL SYNTHESIS
INHIBIT → LEADS TO DEATH.
⇒ SEED GERMINATION
enzymes synthesis
α- amylase
GA
⇒ MALTING PROCESS: SPEED UP
BARLEY SEED
SPEED UP
α- amylase synthesis
STARCH → MALTOSE
MALTASE
GLUCOSE
ZYMASE
ETHANOL (BREWING INDUSTRY).
Starch + α-amylase
MALT
⇒ PROMOTE BOLTING IN ROSETE PLANT (CABBAGE, BEET), JUST PRIOR TO FLOWERING
INTERNODE SHORT
ABA: INHIBIT SEED GERMINATION
GA & ABA: ANTAGONIST
PROMOTE
PREVENT
* OVERCOME GENETIC DWARFISM
STEM ELONGATION / internode elongation (BOLTING).

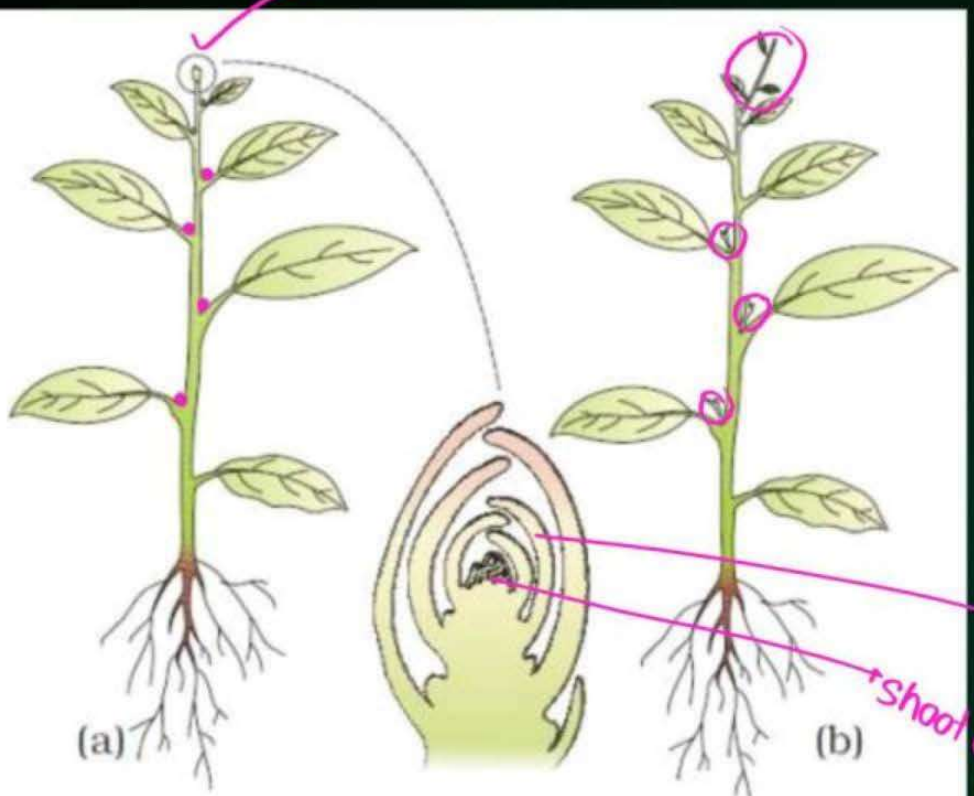
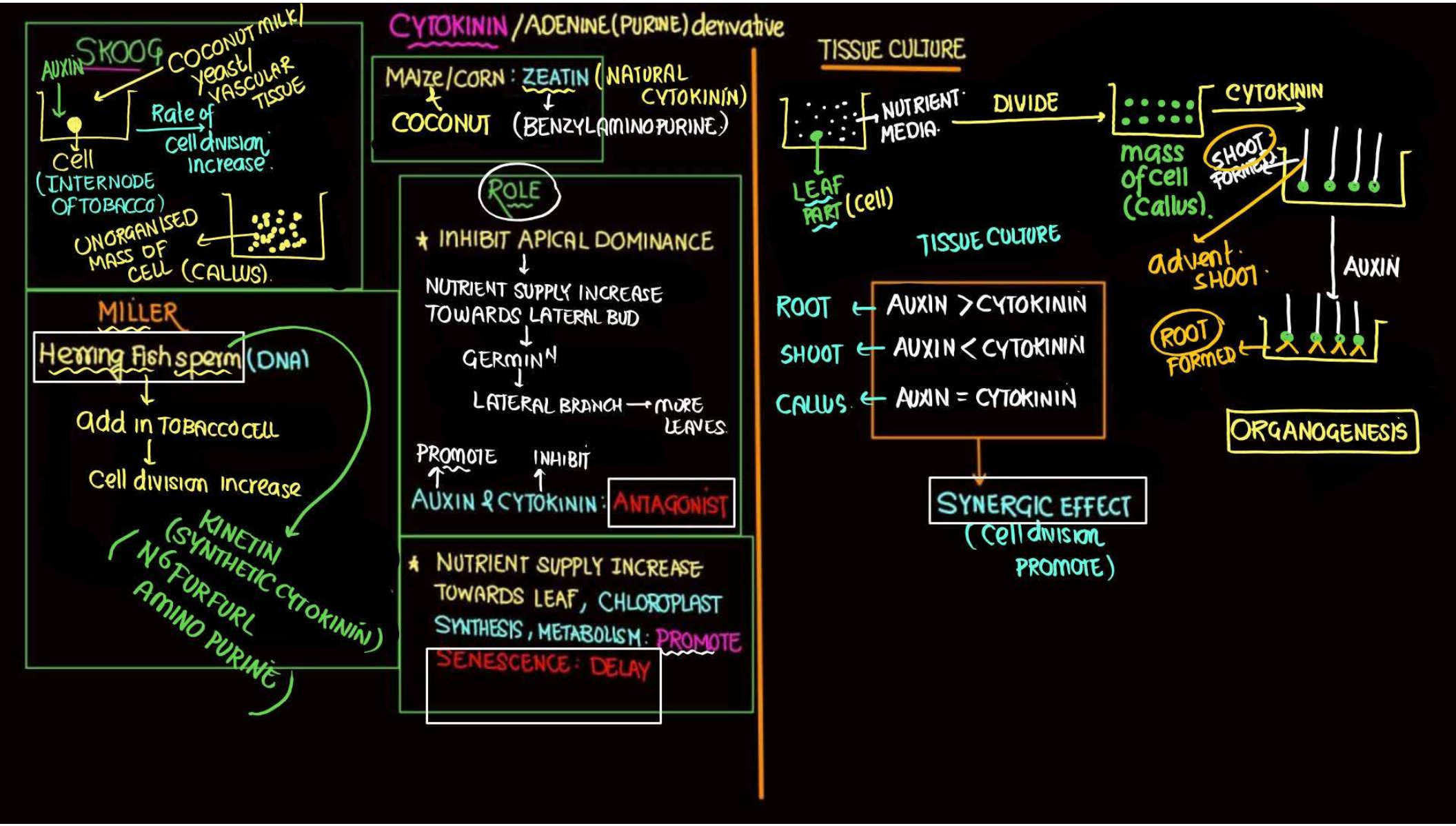


Figure 13.11 Apical dominance in plants :
(a) A plant with apical bud intact
(b) A plant with apical bud removed
Note the growth of lateral buds into branches after decapitation.


SKOOG
AUXIN
COCONUT MILK/ Yeast/ VASCULAR TISSUE
Rate of cell division increase
Cell (INTERNODE OF TOBACCO)
UNORGANISED MASS OF CELL (CALLUS)
MILLER
Herring Fish sperm (DNA)
add in TOBACCO CELL
Cell division increase
KINETIN (SYNTHETIC CYTOKININ)
(N6 FURFURL AMINO PURINE)
CYTOKININ / ADENINE (PURINE) derivative
MAIZE/CORN : ZEATIN (NATURAL CYTOKININ)
COCONUT (BENZYLAMINOPURINE)
ROLE
* INHIBIT APICAL DOMINANCE
NUTRIENT SUPPLY INCREASE TOWARDS LATERAL BUD
GERMINN
LATERAL BRANCH → MORE LEAVES
PROMOTE
INHIBIT
AUXIN & CYTOKININ : ANTAGONIST
* NUTRIENT SUPPLY INCREASE TOWARDS LEAF, CHLOROPLAST SYNTHESIS, METABOLISM : PROMOTE
SENESCENCE : DELAY
TISSUE CULTURE
NUTRIENT MEDIA
DIVIDE
LEAF PART (cell)
mass of cell (Callus)
CYTOKININ
SHOOT FORMED
advent. SHOOT
AUXIN
ROOT FORMED
TISSUE CULTURE
ROOT ← AUXIN > CYTOKININ
SHOOT ← AUXIN < CYTOKININ
CALLUS ← AUXIN = CYTOKININ
SYNERGIC EFFECT
(Cell division PROMOTE)
ORGANOGENESIS

ABA

GROWTH INHIBITOR.

