Inhibitors :→ These are chemicals that inhibit respiration.

① Cyanide :→ Inhibit Complex IV in ETS.
↳ Sodium Azide
↳ H_2S
↳ Butyrate.

② Malonate / Malonic acid :→
Competative inhibitor → Succinate dehydrogenase.

③ 2, 4, Dinitrophenol → directly inhibit ATP synthesis
called as uncoupling.

PLANT GROWTH & DEVELOPMENT.

↳ Seed germinates → Shoot Root → Seedling → Young tree → mature tree

↓

↳ increase in length

↳ increase in girth.

↳ Size increase → ↳ increase in length

↳ increase in diameter.

Growth :- It is irreversible, permanent increase.

In growth → increase in size, volume, weight.

↳ when new material / cells are constantly added into it.

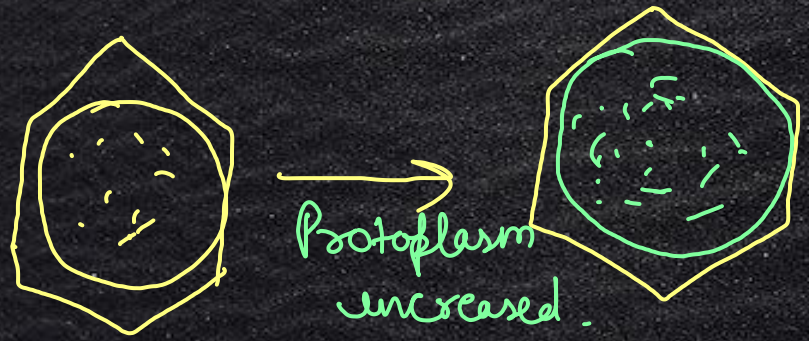
↳ Growth can takes place by two ways

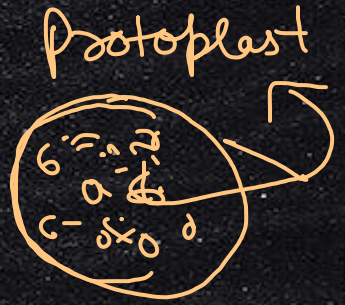
Within the cell / Intracellular.

Outside of the cell / Extracellular.

↳ In growing stages of plant → cells grow very fastly → so metabolic rate will be high

In real :- plant growth — is increase in protoplasm Content





? Can we measure this growth, that is taking place inside the Cell?

Ans :- No.

But we have another parameters by which we can measure growth.

(1) Increase in cell size :- means growth is taking place.

→ Watermelon → cell size can increase upto 3,50,000 times

(2) Increase in the fresh weight [organic matter + water]

(3) Increase in the length of the plant :→ Growth of pollen tube.

device used to measure growth → axonmeter.

(4) Increase in surface area.

(5) Increase in volume.

(6) Increase in cell number → maize (eg:-)

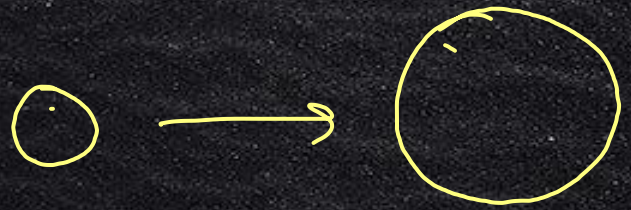
gn Root apical meristem cells → Can form 17,500 new cells in per hour.

NCERT → wooden log → soaked in water → Swells.

→ We cannot call it as growth, → because when water evaporates, it will regain its shape.

(2) Merlin ↓ 40 kg. —1 month→ 70kg.

Auxetic growth :⇒ It is the type of growth in which cell number do not increase, but there is increase cell size / surface area.



Growth

Plants

↳ Growth in plants is indeterminate/unlimited.

↳ this is due to presence of special type of cells in plants → called as meristem.

Animals

↳ Limited

↓
1° meristem

↳ present from earlier (embryo)

↳ increase in length.

↳ RAM & SAM

↓
2° meristem. (lateral meristem)

↳ formed after 1° meristem.

↳ Increase in girth / Width

↓

Vascular Cambium

Cork Cambium.

② Growth is open.
↳ new cells are always added.

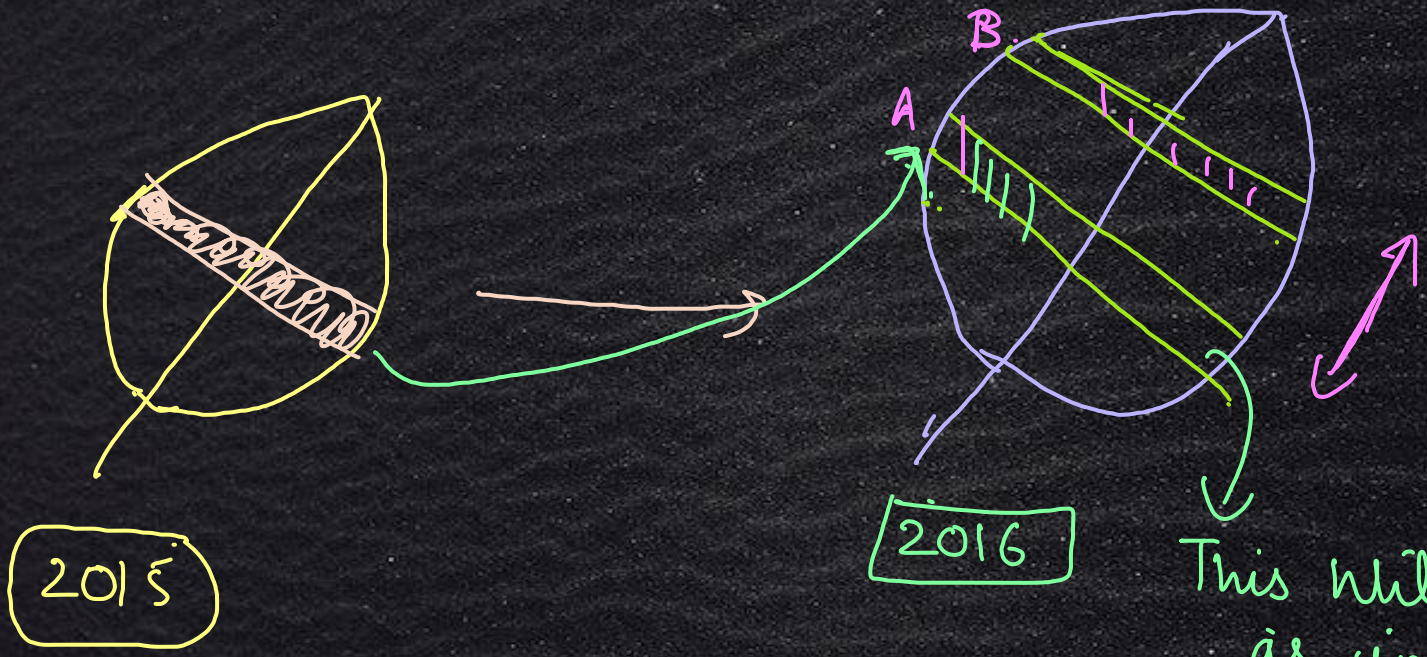
↳ Closed type

③ Specialised regions show growth. (localised growth)

↳ Shoot apics, Root apics. (restricted to certain).

↳ non uniform growth.

③ overall growth / Diffused growth / uniform growth / Proportionate growth.



This will remain as in the year 2014.

But, the cells nearby of the strip → will growth.

(9.) Increase in the no. of organs.

(9.) no increase in no. of organs.

Phases of growth

There are three phases of growth :-

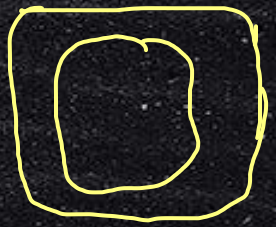
Phase 1 :- Meristematic / Phase of cell division

Phase 2 :- Enlongation / Phase of enlargement.

Phase 3 :- Maturation / Differentiation phase.

① Phase 1 :- Meristematic / Phase of Cell division.

↳ The cell which divides → present in Root apex and shoot apex.



↳ They have dense protoplasm.

↳ no vacoule / or present in peripheral.

↳ High respiration rate.

↳ At initial stages → only primary cellwall is there.

↳ Size of the cell is small.

↳ Cell wall are thin.

Enlongation phase → Phase of enlargement

↳ This phase comes after meristematic phase.

↳ No division takes place.

↳ Vacoulisation ⟶ Size increase. and no also.

↳ 2° cell wall deposition (inner to the 1° membane

III. Maturation phase / Differentiation phase

Two types of differentiation

Structural

↳ Cell → maximum size.

↳ 2° wall is present

↳ maximum no. of vacuole.

Physiological

↳ Cells will perform particular function.

Eg:- → Root hair cell.

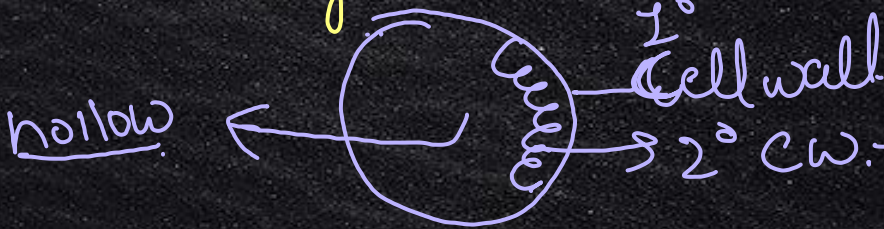
↳ To absorb water and

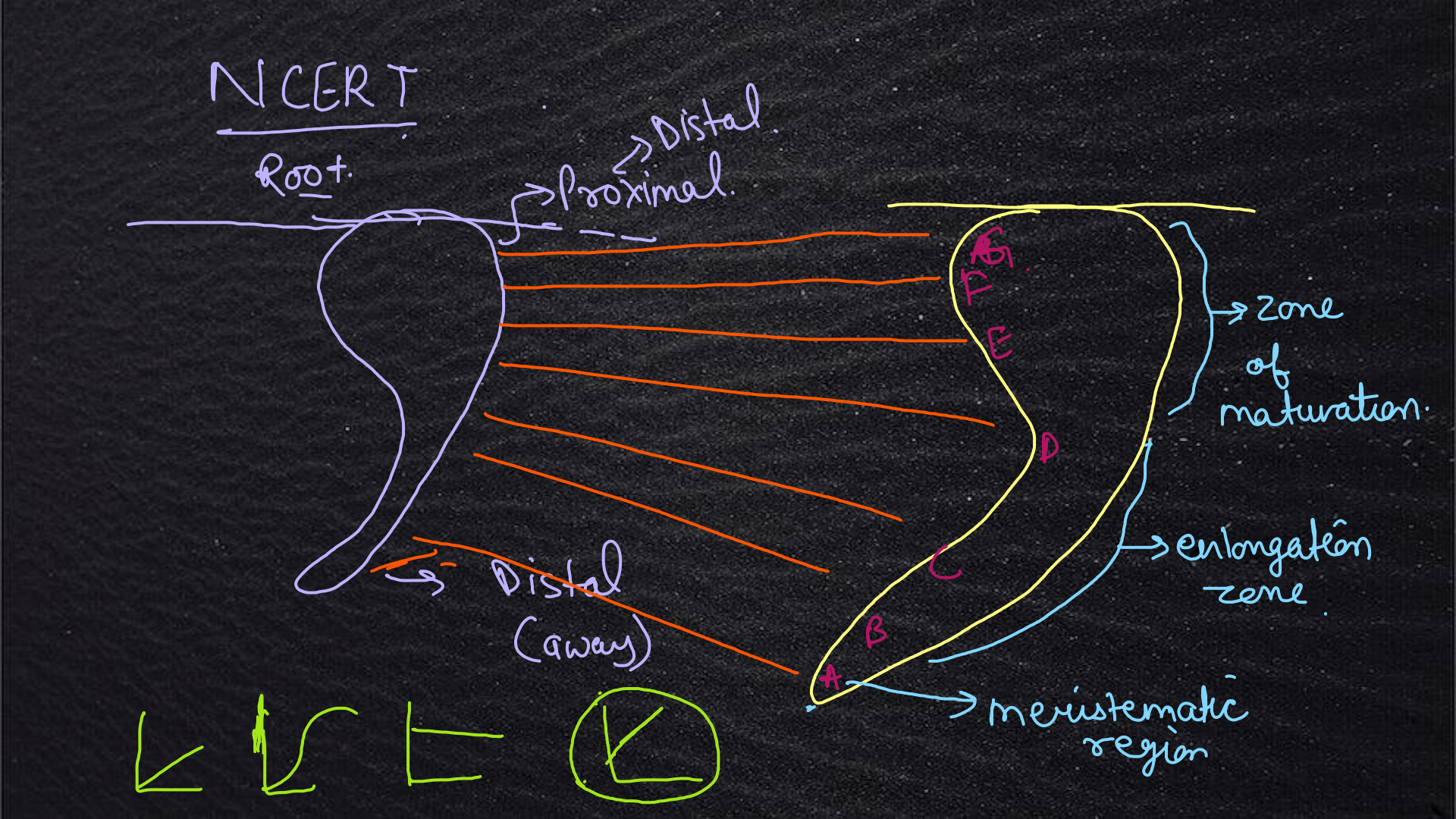
minerals.

e.g.:→ Mesophyll
↳ Photosynthesis

↳ Sometimes, → during differentiation ⟶ cell looses its protoplasm.

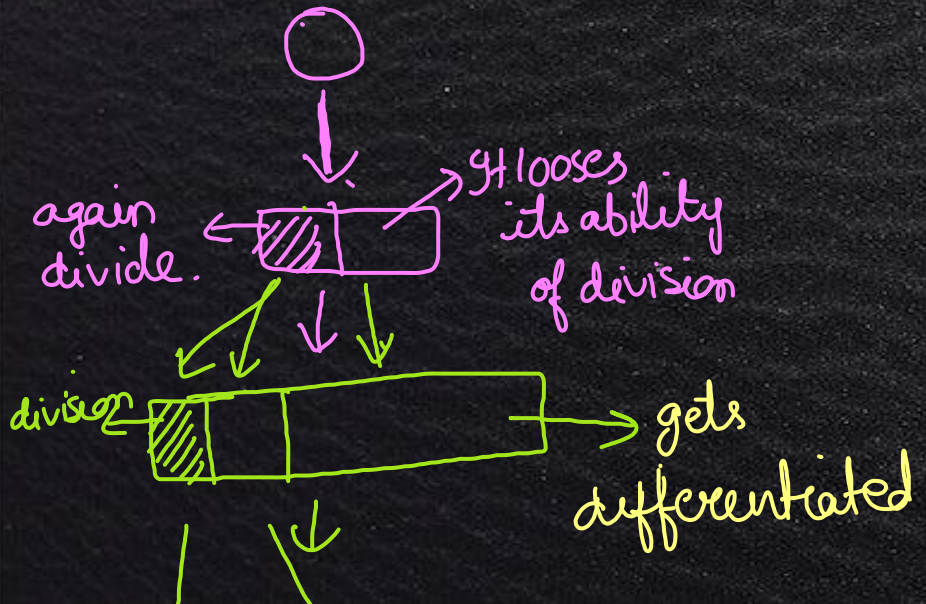
For example :→ Sclerenchyma cells.



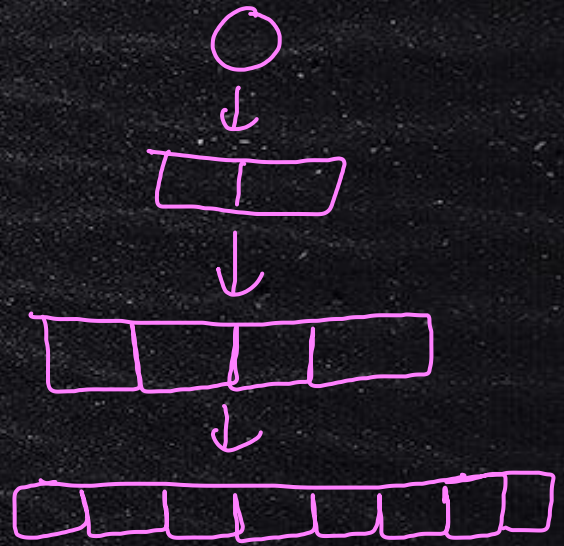

NCERT
Root.
Proximal.
Distal.
Distal
(away)
A
B
C
D
E
F
G
zone
of
maturation.
elongation
zone.
meristematic
region

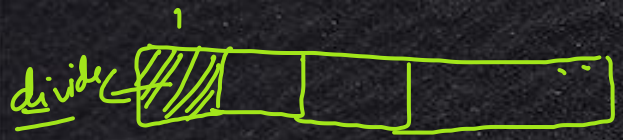
Growth rate :→ Increase in growth per unit time.