⇒ PROMOTE

INHIBIT : METABOLISM,
PROTEIN SYNTHESIS,
CHLOROPHYL SYNTHESIS,
SEED GERMINATION

PROMOTE : → ABSCISSION
→ SENESCENCE

STRESS CONDITION (HORMONE) : DROUGHT : H_2O LESS
↓
STOMATA : CLOSED
TRANSPIRATION : DECREASE

NOTE: Synthesis of
PROTEIN
↓
HELP
SEED MATURATION

Chemical same :

Composition : Inhibitor-β
Abscission-II
DORMIN
→ Isolated from diff source.

ABA

Topic : NCERT BOOSTER

13.4.3.3 Cytokinins

Cytokinins have specific effects on cytokinesis, and were discovered as kinetin (a modified form of adenine, a purine) from the autoclaved herring sperm DNA. Kinetin does not occur naturally in plants. Search for natural substances with cytokinin-like activities led to the isolation of zeatin from corn-kernels and coconut milk. Since the discovery of zeatin, several naturally occurring cytokinins, and some synthetic compounds with cell division promoting activity, have been identified.

Natural cytokinins are synthesised in regions where rapid cell division occurs, for example, root apices, developing shoot buds, young fruits etc. It helps to produce new leaves, chloroplasts in leaves, lateral shoot growth and adventitious shoot formation. Cytokinins help overcome the apical dominance. They promote nutrient mobilisation which helps in the delay of leaf senescence.

13.4.3.5 Abscisic acid

PROMOTE

As mentioned earlier, abscisic acid **(ABA)** was discovered for its role in regulating abscission and dormancy. But like other PGRs, it also has other wide ranging effects on plant growth and development. It acts as a general plant growth inhibitor and an inhibitor of plant metabolism. ABA inhibits seed germination. ABA stimulates the closure of stomata and increases the tolerance of plants to various kinds of stresses.

Therefore, it is also called the stress hormone. ABA plays an important role in seed development, maturation and dormancy. By inducing dormancy, ABA helps seeds to withstand desiccation and other factors unfavourable for growth. In most situations, ABA acts as an antagonist to GAs.

seed germ^n.

जिवा-रक्षा है

dry condr

13.4.2 The Discovery of Plant Growth Regulators

Interestingly, the discovery of each of the five major groups of PGRs have been accidental. → By Luck.
All this started with the observation of Charles Darwin and his son Francis Darwin when they observed that the coleoptiles of canary grass Phalans.
responded to unilateral illumination by growing towards the light source (phototropism).

After a series of experiments, it was concluded that the tip of coleoptile was the site of transmittable influence that caused the bending of the entire coleoptile (Figure 13.10). Auxin was isolated by F.W. Went from tips of coleoptiles of oat seedlings.

Chemical / AUXIN

AVENA.

The 'bakanae' (foolish seedling) disease of rice seedlings, was caused by a fungal pathogen *Gibberella fujikuroi*. E. Kurosawa (1926) reported the appearance of symptoms of the disease in rice seedlings when they were treated with sterile filtrates of the fungus. The active substances were later identified as gibberellic acid.

F. Skoog and his co-workers observed that from the internodal segments of tobacco stems the callus (a mass of undifferentiated cells) proliferated only if, in addition to auxins the nutrients medium was supplemented with one of the following: extracts of vascular tissues, yeast extract, coconut milk or DNA. Miller et al. (1955), later identified and crystallised the cytokinesis promoting active substance that they termed kinetin. (Herring fish sperm)

During mid-1960s, three independent researches reported the purification and chemical characterisation of three different kinds of inhibitors: inhibitor-B, abscission II and dormin. Later all the three were proved to be chemically identical. It was named abscisic acid (ABA).

13.4.3.2 Gibberellins

Gibberellins are another kind of promotory PGR. There are more than 100 gibberellins reported from widely different organisms such as fungi and higher plants. They are denoted as GA_1, GA_2, GA_3 and so on. However, Gibberellic acid (GA_3) was one of the first gibberellins to be discovered and remains the most intensively studied form.

All GAs are acidic. They produce a wide range of physiological responses in the plants. Their ability to cause an increase in length of axis is used to increase the length of grapes stalks. Gibberellins, cause fruits like apple to elongate and improve its shape. They also delay senescence. Thus, the fruits can be left on the tree longer so as to extend the market period. GA_3 is used to speed up the malting process in brewing industry.

Sugarcane stores carbohydrate as sugar in their stems. Spraying sugarcane crop with gibberellins increases the length of the stem, thus increasing the yield by as much as 20 tonnes per acre.

Spraying juvenile conifers with GAs hastens the maturity period, thus leading to early seed production. Gibberellins also promotes bolting (internode elongation just prior to flowering) in beet, cabbages and many plants with rosette habit.

2nd year.

Internode short

1st

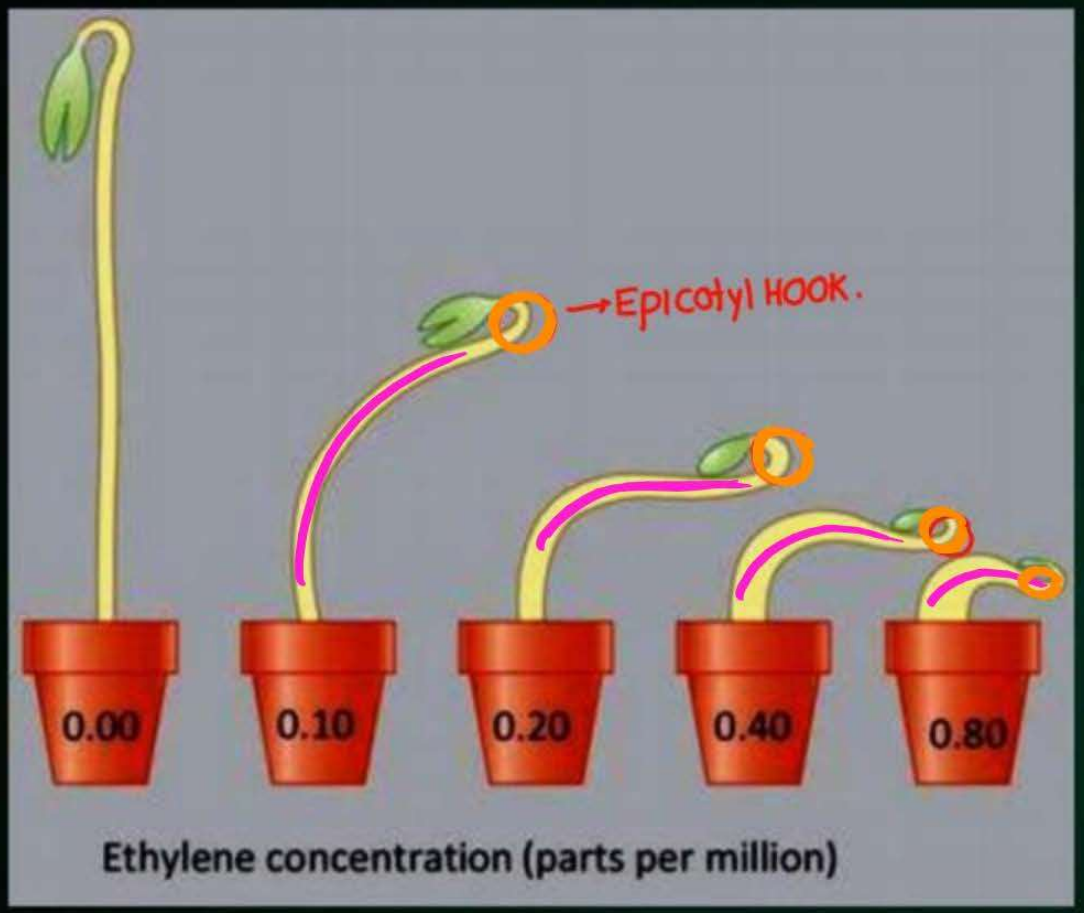
Bolting: inhibit

2nd.

Internode elongate

Stem: develop.

Promote (Bolting)



Ethylene

DICOT SEED IN SOIL
↓
SEEDLING

HORIZONTAL GROWTH.
SWELLING OF AXIS
TIP OF SHOOT → BED → HOOK FORMTN

TRIPLE RESPONSE.

ETHYLENE

FRUIT RIPENING HORMONE

ALREADY EXPLAINED ← TRIPLE RESPONSE

* Gaseous HORMONE, COUSIN

ORANGE → UNRIPENED BANANA (gas)

↓ RIPENING

RATE OF RESPIRATION:
INCREASE DURING RIPENING OF FRUIT

CLIMACTERIC RESPIRATION

* FLOWERING: PINE APPLE, MANGO
* SENESCENCE, ABSCISSION: PROMOTE

GA, CYTOKININ —INHIBIT→ SENESCENCE

ABA, Ethylene —PROMOTE→ SENESCENCE

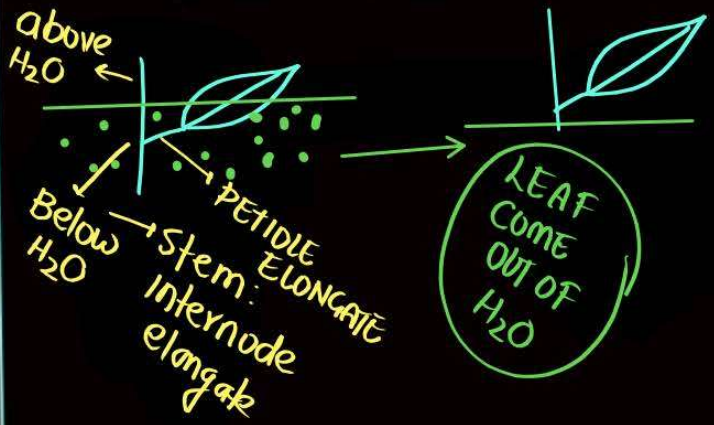
ANTAGONIST

⇒ ROOT GROWTH/ROOT HAIR FORMTN
ABSORPTION INCREASE

⇒ SEED GERMINATION: PEA

⇒ POTATO/TUBER: BUD DORMANCY BREAK

⇒ PETIOLE (RICE PLANT)



Ethepon (aqueous soln)

SPRAY

Ethepon —metabolism→ Ethylene

H.H. Cousins (1910) confirmed the release of a volatile substance from ripened oranges that hastened the ripening of stored unripened bananas. Later this volatile substance was identified as ethylene, a gaseous PGR.