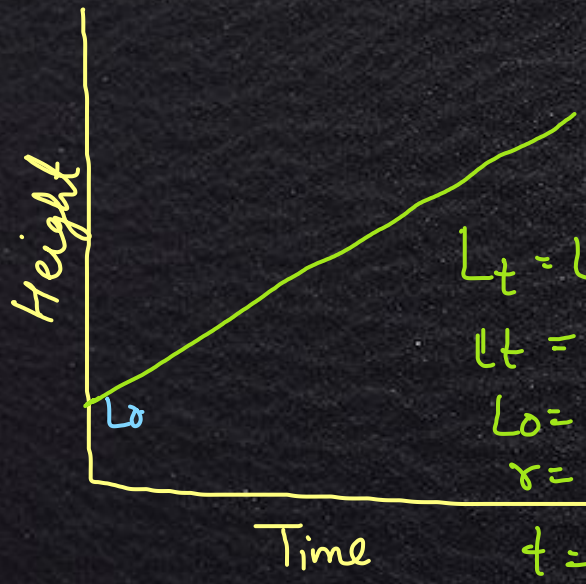
Arithematic growth rate



Geomatric growth rate







$L_t = L_o + rt$

L_t = length at time t

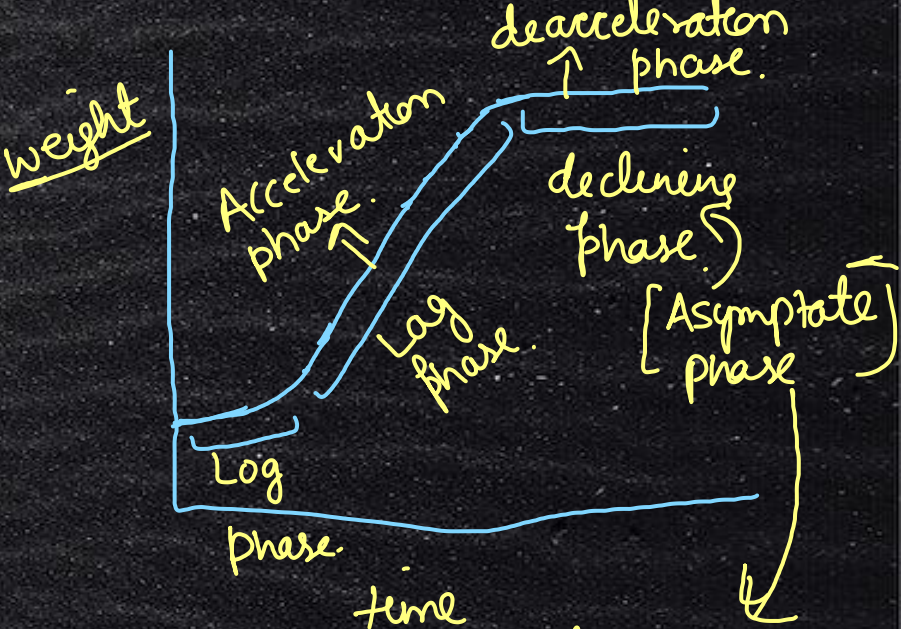
L_o = initial length

r = growth rate

t = time

↳ Graph will be linear.

↳ Here growth will be exponential



All nutrients used up by the plant, so growth

We will not start from zero in graph because initially, there is some length present in plant.

↳ Example :→ Root enlongates at such constant rate.

rate = 10.

↳ Curve → Sigmoid.

equation :→ $W_t = W_0 e^{rt}$

W_t = weight at time t

W_0 = initial weight

e :- log

r = relative growth rate

eg :→ Bacteria in culture.

↳ Zygote → Embryo.

zygote

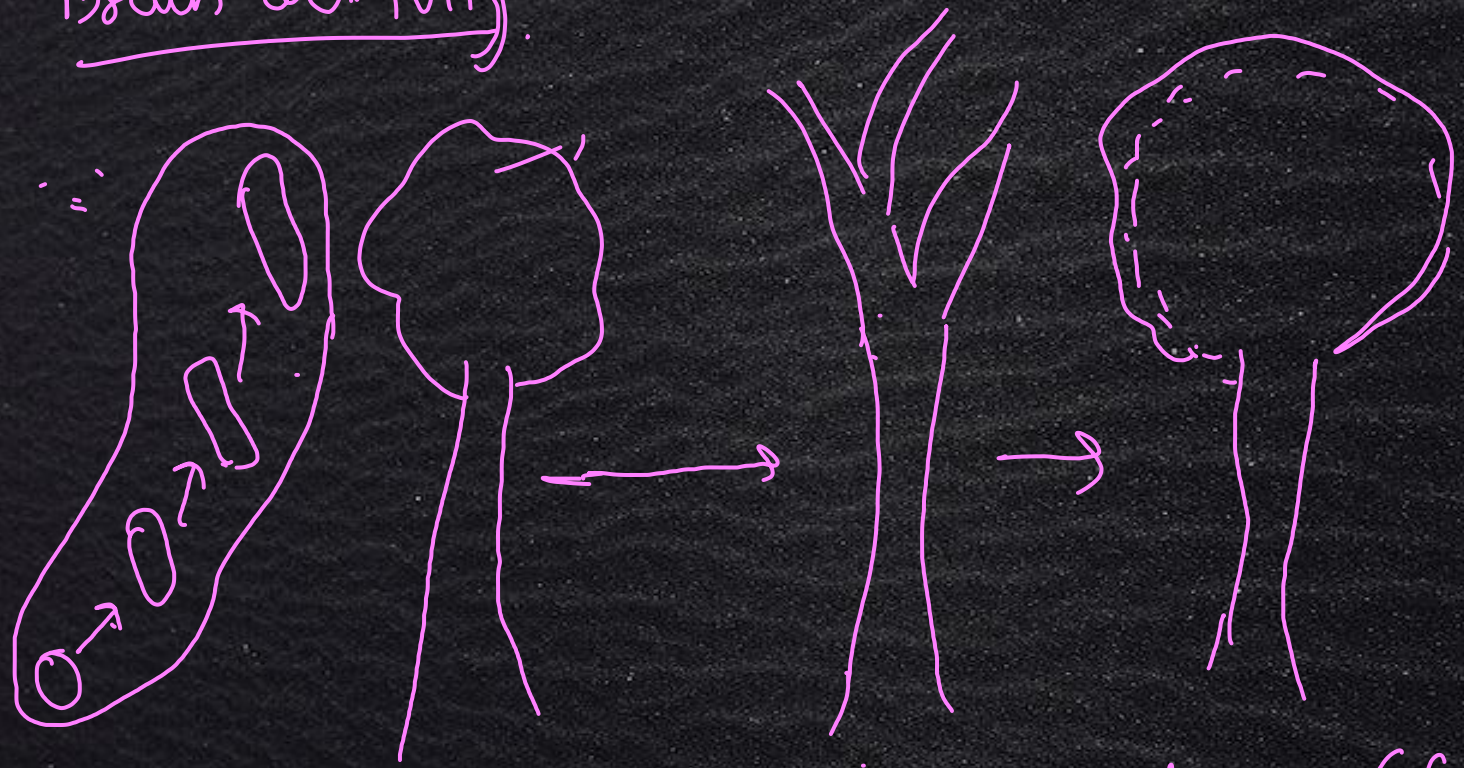
↳ initially it shows arithmetic growth.

[1, 2, 3, 4]

on the depending upon function decided by cells.

it shows geometric growth

Brain activity.



↳ Does plant following sigmoid curve. (Geometric growth)

no ↳ plant us showing seasonal variation.

Ways to measure growth

- Absolute growth rate
- Relative growth rate.

Final − Initial

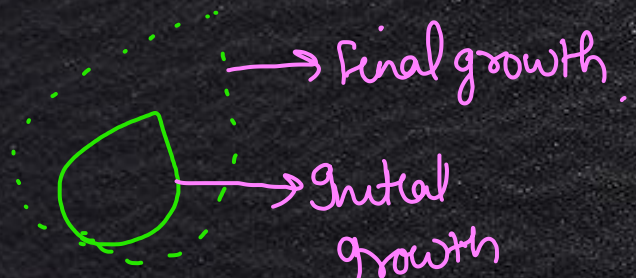
$$\frac{\text{Final} - \text{Initial}}{\text{Initial}} \times 100.$$

40K pm → 80K pm

→ 40K (Abs.)

40K pm → 90Km

Case - I



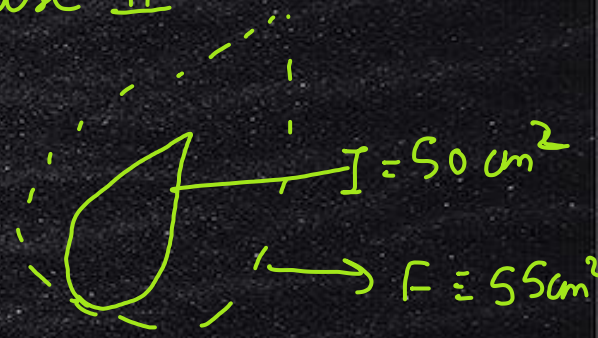
$I = 5\ cm^2$

$F = 10\ cm^2$

$AG = 5\ cm^2$.

$RG = 100\%$.

Case - II



$AG = 5cm^2$

$RG = 10\%$.

Conditions required for growth

1) H_2O
   - act as medium for all enzymatic activity
   - it keeps the cell turgid (cell enlargement).

2) Nutrients
3) oxygen → Respiration
4) Temperature → Optimum.
5) Light
6) Gravity.

Differentiation, dedifferentiation, Redifferentiation

Meristematic cell. (increase length)

differentiation → Looses their ability of division

Become primary permant tissue

De-differentiation → regains the capacity of division

Form Secondary meristem

Re-differentiation → again Looses the capacity of division & perform specific function.

Form Secondary permanent tissue.

For example,

Seed.

Embryo
↓
have
meristem

Seedling
↓
has
1° meristem
(present in
both monocot
& dicot)

differentiation
looses the
capacity
of division

1° permanent tissue
↓
Parenchyma,
Sclerenchyma,
Collenchyma,
1° xylem,
1° phloem,
1° medullary
rays.

present in both
monocot & dicot.

In Dicots only → 1° permanent tissue [Parenchyma]

Dedifferentiation

↓ regain the capacity of division

2° meristem → Vascular Cambium / Fascicular Cambium and Cork Cambium / Phellogen

Redifferentiation

↓ Looses the power of division

2° permanent tissue

↳ 2° Cortex / Phelloderm

↳ Cork / Phellem

↳ 2° xylem

↳ 2° Phloem

↳ 2° medullary rays.

Rack your Brain

Phellem, Vascular Cambium, SAM, Parenchyma, Phellodem, 1° phloem.

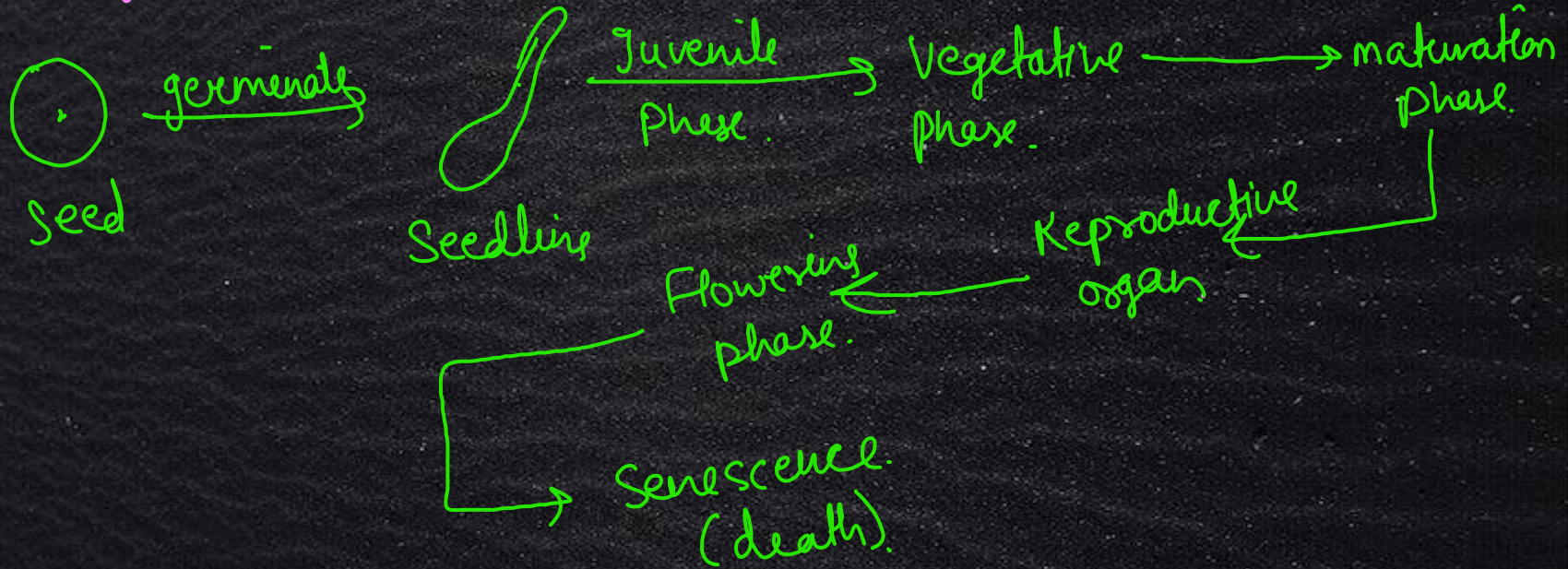
How many of them are the product of

Differentiation	Dedifferentiation	Re-differentiation
1) Parenchyma 2) 1° phloem	Vascular Cambium.	Phellem Phellodem.

Development

In human { Infant → toddler → adolescent / Teenage → adult → ageing → Senescence (death).

↳ It is defined as sequence of changes occuring in the life span of organism till death.



Meristematic cells → Plasmatic growth → enlargement Expansion → differentiate Development.

↓

protoplasm growth

↳ cell will enlarge.

↳ Development in organism → fixed pathway

↓

because the development pathway is controlling by genes.

↳ In some plants, this development can be changed due to requirement. ⟶ so it is known as Plasticity.

For example :- Heterophilly (Having different kind of leaf in plant)

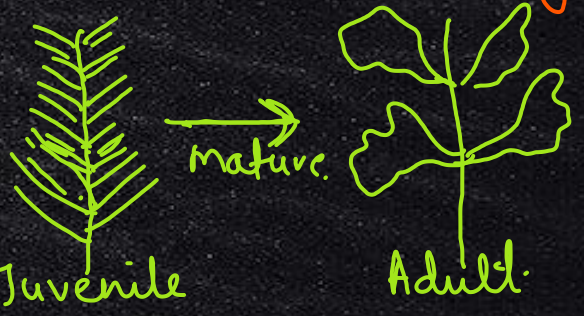
Environmental Heterophilly.

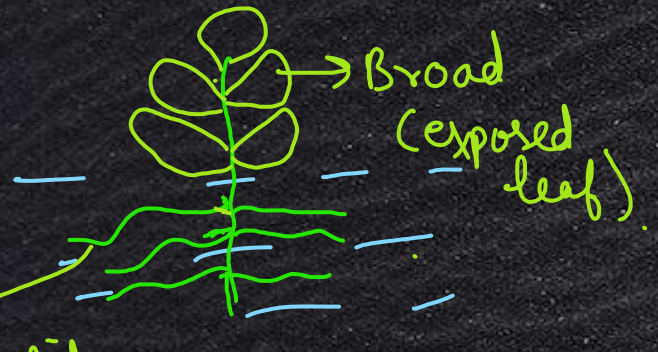
eg :- Ranunculus (Buttercup)

↳ It is aquatic plant

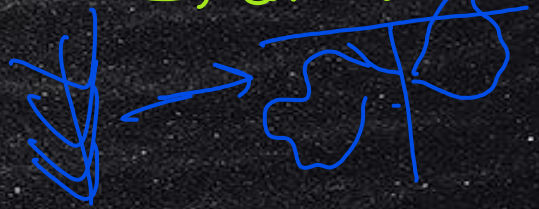
↳ half submerged.