Let us study some of the physiological effects of these five categories of PGRs in the next section.

13.4 Plant Growth Regulators

13.4.1 Characteristics

The plant growth regulators (PGRs) are small, simple molecules of diverse chemical composition. They could be indole compounds (indole-3-acetic acid, IAA); adenine derivatives (N^6-furfurylamino purine, kinetin), derivatives of carotenoids (abscisic acid, ABA); terpenes (gibberellic acid, GA_3) or gases (ethylene, C_2H_4). Plant growth regulators are variously described as plant growth substances, plant hormones or phytohormones in literature.

AUXIN (INDOLE / TRYPTOPHAN DERIVATIVE)

Cytokinin

methionine

The PGRs can be broadly divided into two groups based on their functions in a living plant body. One group of PGRs are involved in growth promoting activities, such as cell division, cell enlargement, pattern formation, tropic growth, flowering, fruiting and seed formation. These are also called plant growth promoters, e.g., auxins, gibberellins and cytokinins. The PGRs of the other group play an important role in plant responses to wounds and stresses of biotic and abiotic origin. They are also involved in various growth inhibiting activities such as dormancy and abscission. The PGR abscisic acid belongs to this group. The gaseous PGR, ethylene, could fit either of the groups, but it is largely an inhibitor of growth activities.

Photoperiodism

cell attain particular structure, shape, size, FUNCTION

PROMOTER OR INHIBITOR

13.4.3.4 Ethylene

Ethylene is a simple gaseous PGR. It is synthesised in large amounts by tissues undergoing senescence and ripening fruits. Influences of ethylene on plants include horizontal growth of seedlings, swelling of the axis and apical hook formation in dicot seedlings. Ethylene promotes senescence and abscission of plant organs especially of leaves and flowers. Ethylene is highly effective in fruit ripening. It enhances the respiration rate during ripening of the fruits. This rise in rate of respiration is called respiratory climactic.

Ethylene breaks seed and bud dormancy, initiates germination in peanut seeds, sprouting of potato tubers. Ethylene promotes rapid internode/petiole elongation in deep water rice plants. It helps leaves/ upper parts of the shoot to remain above water. Ethylene also promotes root growth and root hair formation, thus helping the plants to increase their absorption surface.

Ethylene is used to initiate flowering and for synchronising fruit-set in pineapples. It also induces flowering in mango. Since ethylene regulates so many physiological processes, it is one of the most widely used PGR in agriculture. The most widely used compound as source of ethylene is ethephon. Ethephon in an aqueous solution is readily absorbed and transported within the plant and releases ethylene slowly. Ethephon hastens fruit ripening in tomatoes and apples and accelerates abscission in flowers and fruits (thinning of cotton, cherry, walnut). It promotes female flowers in cucumbers thereby increasing the yield.

SPEED UP

PROMOTE

helps in

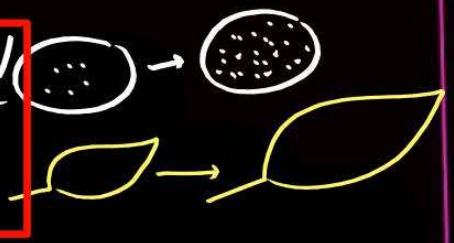
Compare to male flower

Male flower no increase : Gibberelin

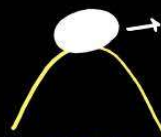
Femaleness
Auxin, Cytokinin, Ethylene

GROWTH

★ INCREASE IN
- NUMBER OF CELL.
- NUMBER OF INDN-IDUAL.
- SIZE OF ORGAN.



★ FUNDAMENTAL PROPERY → also shown BY NONLIVING



→ snow deposition → snow disappear.

MOUNTAIN → size increase ↓ growth.

Reversible

LIVING: IRREVERSIBLE

→ NEED ENERGY.

FROM METABOLISM

Wood (solid) → H_2O → wood swell → imbibition.
(NON-LIVING).

H_2O Remove → wood Regain its shape

Reversible

PLANT GROWTH

⇒ CONTINOUS / UnLimited / Indefinite

SHOOT → MERISTEMATIC CELL → CONTINUOUS DIVIDE → LENGTH OF ROOT, STEM → INCREASE → PRIMARY GROWTH

ROOT →

OPEN TYPE OF GROWTH

(M.C)
⇒ MERISTEMATIC CELL (DIVIDING CELL) → divide → Mer. cell (NUMBER INCREASE) → differenthation (stop division) → permanent Tissue (parenchyma)

FORM → ORGAN OF PLANT → LEAF (MESOPHYLL CELL) PARENCHYMA TOUS TISSUE

GROWTH IS MEASURABLE

⇒ GROWTH ∝ PROTOPLASM → measurement difficult

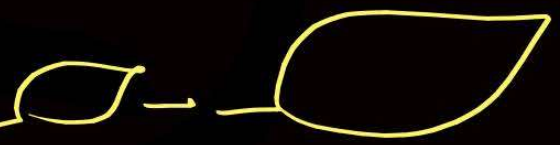
INCREASE (CONTENT OF NUCLEUS & CYTOPLASM INCREASE)

SO WE MEASURE SOME DIFFERENT PARAMETER.

* Number: Maize: ROOT TIP → ONE CELL DIVIDE → 17500 Cell produce / hour

* SIZE: (volume)
  - WATERMELON: Cell size increase 350,000 Times

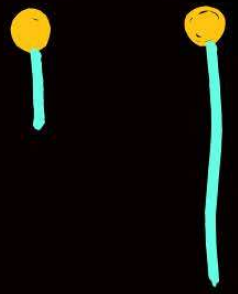
* SURFACE AREA: Leaf (increase)



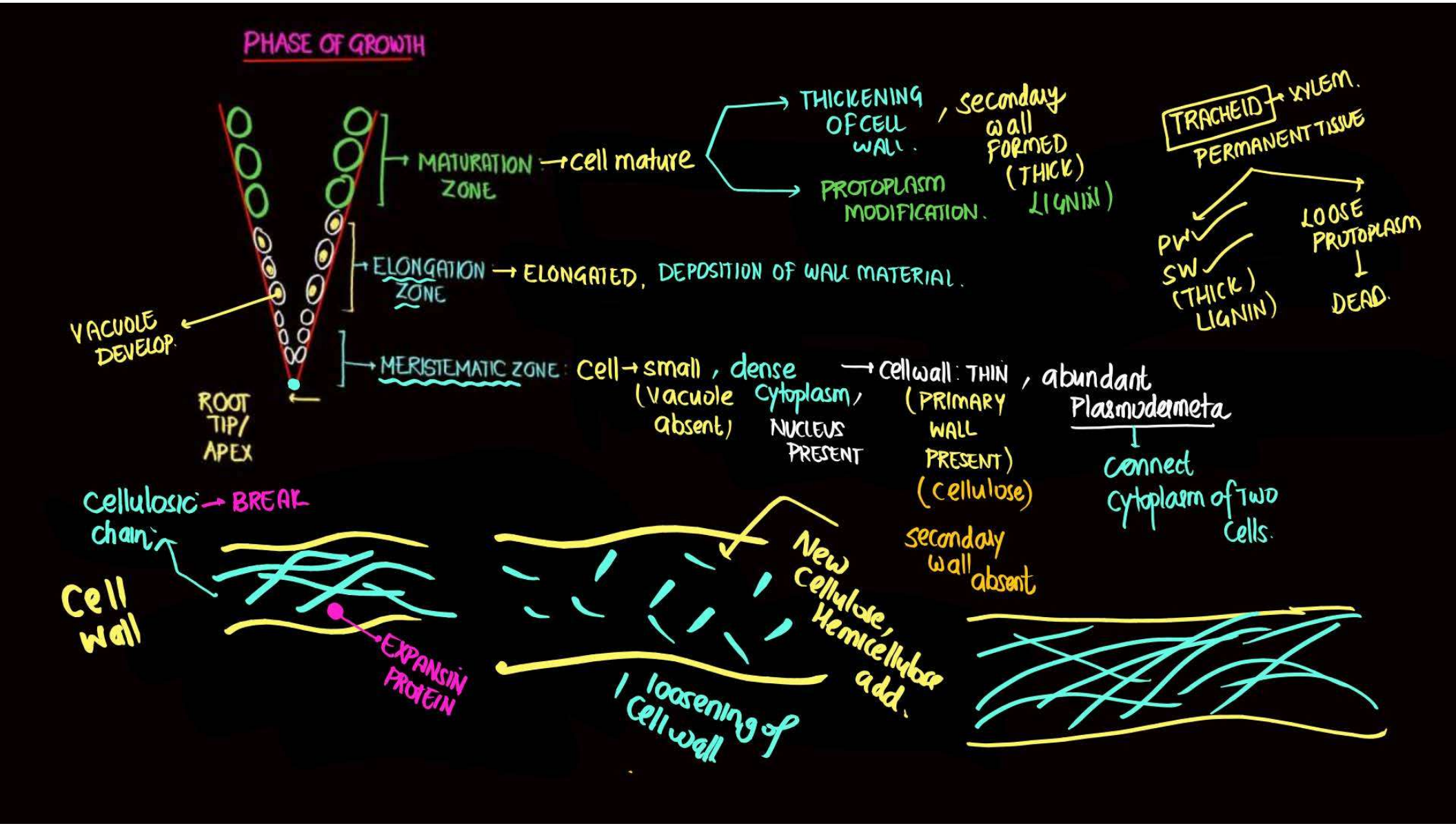
* LENGTH:

* FRESH WEIGHT: DRY WEIGHT + H_2O.

POLLEN GRAIN



Length of pollen Tube ↑.


PHASE OF GROWTH
MATURATION ZONE → cell mature
THICKENING OF CELL WALL, secondary wall FORMED (THICK) LIGNIN)
PROTOPLASM MODIFICATION.
TRACHEID → XYLEM. PERMANENT TISSUE
PW
SW (THICK) LIGNIN)
LOOSE PROTOPLASM
DEAD.
ELONGATION ZONE → ELONGATED, DEPOSITION OF WALL MATERIAL.
VACUOLE DEVELOP.
MERISTEMATIC ZONE: Cell → small, dense (Vacuole absent) Cytoplasm, NUCLEUS PRESENT → Cellwall: THIN, (PRIMARY WALL PRESENT) (cellulose)
abundant Plasmodemeta
connect Cytoplasm of two Cells.
ROOT TIP/ APEX
Cellulosic chain → BREAK
Cell wall
EXPANSIN PROTEIN
New Cellulose, Hemicellulose add.
loosening of Cell wall
secondary wall absent

Differentiation, Dedifferentiation, Redifferentiation

Differentiation

Mer. Cell. (division)

stop division

Permanent Tissue

TRACHERY ELEMENT (TRACHEID, VESSELS)

Cells of xylem (H_2O CONDUCTION)

WATER + XYLEM WALL

H_2O

H_2O

H_2O

loose PROTOPLASM

CAVITY FORMED (LUMEN)

H_2O CONDUCTION

Primary wall

Secondary wall (LIGNIN)

FORCE OF ATTRACTION (COHESION)

adhesion

Dedifferentiation

diff^{N}.

dediff^{N}.

Regain capacity of division

merist cell

Perm. Tissue (NOT DIVIDE)

meris. cell.

NEET

TISSUE CULTURE

LEAF

dediff^{n}.

meristcell.

PARENCHYMA (PERMANENT TISSUE)

NUTRIENT MEDIA

Interfascicular Cambium

CORK CAMBIUM

Redifferentiation

mer. cell. div^{n}

↓ differentiation

perm. Tissue. — Cell NOT DIVIDING

↓ dediff^{n}. — ↓ Cell Regain capacity of div^{n}.

mer. cell.

↓ Rediff^{n}

perm. Tissue.

eg: sec. xylem
sec. phloem
CORK.
Secondary CORTEX

CONDITION FOR GROWTH

NUTRIENTS ✓

⇒ Nitrogenous compound: synthesis protoplasm

⇒ Carbohydrate: energy, cell wall synthesis

⇒ MICRONUTRIENT & MACRONUTRIENT ✓

TEMPERATURE

⇒ 25 - 30°C

⇒ MORE TEMP: DENATURAION OF ENZYMES

⇒ LOW TEMP: INACTIVATE ENZYME

LIGHT

⇒ Chlorophyll synthesis

⇒ Flowering

H_2O

* enter into cell ✓
  ↓
  cell swell (TURGIDITY) ✓
  ↓
  EXPANSION/ELONGATION IN CELL
* also provide medium for enzyme action

Oxygen

* Aerobic Resp^n ✓
* glucose Breakdown.

Gravity

* Determine ROOT, SHOOT

13.1.4 Growth Rates

50 Bact → 20 minute → 100 Bact (In Terms of number)

The increased growth per unit time is termed as growth rate. Thus, rate of growth can be expressed mathematically. An organism, or a part of the organism can produce more cells in a variety of ways.

Bacteria

Leaf of plant

The growth rate shows an increase that may be arithmetic or geometrical (Figure 13.4).

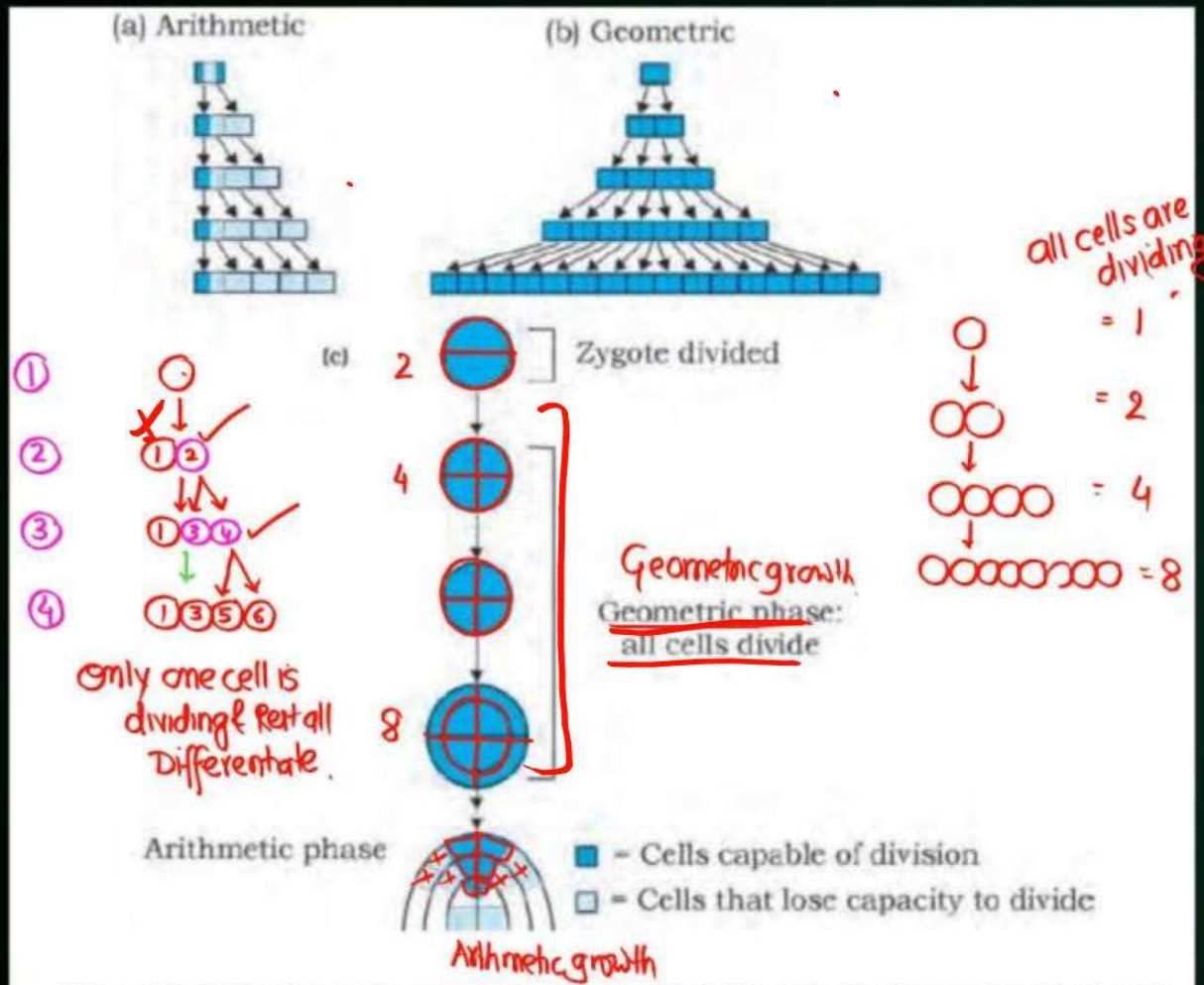


Figure 13.4 Diagrammatic representation of : (a) Arithmetic (b) Geometric growth and (c) Stages during embryo development showing geometric and arithematic phases

all cells are dividing

= 1

= 2

= 4

= 8

Only one cell is dividing & rest all Differentiate.