Developmental Heterophilly.





eg: Cotton
Lakshpur.
Coriander.



Ribbon like leaf → helps to movement of water

Development = Growth + Differentiation

↓

depends upon.

↓

Extrinsic factor.

↳ Temperature

↳ O_2

↳ Light

↳ H_2O.

↓

Intrinsic factor.

Intracellular (inside the cell)

↓

Genetic factor.

Intercellular

↓

Phytohormones / Plant hormones.

Plant hormones / Plant growth regulator.

- They are required in low Concentration.
- Controls and regulate various physiological activities → division, differentiation, enlongation.
- Their activity will be at the site of formation

or away from the site.

PGR

Growth promotere

↳ Division
↳ Enlongation
↳ Germination

① AUXIN

Growth inhibitor

↳ Abscision
↳ Senescence
↳ Dormancy.

④ Abscisic acid

Dual

Promoter. Inhibitor

⑤ Ethylene.
(mainly inhibits)

② Gibberellin

③ Cytokinin

Senescence

Hormones → ① chemical nature

② Precursor

③ Discovery

④ Isolation

⑤ Physiological role

⑥ Commercial role.

⑦ Bioassay

↙ Qualitative & Quantitative test.

AUXIN :→

↳ derived from greek word → Auxein.

chemical nature

↳ Indole Compound.

Precursor

↳ Tryptophan (a.a) for tryptophan amino acid formation

↓

require (Zn).

Auxin

- Natural.
  - ↳ IAA
    Indole acetic acid
- Synthetic
  - ↳ 2,4,D
    ↓
    2,4 Dichlorophenoxyacetic acid

↳ IBA
Indole Butyric acid

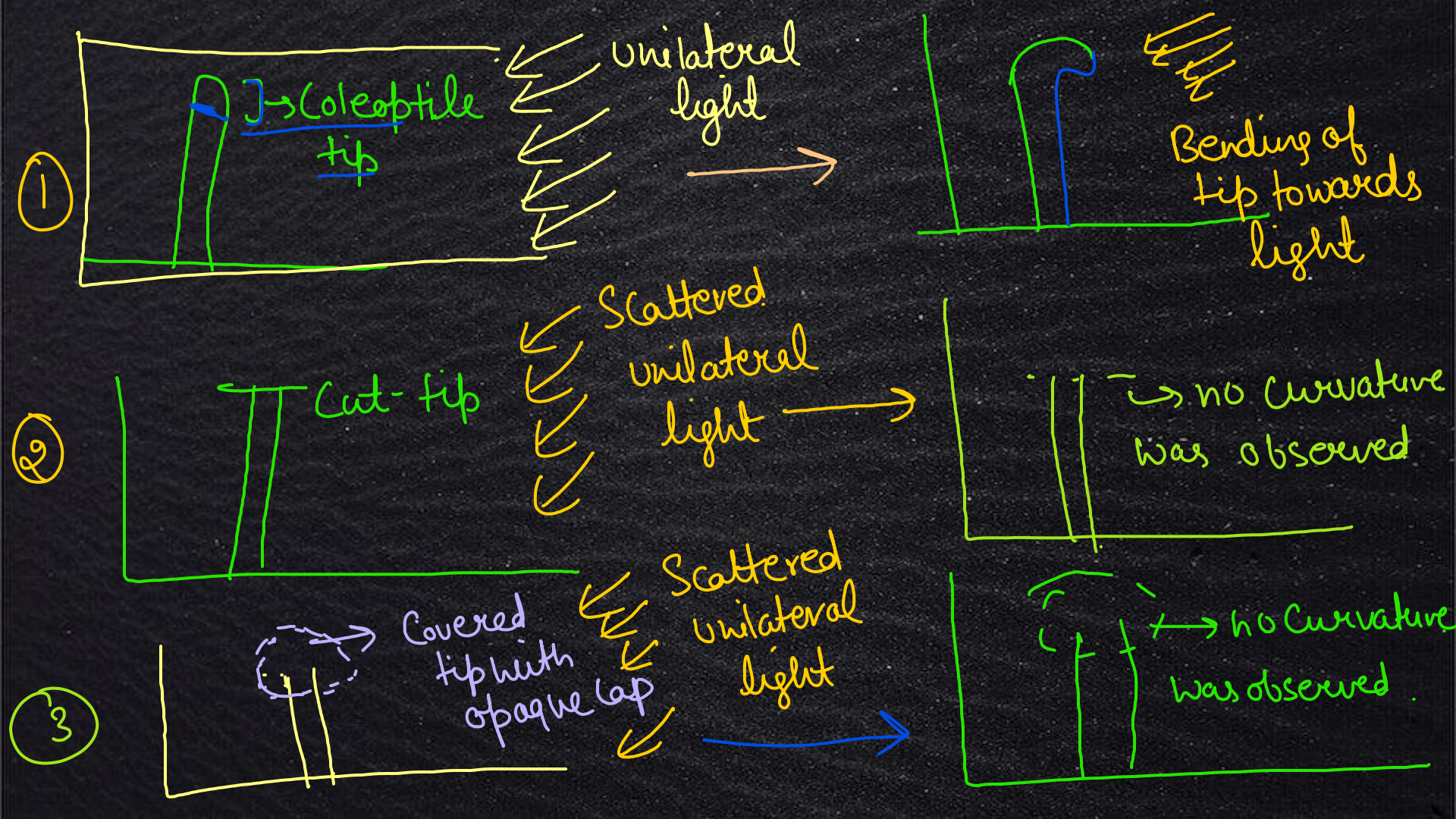
↳ NAA → Napthelene acetic acid

Discovery :- Credit goes to Charles Darwin & Francis Darwin

↳ Experimental material → Canary grass (monocot)

↳ But their experiment topic → Photo-tropism

→ movement of plants towards light


1
Coleoptile tip
Unilateral light
Bending of tip towards light
2
Cut-tip
Scattered unilateral light
→ no curvature was observed
3
Covered tip with opaque cap
Scattered unilateral light
→ no curvature was observed

↳ So they concluded that, there is something, i.e. present in tip of Canary grass.

☆ Auxin is shade loving hormone.

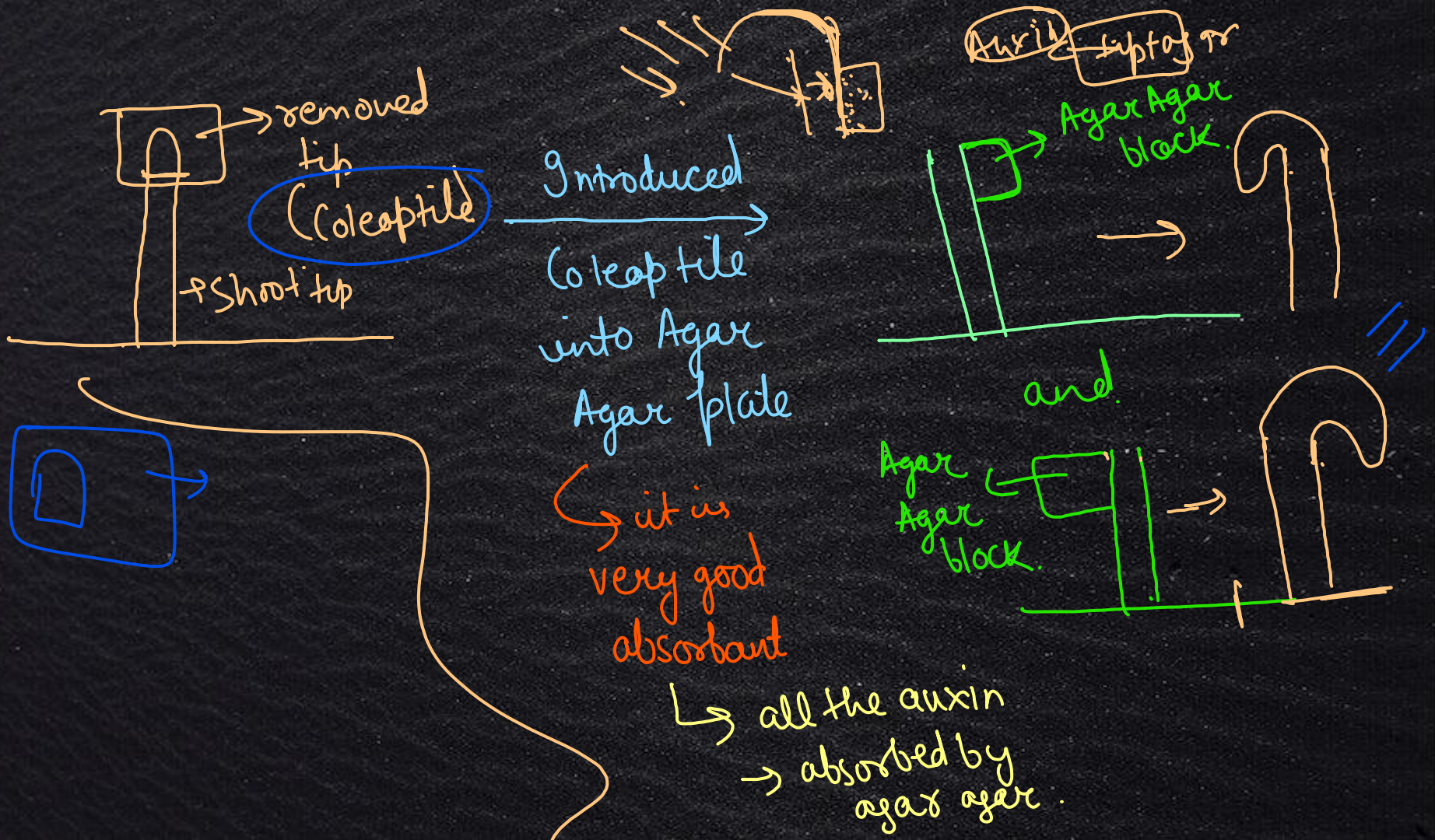
☆ Auxin helps in enlargation, → it shows bending towards light

Isolation of Auxin / Extraction of Auxin

↳ Isolation was done by F. W Went

- Gave bioassay.
- gave name to this hormone as auxin.
- Isolation of this hormone from Oats (Avena sativa)
  ↳ monocot.

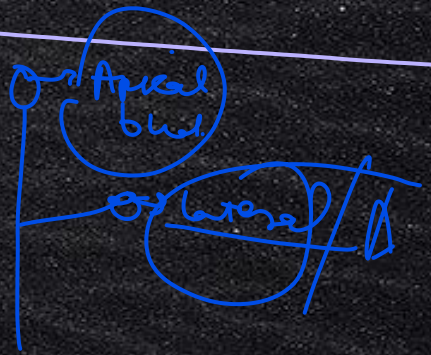
Avena curvature test → bioassay


removed tip
(Coleoptile)
Shoot tip
Introduced
Coleoptile into Agar
Agar plate
it is very good absorbant
all the auxin → absorbed by agar agar.
Auxin
tip
Agar Agar block.
and
Agar Agar block.

Bioassay :- He isolated auxin hormones and performed Avena curvature test.

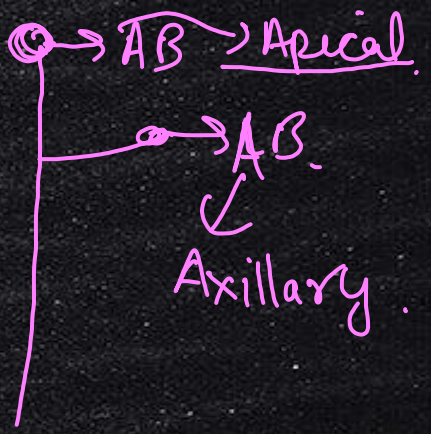
In animals, Ist time Auxin was isolated from Human urine.

Physiological role



↳ It helps in apical domenance.

Auxin promotes apical buds and inhibit the growth of axillary buds.



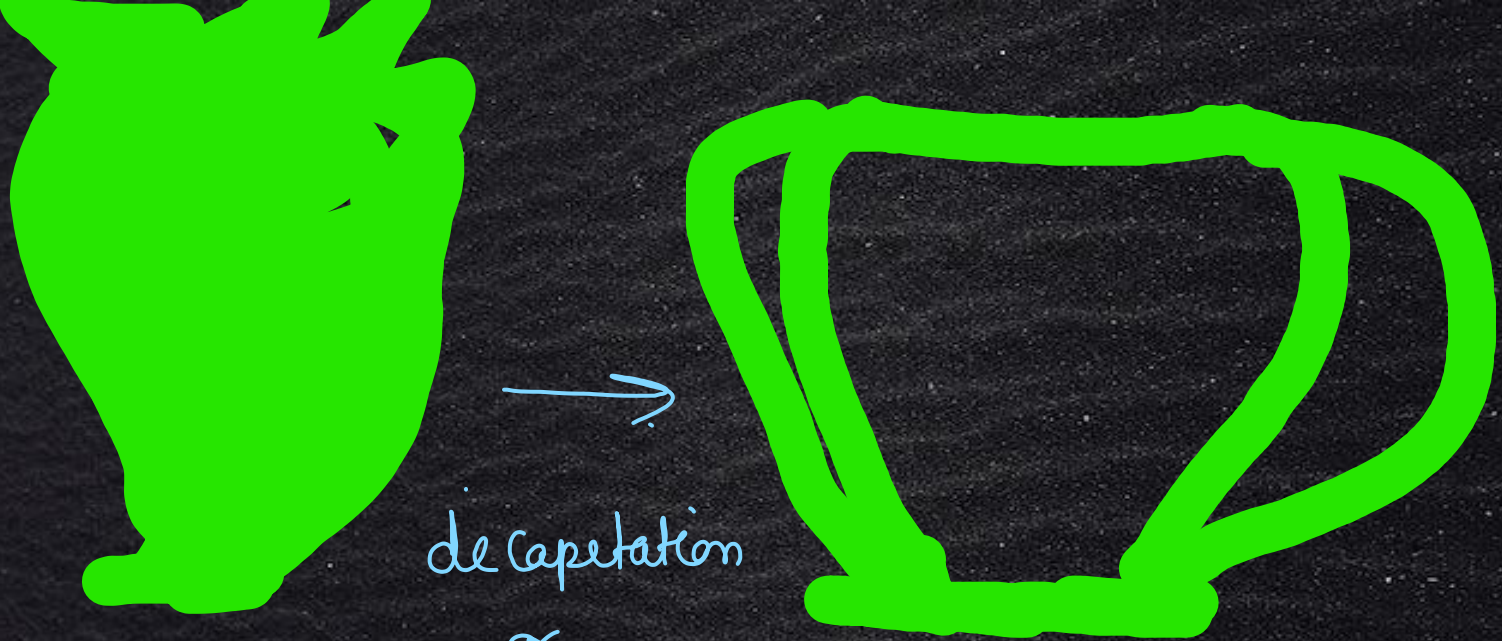
↳

decapitation

↳ Removal of apical buds known as ~~power~~ Pruning.

↳ If we cut apical buds of plant → so, plant will not attain more height → because Auxin is present in apical.

and plant will increase its diameter



decapetation
or
Hedging.

→ Pruning

Examples: Can be seen in Tea plantation, Hedge making.