Geomet growth > Arithmetic growth

Initial : geometric growth. → dev. of zygote

Later : arth. growth

In arithmetic growth, following mitotic cell division, only one daughter cell continues to divide while the other differentiates and matures. The simplest expression of arithmetic growth is exemplified by a root elongating at a constant rate. Look at Figure 13.5. On plotting the length of the organ against time, a linear curve is obtained. Mathematically, it is expressed as

$L_t = L_0 + rt$

(L_0: initial)

L_t = length at time 't'

L_0 = length at time 'zero'

r = growth rate / elongation per unit time.

straight line
(Linear curve)

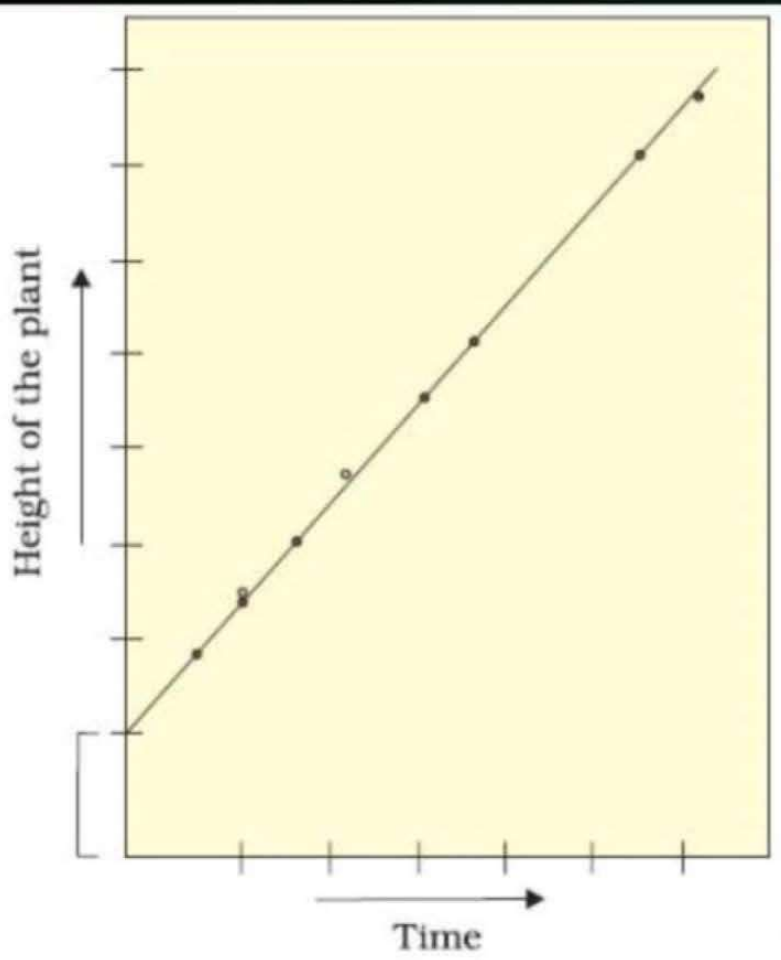
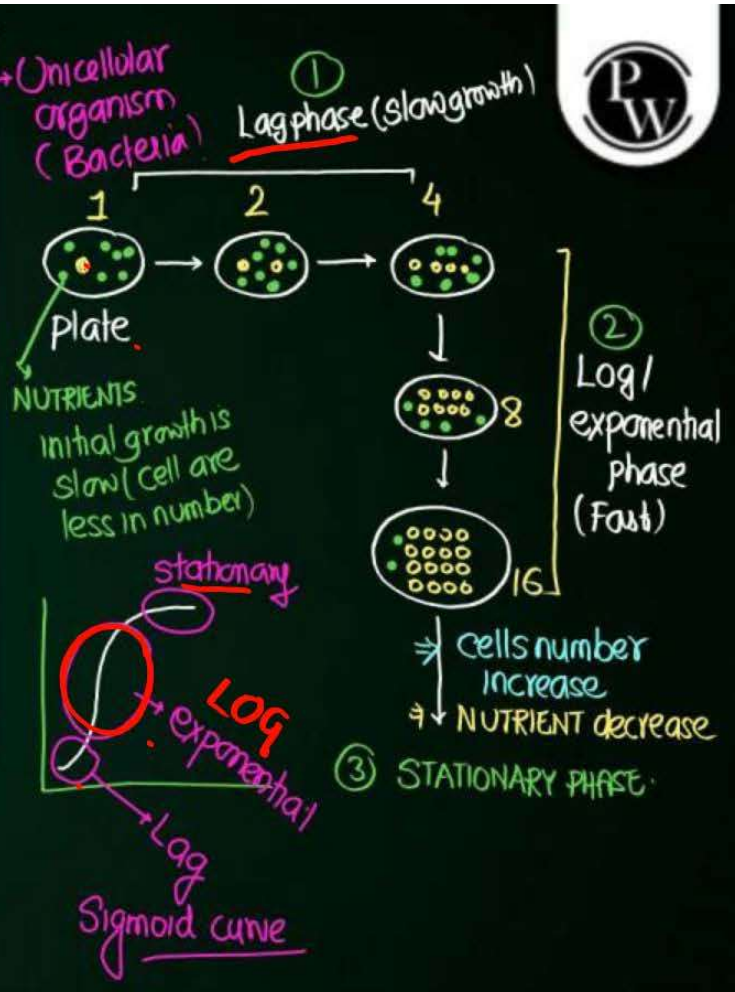


Figure 13.5 Constant linear growth, a plot of length L against time t

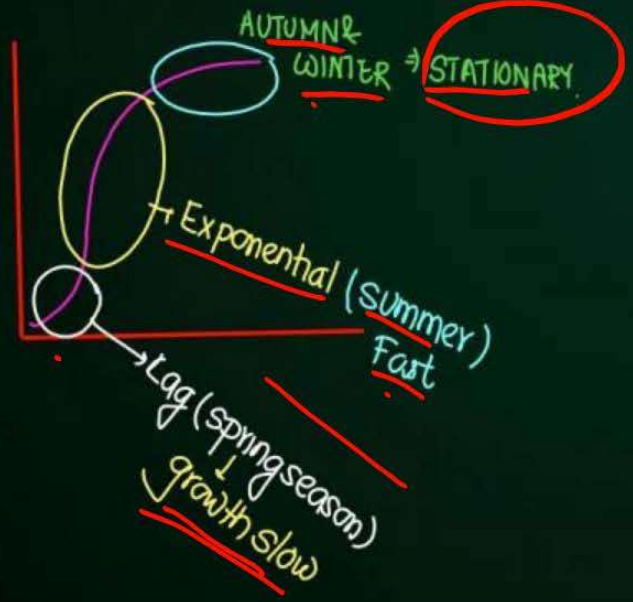
Let us now see what happens in geometrical growth. In most systems, the initial growth is slow (lag phase), and it increases rapidly thereafter – at an exponential rate (log or exponential phase). Here, both the progeny cells following mitotic cell division retain the ability to divide and continue to do so. However, with limited nutrient supply, the growth slows down leading to a stationary phase. If we plot the parameter of growth against time, we get a typical sigmoid or S-curve (Figure 13.6).



A sigmoid curve is a characteristic of living organism growing in a natural environment. It is typical for all cells, tissues and organs of a plant. *Can you think of more similar examples? What kind of a curve can you expect in a tree showing seasonal activities?*

→ Bacteria

→ Sigmoid curve



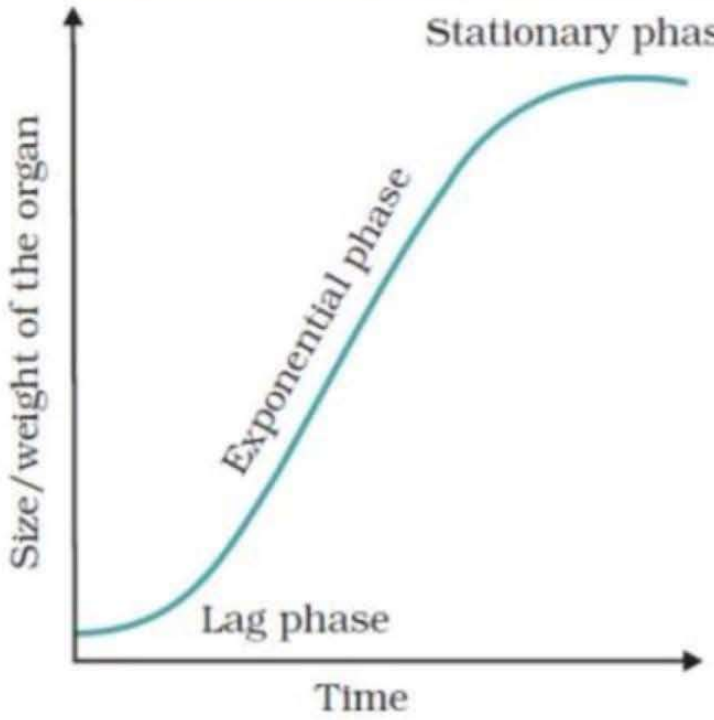


Figure 13.6 An idealised sigmoid growth curve typical of cells in culture, and many higher plants and plant organs

The exponential growth can be expressed as

$W_1 = W_0 e^{rt}$

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

Here, r is the relative growth rate and is also the measure of the ability of the plant to produce new plant material, referred to as efficiency index. Hence, the final size of W_1 depends on the initial size, W_0.