2 Abscision (leaf fall) :- prevents falling of young leaves.

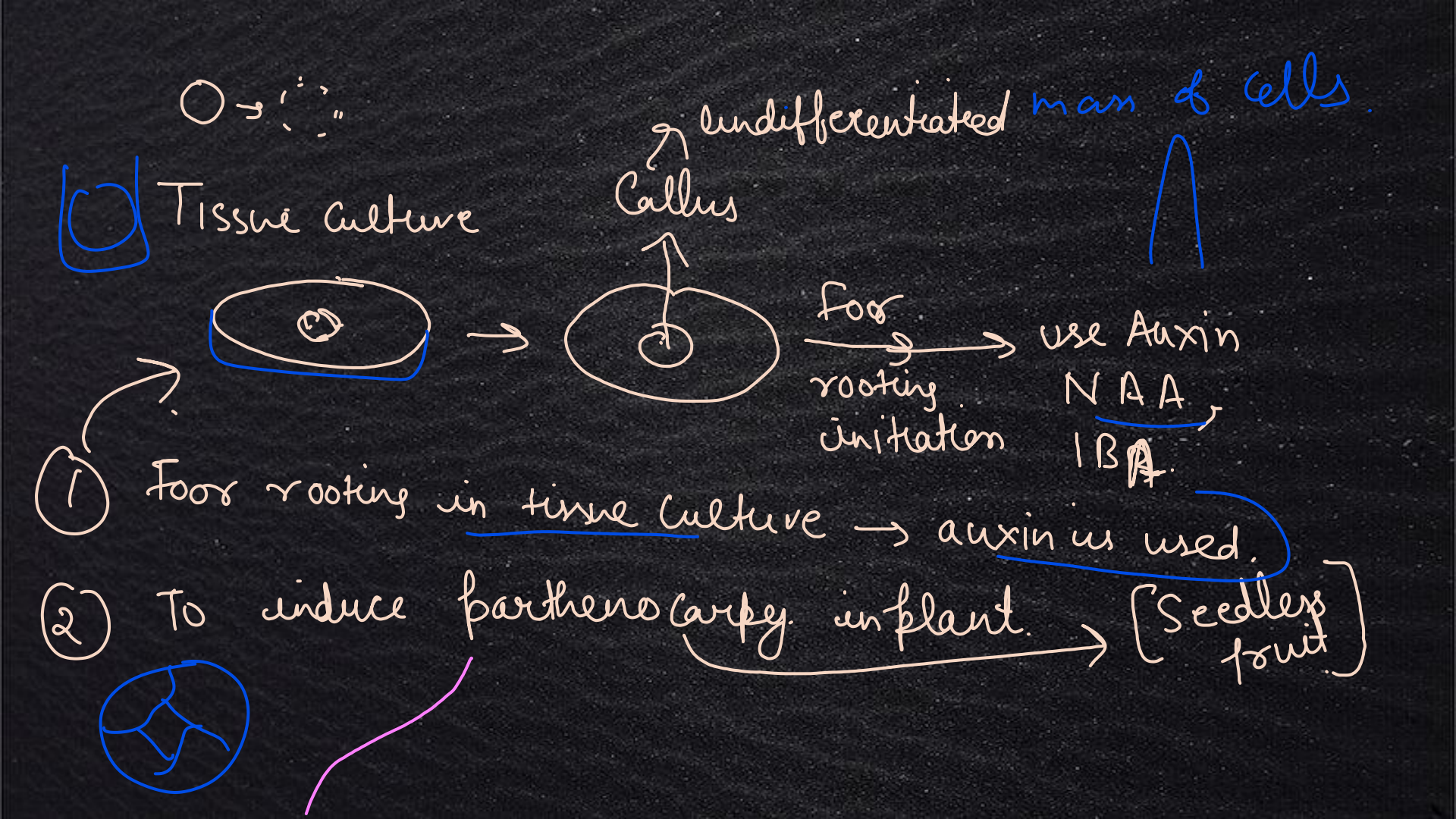
3 Along with Cytokinin → it promotes Cell division.

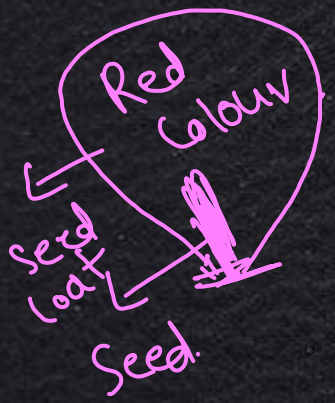
4 Cell enlongation ↑

5 Xylem differentiation

6 Senescence → death.

Commercial use of Auxin :→


undifferentiated mass of cells.
Callus
Tissue culture
For rooting initiation
use Auxin
NAA
IBA
(1) For rooting in tissue culture → auxin is used.
(2) To induce parthenocarpy in plant.
[Seedless fruit]



↳ [Parthenocarpy fails in pomegranate because.

because we eat seed + seed coat (~~pink~~ red colour)

↳ Induces flowering in Litchi & Pineapple.

↳ Also act as weedicide (2,4,D) → Synthetic auxin

↓

Cause defoliation of weeds

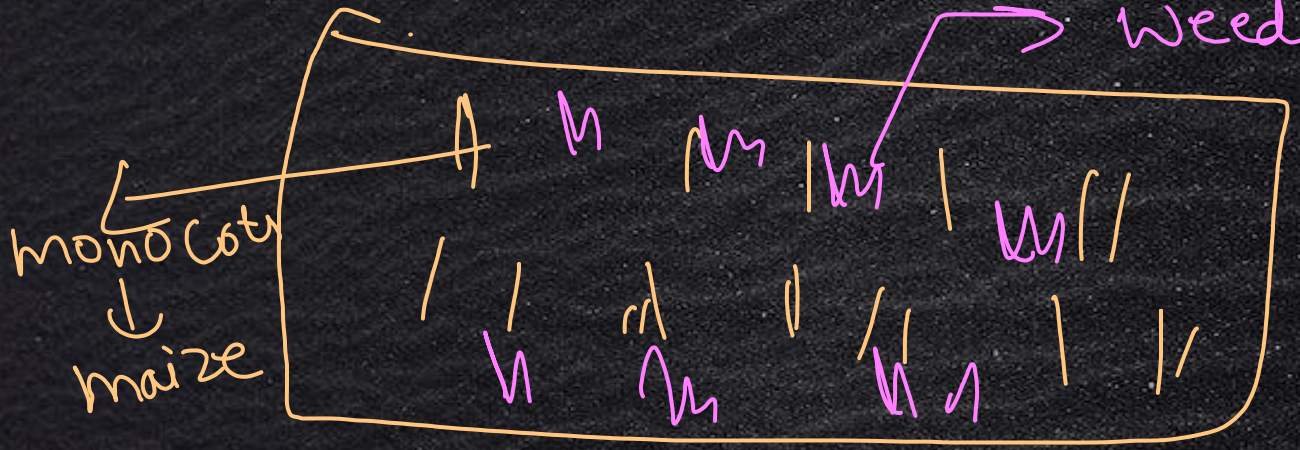
↳ falling of leaves.

plant will die. ← no food ← no photosynthesis

↳ drawback of 2,4 D → it has narrow spectrum -

→ 97 Cannot act on every plant

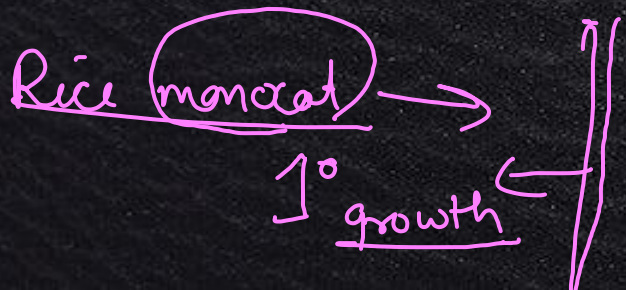
↳ only shows its action on dicot plant.



(5) It also act as Agent orange → 2,4-D
2,4,5-D

Gibberellins / Gibberalic acid

- Chemical nature → Terpenes / Terpenoids
- Precursor → Acetyl CoA / Melvanoic acid.
- Discovery → Kurosawa.



Scientist

↳ Grow rice in field

↳ observed. ① Lodging → falls down because it unable to hold its weight

② Seeds were sterile

↳ So, they named this disease → Foolish disease.

or Bakane disease.

But scientist → Kurosawa observed that, there is infection in rice plant of fungi named as Gibberala fujikoroi

↳ (Ascomycetes)

↓

producing substance

↓

that enlongates the plant and falls down.

↓

So, discovered Gibberillin.