FD: पैसा / W_1

- Initial money (initial size) W_0
- r: Rate of interest : 6% / 7% / 8% : (r)
- t: 2 years / 3 years.

W_1 (FINAL PAISA/SIZE) after FIXED DEPOSIT.

Quantitative comparisons between the growth of living system can also be made in two ways : (i) measurement and the comparison of total growth per unit time is called the absolute growth rate. (ii) The growth of the given system per unit time expressed on a common basis, e.g., per unit initial parameter is called the relative growth rate. In Figure 13.7 two leaves, A and B, are drawn that are of different sizes but shows absolute increase in area in the given time to give leaves, A^1 and B^1. However, one of them shows much higher relative growth rate. Which one and why?

Leaf A > leaf B

Bz leaf A inital size is small.

Absol. growth Rate: same ($5cm^2$)

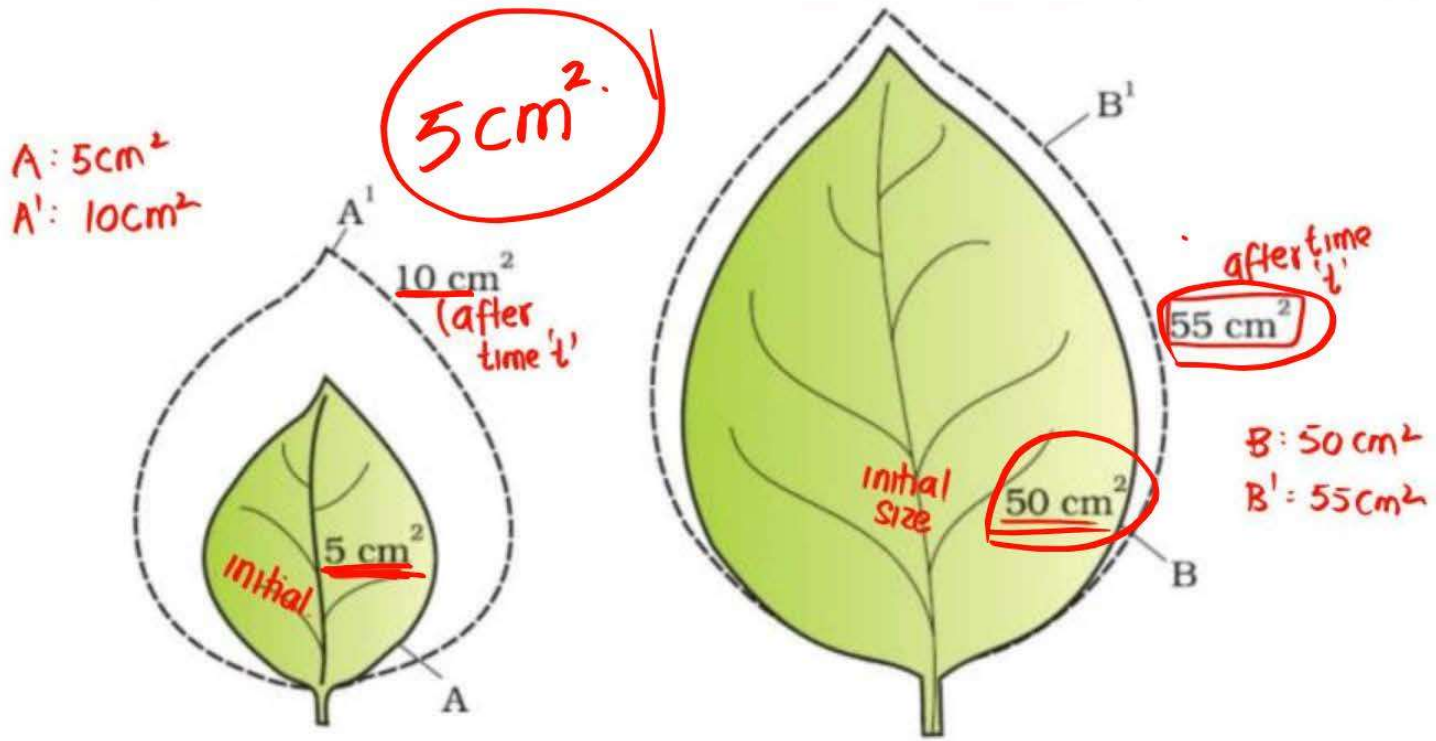


Figure 13.7 Diagrammatic comparison of absolute and relative growth rates. Both leaves A and B have increased their area by 5 cm^2 in a given time to produce A^1, B^1 leaves.

(AGR)
Absolute growth Rate
A: growth/per unit Time
5cm².
B: 5 cm².
⇒ AGR of Both A & B leaf are same

Relative growth Rate :
growth / initial growth.
A: $\frac{5}{5cm^2} \times 100 \Rightarrow 100\%$
B: $\frac{5}{50} \times 100 \Rightarrow 10\%$

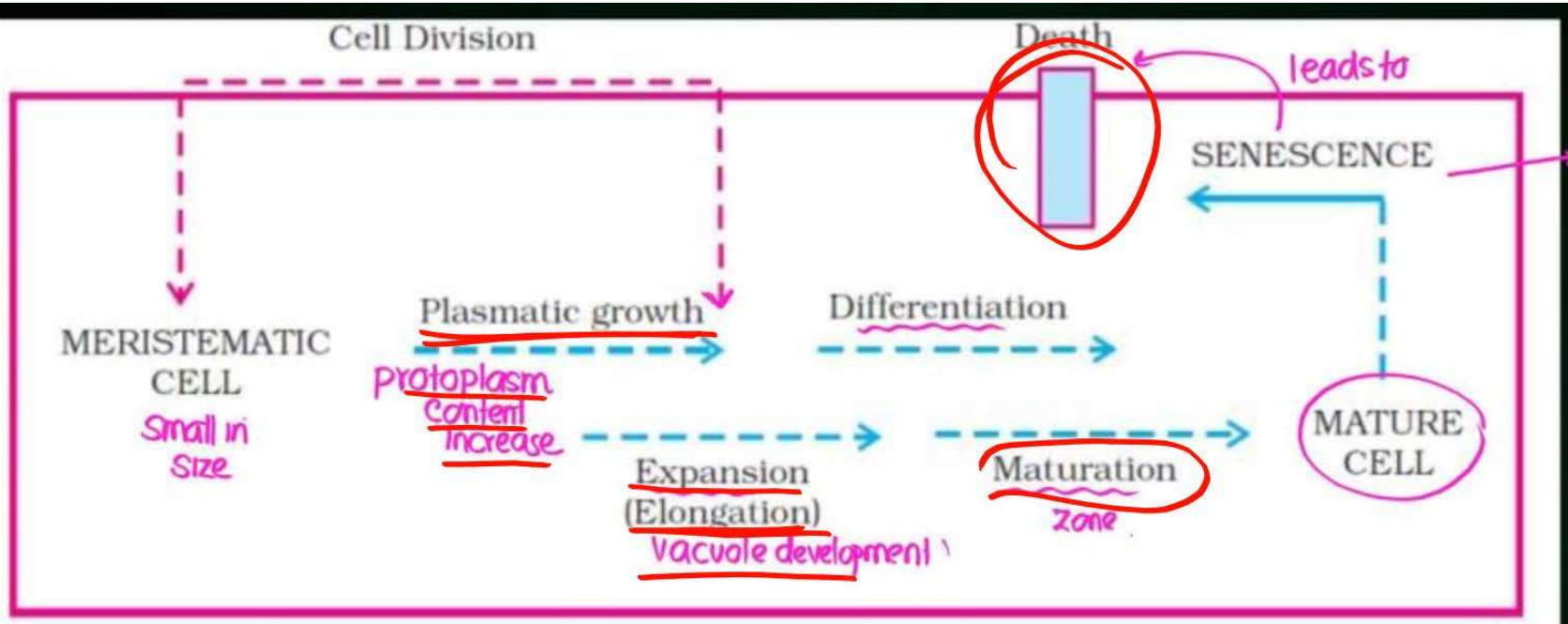
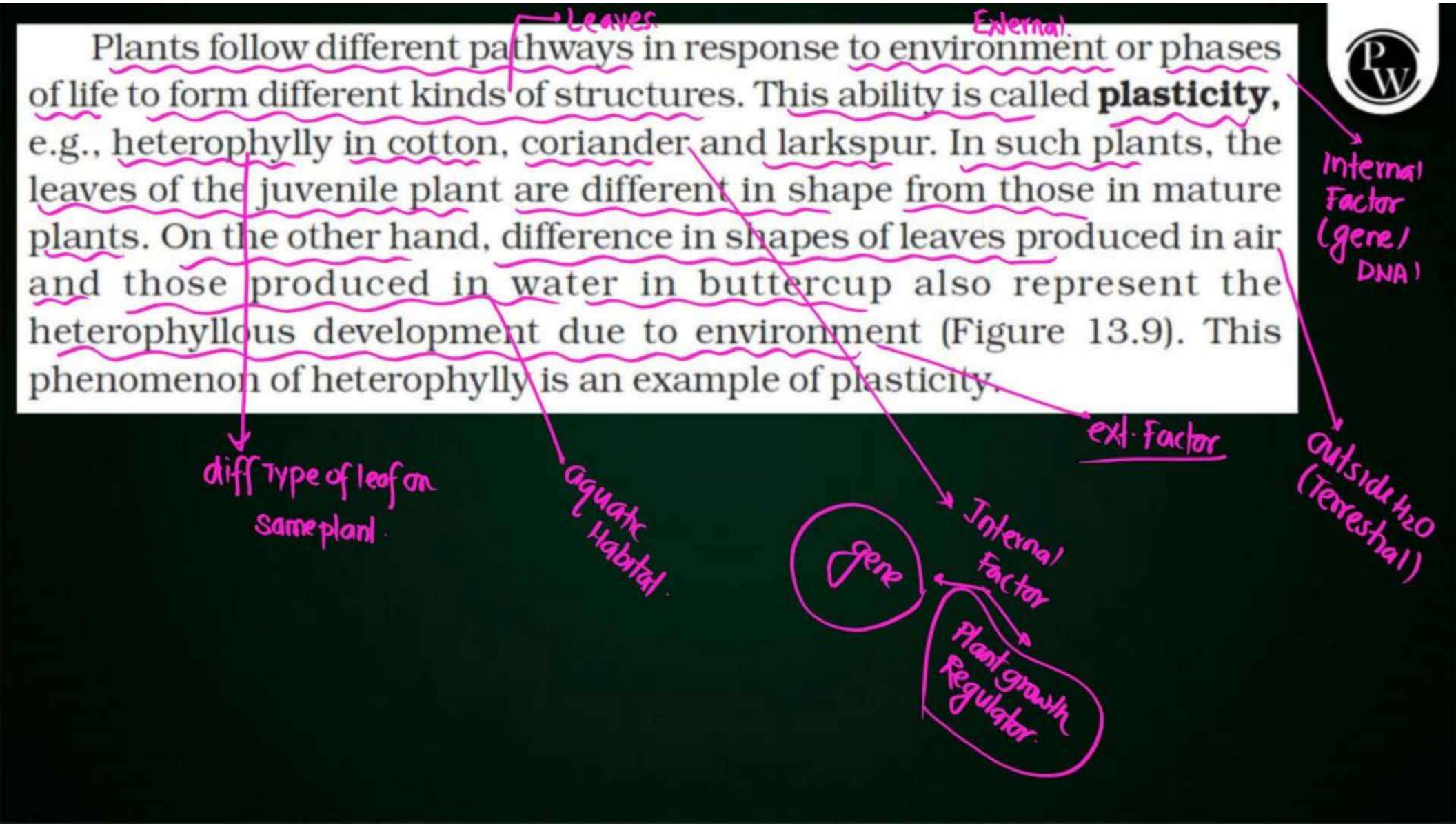