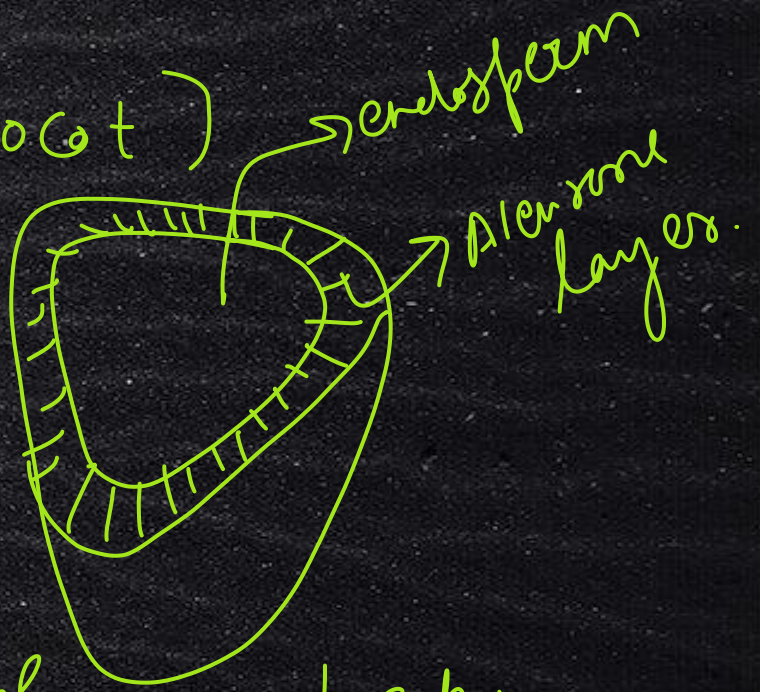
Bioassay of Gibberellin :→

α-amylase endosperm test

↳ performed in barley (monocot)

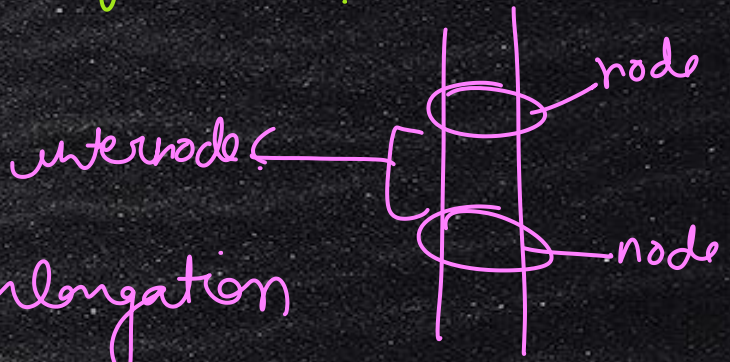
↳ monocot endosperm secretes Gibberellin

↳ outer layer of endosperm → Aleurone layer → α-amylase → breaks



Starch into glucose.

Physiological roles



↳ It helps in internode elongation
(for example in Sugarcane

↳ Seed germination
↳ It helps in breaking of seed dormancy.
↳ Induces bolting in rosette plant (Cabbage, Cauliflower)

Bolting :- enlongation of internode just before flowering.

Commercial role :-

↳ used in maturation of seed in conifers
for example → Pirus seed (Chilgoza).

↳ To increase the yield of sugarcane.

↳ To increase the process of malting.

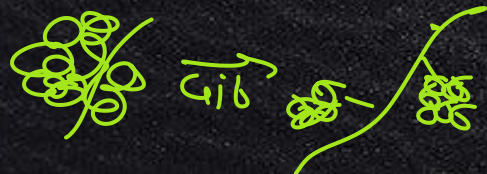
↳ In hilly area → to skip snowfall season
for example → apple

(Flowering phase - will be halted)

So
to delay ripening

↳ To maintain fruit shape

↳ To increase stock → so it prevents overcrowding in grapes.



[All hormones show feminising effect, but Gibberellin shows masculine effect]

↳ induces male flower.

For example
↳ in Cucumber

↳ To induce flowering in short day plants

Cytokinin :→

Chemical nature → Purine derivate (Adenine).

Precursor :→ tRNA

Discovery → Skoog and his colleagues in tobacco pith.

Took pith of Tobacco -

(1) Firstly added Auxin in callus
↳ shows slow growth.

(2) added three things

- extract of vascular tissue
- Coconut milk
- Yeast

→ Callus —shows→ fast division

Concluded that, there is something, that enhances - cell division (Cytokinin).

Isolation :→ done by Miller et. al. (coworkers)

They took fish.

(Herring fish)

↓

extract sperm → DNA is present (Purine & pyrimi

Adenine is required for cytokinin.

Autoclave → 121°C for 10 min

nucleus → burst out

releasing purine & pyramidine

(Kinetin)

1st natural cytokinin extracted → Zeatin from maize & coconut

Physiological roles

1. Helps in cell division along with Auxin

   Auxin + Cytokinin act as Synergistically

2. It do not helps in apical growth but promotes lateral growth

   A + C ⟶ antagonistically

③ Act as antiageging hormone means delay senescence.

Adds up → new leaves
→ form DNA, RNA, protein
→ prevent chlorophyll from degradation
→ helps in mobalisation nutrients.

Commercial role

1) It increase shelf life of cut vegetable and fruits.

2) helps in shoot development in explant (callus)

3) It induces feminishing effect
↳ all female flower

Bio assay → ① chlorophyll preservation test.
② Tobacco pith culture.

Ethylene

Chemical nature → gaseous.

Precursor → Methionine.

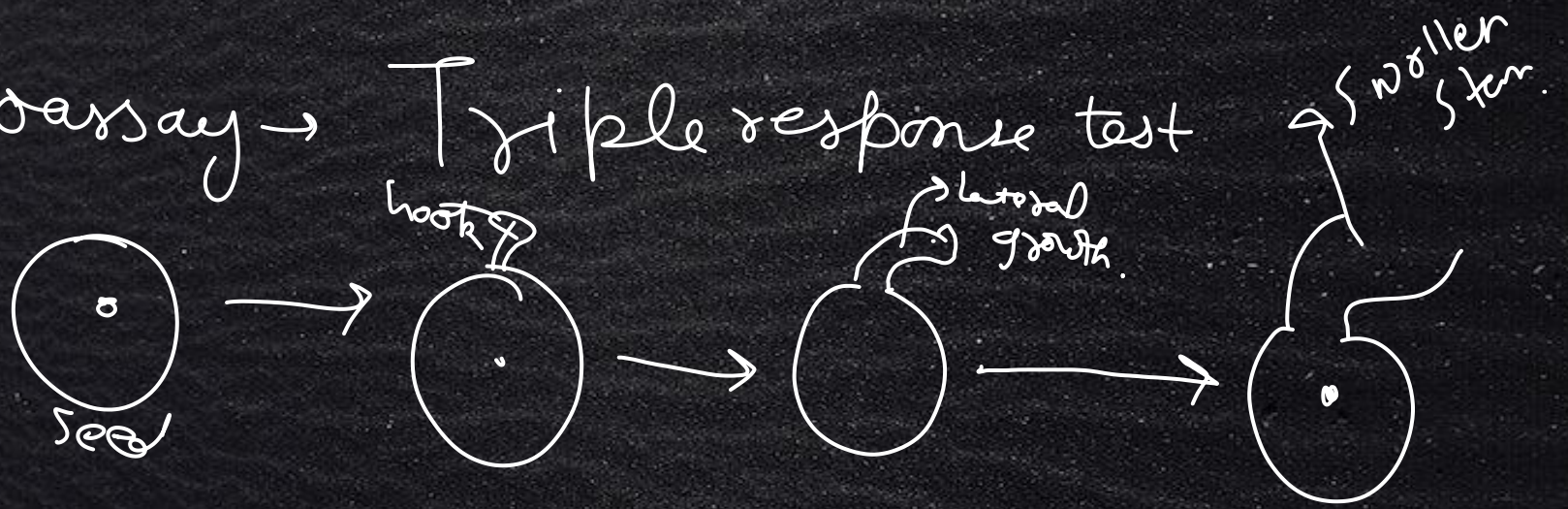
Discovery → done by H.H Cousins (1918).

They took a.

Kept both together for few days

Then observed → Banana ⟶ ripened.

Bioassay → Triple response test



Physiological role

↳ Promotes senescence.

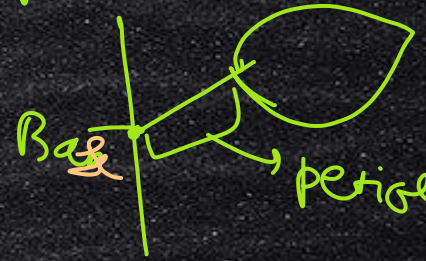
↳ Promotes Abscission (falling of mature leaves)

↳ fruit ripening

↳ At the time of ripening - respiration rate high

So, it increases climacteric effect

↳ It helps in stem & petiole enlongation



Submerged aquatic plants

partially Submerged

Rice.

(In other plants → Gibberllin helps in enlongation)