Figure 13.8 Sequence of the developmental process in a plant cell

Plants follow different pathways in response to environment or phases of life to form different kinds of structures. This ability is called **plasticity**, e.g., heterophylly in cotton, coriander and larkspur. In such plants, the leaves of the juvenile plant are different in shape from those in mature plants. On the other hand, difference in shapes of leaves produced in air and those produced in water in buttercup also represent the heterophyllous development due to environment (Figure 13.9). This phenomenon of heterophylly is an example of plasticity.



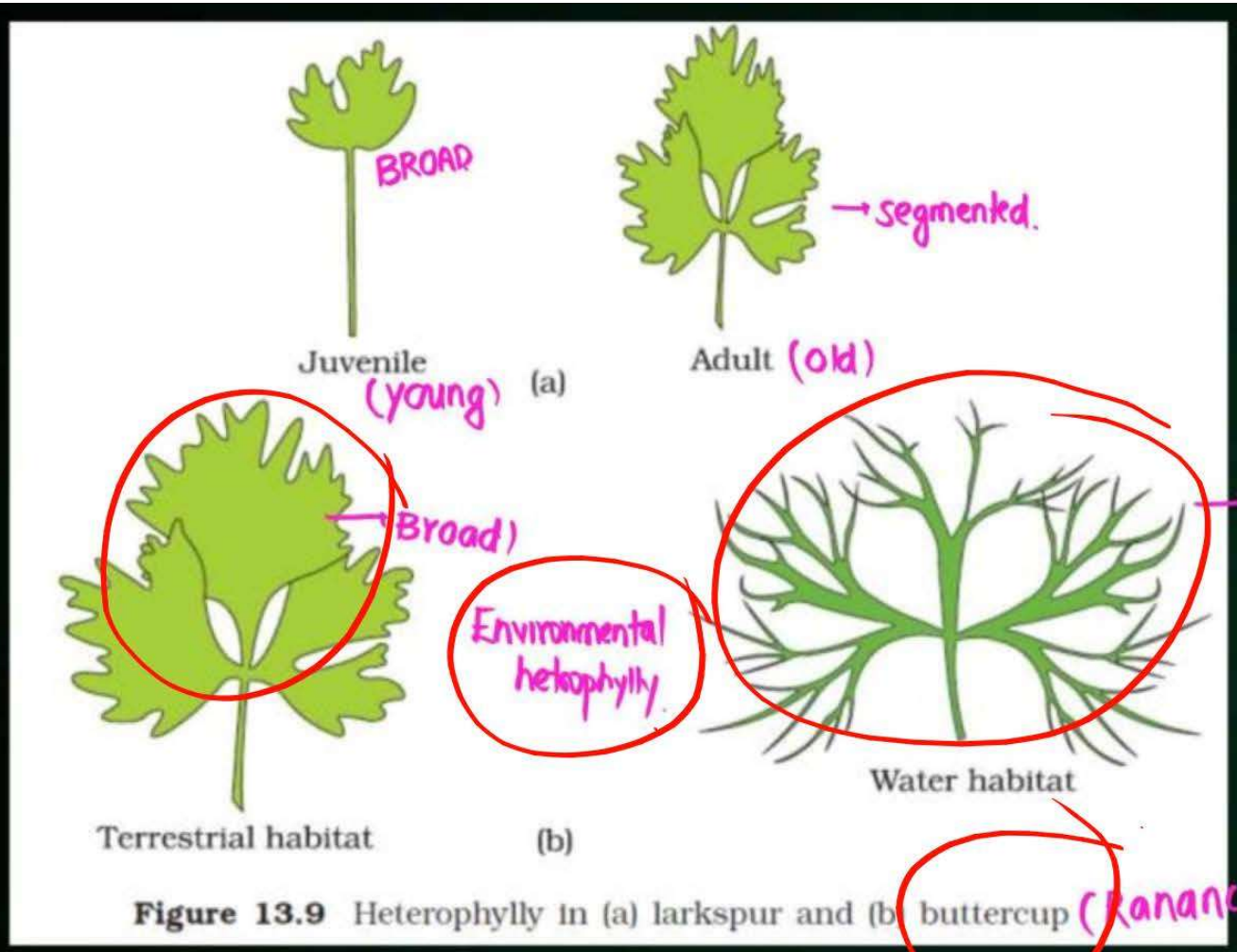


Figure 13.9 Heterophylly in (a) larkspur and (b) buttercup (Ranunculus)

Thus, growth, differentiation and development are very closely related events in the life of a plant. Broadly, development is considered as the sum of growth and differentiation. Development in plants (i.e., both growth and differentiation) is under the control of intrinsic and extrinsic factors. The former includes both intracellular (genetic) or intercellular factors (chemicals such as plant growth regulators) while the latter includes light, temperature, water, oxygen, nutrition, etc.

DNA

QUESTION

2,4-D

monocot.

Auxin is used by gardeners to prepare weed-free lawns. But no damage is caused to grass as auxin (2024)

1. promotes apical dominance.
2. promotes abscission of mature leaves only.
3. does not affect mature monocotyledonous plants.
4. can help in cell division in grasses, to produce growth.

QUESTION

Spraying sugarcane crop with which of the following plant growth regulators, increases the length of stem, thus, increasing the yield? (2024)

1. Auxin
2. Gibberellin
3. Cytokinin
4. Abscisic acid

QUESTION

Which hormone promotes internode/petiole elongation in deep water rice? (2023)

1. Kinetin
2. Ethylene
3. 2, 4-D
4. GA_3

QUESTION

In tissue culture experiments, leaf mesophyll cells are put in a culture medium to form callus. This phenomenon may be called as: (2023)

1. dedifferentiation
2. development
3. senescence
4. differentiation.

QUESTION

Spraying of which of the following phytohormone on juvenile conifers helps in hastening the maturity period, that leads to early seed production? (2023)

1. Gibberellic Acid
2. Zeatin
3. Abscisic Acid
4. Indole-3-butyric Acid

QUESTION

The phenomenon which is influenced by auxin and also played a major role in its discovery:
(2023 Manipur)

1. phototropism
2. root initiation
3. gravitropism
4. apical Dominance.

QUESTION

Match List-I with List-II. (2023 Manipur)

Choose the correct answer from the options given below:

1. A-Q, B-P, C-S, D-R
2. A-S, B-R, C-Q, D-P
3. A-P, B-R, C-S, D-Q
4. A-R, B-Q, C-P, D-S

	List-I		List-II
A.	Auxin	P.	Promotes female flower formation in cucumber
B.	Gibberellin	Q.	Overcoming apical dominance
C.	Cytokinin	R.	Increase in the length of grape stalks
D.	Ethylene	S.	Promotes flowering in pineapple

QUESTION

Which of the following statements is NOT correct? (2023 Manipur)

1. Phase of cell elongation of plant cells is characterized by increased vacuolation.
2. Cells in the meristematic phase of growth exhibit abundant plasmodesmatal connections.
3. Plant growth is generally ~~determinate~~ indet.
4. Plant growth is measurable.

QUESTION

Production of Cucumber has increased manifold in recent years. Application of which of the following phytohormones has resulted in this increased yield as the hormone is known to produce female flowers in the plants: (2022)

1. Cytokinin
2. ABA
3. Gibberellin
4. Ethylene

QUESTION

Which one of the following plants does NOT show plasticity? (2022)

1. Maize
2. Cotton
3. Coriander
4. Buttercup

QUESTION

The gaseous plant growth regulator is used in plants to: (2022)

1. kill dicotyledonous weeds in the fields X A
2. speed up the malting process X G
3. promote root growth and roothair formation to increase the absorption surface
4. help overcome apical dominance C

QUESTION

Which of the following growth regulators is an adenine derivative? (2022-II)

1. Auxin
2. Cytokinin
3. Ethylene
4. Abscisic acid

QUESTION

The phenomenon by which the undividing parenchyma cells start to divide mitotically during plant tissue culture is called as: (2022-II)

1. differentiation
2. dedifferentiation
3. redifferentiation
4. secondary growth.

QUESTION

The ability of plants to follow different pathways in response to environment leading to formation of different kinds of structures is called: (2022-II)

1. redifferentiation
2. development
3. plasticity
4. differentiation

QUESTION

The plant hormone used to destroy weeds in a field is: (2021)

1. NAA
2. 2, 4-D
3. IBA
4. IAA

QUESTION

Plants follow different pathways in response to environment or phase of life to form different kinds of structures. This ability is called: (2021)

1. flexibility
2. plasticity
3. maturity
4. elasticity.

QUESTION

The process of growth is maximum during: (2020)

1. Lag phase
2. Senescence
3. Dormancy
4. Log phase

QUESTION

Name the plant growth regulator which upon spraying on sugarcane crop, increases the length of stem, thus increasing the yield of sugarcane crop. (2020)

1. Gibberellin
2. Ethylene
3. Abscisic acid
4. Cytokinin

QUESTION

Match the following concerning the activity/function and the phytohormone involved.
Select the correct option from following: (2020 Covid)

1. A-R; B-S; C-Q; D-P
2. A-S; B-R; C-Q; D-P
3. A-S; B-Q; C-P; D-R
4. A-Q; B-R; C-S; D-P

	List-I		List-II
A	Fruit ripener	P.	Abscisic acid
B	Herbicide	Q.	GA_3
C	Bolting agent	R.	2, 4-D
D	Stress hormone	S.	Ethephon

QUESTION

Who coined the term 'Kinetin'? (2020 Covid)

1. Darwin
2. Went
3. Kurosawa
4. Skoog and Miller ✓

QUESTION

It takes very long time for pineapple plants to produce flowers. Which combination of hormones can be applied to artificially induce flowering in pineapple plants throughout the year to increase yield? (2019)

1. Auxin and Ethylene
2. Gibberellin and Cytokinin
3. Gibberellin and Abscisic acid
4. Cytokinin and Abscisic acid

QUESTION

Removal of shoot tips is very useful technique to boost the production of tea leaves. This is because; (2019 Odisha)

1. gibberellins prevent bolting and are inactivated.
2. auxins prevent leaf drop at early stages.
3. effect of auxins is removed and growth of lateral buds is enhanced.
4. gibberellins delay senescence of leaves.

QUESTION

In order to increase the yield of sugarcane crop, which of the following plant growth regulators should be sprayed? (2019 Odisha)

1. Ethylene
2. Auxins
3. Gibberellins
4. Cytokinins

QUESTION

Fruit and leaf drop at early stages can be prevented by the application of: (2017)

1. cytokinins
2. ethylene
3. auxins
4. gibberellic acid.

QUESTION

Match List-I with List-II and select the correct option using codes give below.(2017-Gujarat)

1. A-R; B-S; C-Q; D-P
2. A-R; B-Q; C-S; D-P
3. A-S; B-P; C-R; D-Q
4. A-Q; B-S; C-P; D-R

	List-I		List-II
A.	Cytokinin	P.	Stimulates closure of stomata
B.	Ethylene	Q.	Increases stem length
C.	Gibberellin	R.	Promotes lateral shoot growth
D.	Abscisic acid	S.	Found in large amount in tissues undergoing senescence

QUESTION

Growth hormone Auxin was isolated by F.W. Went from tips of seeding coleoptile of:

(2017-Gujarat)

1. rice
2. maize
3. wheat
4. oat / Avena sativa

Topic : NCERT BOOSTER

13.4.3 Physiological Effects of Plant Growth Regulators

13.4.3.1 Auxins

Auxins (from Greek 'auxein' : to grow) was first isolated from human urine. The term 'auxin' is applied to the indole-3-acetic acid (IAA), and to other natural and synthetic compounds having certain growth regulating properties. They are generally produced by the growing apices of the stems and roots, from where they migrate to the regions of their action.

NAA
2,4-D
IBA
Natural.
AUXIN NOT METABOLISED IN BODY
SUB-APICAL REGION

Auxins like IAA and indole butyric acid (IBA) have been isolated from plants. NAA (naphthalene acetic acid) and 2, 4-D (2, 4-dichlorophenoxyacetic) are synthetic auxins. All these auxins have been used extensively in agricultural and horticultural practices.

They help to initiate rooting in stem cuttings, an application widely used for plant propagation. Auxins promote flowering e.g. in pineapples. They help to prevent fruit and leaf drop at early stages but promote the abscission of older mature leaves and fruits.

PREVENT (young)

In most higher plants, the growing apical bud inhibits the growth of the lateral (axillary) buds, a phenomenon called **apical dominance**. Removal of shoot tips (decapitation) usually results in the growth of lateral buds (Figure 13.11). It is widely applied in tea plantations, hedge-making. Can you explain why?

apical BUD REMOVE

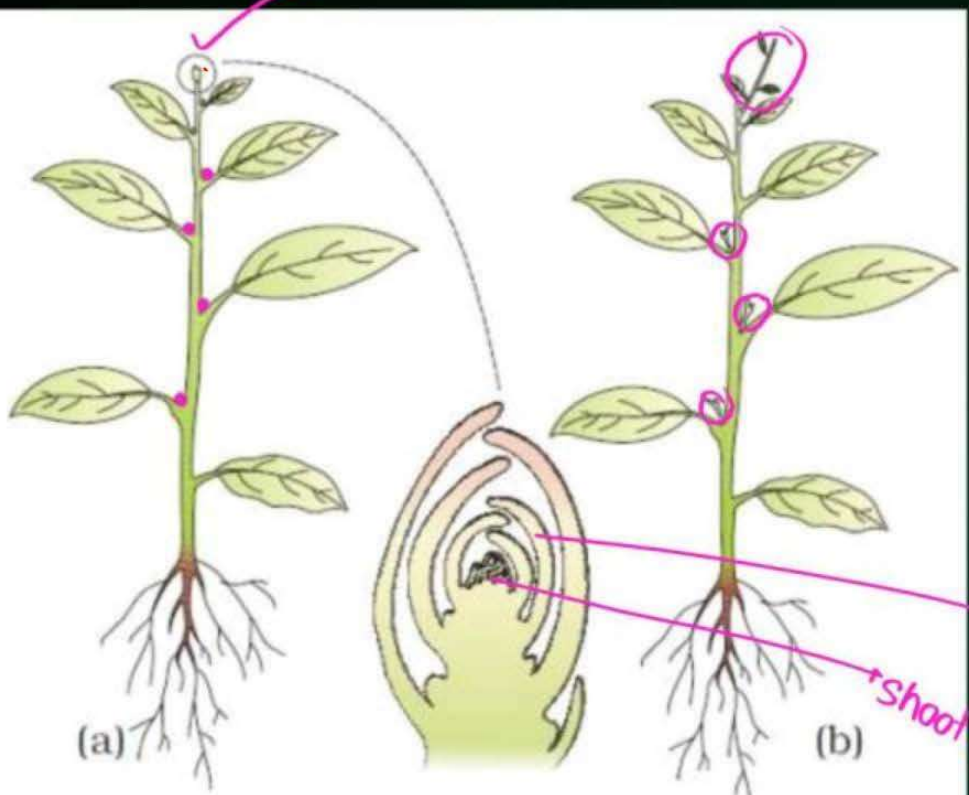


Figure 13.11 Apical dominance in plants :
(a) A plant with apical bud intact
(b) A plant with apical bud removed
Note the growth of lateral buds into branches after decapitation.

Auxins also induce parthenocarpy, e.g., in tomatoes. They are widely used as herbicides. / weedicides 2, 4-D, widely used to kill dicotyledonous weeds, does not affect mature monocotyledonous plants. It is used to prepare weed-free lawns by gardeners. Auxin also controls xylem differentiation and helps in cell division.