Kicchakishor III BSC CBZ 025

plant physiology - III
CYTOLOGY, Genetics,
Evolution & plant Breeding.

paper 7 & 8 NOTES.

"Kishor publications"

prepared by myself
my own notes.

25-04-2020 : saturday.

- m.R. kuy

" If You want To
Succed
Never Compare
Yourself with Anyone
Else. Ever.
- Kicchakishor
[m.R. kuy]

ENZYMES.

A substance produced by a living organism which acts as a catalyst to bring about a specific chemical reaction.

* The 1st enzyme was isolated by E. Buncher in 1903 for which he was awarded Noble prize.

Active site: It is a region on the surface of an enzyme to which substrates will bind & catalyses a chemical rxn.

Substrate: The biochemical which is acted upon by an enzyme.

product: The chemical formed after the completion of a rxn are turned as product

Exoenzymes: Enzymes functional outside the living cells.
Ex:- Enzymes present in digestive juices, lysozymes of tears.

Endoenzymes: Enzymes functional inside living cells
Ex: Enzymes of kreb cycle
Enzymes of glycolysis

Nomenclature:
Enzymes are named after the reaction they catalyses Alc IUBN an enzyme has 2- parts

* 1st part is the name of the substrate for the enzymes
* 2nd part is the type of reaction catalyzed by the enzyme. this part ends with the suffix 'ase'

Ex: Lactate dehydrogenase is the enzyme that oxidises lactate by removing 2 atoms of hydrogen from it.

classification:

1) oxido reductase: These catalyse oxidation (or) reduction of their substrate & act by removing (or) adding $\bar{e}$s from substrate

$$2A+H_2+O_2 \xrightarrow{\text{oxidase}} 2A + 2H_2O \; ; \; A + 2(H) \xrightarrow{\text{reductase}} A+H_2$$

2) Transfuase: The enzyme transfers specific group from one substrate to another.

Glutamic ā + oxaloacetic a $\xrightarrow{\text{transfuase}}$ α-lactoglutaric ā + Aspartic ā.

3) Hydrolases: The enzymes catalyze the hydrolysis of complex substrate into simple ones.

Ex: Starch into glucose.

$$C_{12}H_{22}O_{11} + H_2O \xrightarrow{\text{maltase}} 2C_6H_{12}O_6$$

4) Lyases: These catalyse the removal groups from the substrate without addition of water.

Ex: fructose 1,6 diphosphate → dihydroxy acetone phosphate + phosphoglyceraldehyde.

6) Isomerases: These catalyse the rearrangement of molecular str to form isomers.
Ex: Glucose-6-phosphate isomerase fructose-6-phosphate.

6) ligases: These catalyse covalent bonding of 2 substrate to form a large molecule
Ex: pyruvate carboxylase + pyruvate + CO_2 → oxalo acetate.

Isoenzymes: Enzymes which perform similar fun but having dif molecular str

Zymogens: These are inactivated forms of enzymes secreted by cells. these can be activated to the normal enzyme state by chemical modification

Simple enzyme: It is an enzyme which is wholly made up of protein. Active site is formed by specific grouping of its own amino a.
Ex: pepsin, trypsin, urease.

Conjugate enzymes: It is an enzyme which is made up of both protein part, & non-protein part.
Conjugated enzyme = protein part + Non protein part
Holoenzyme Apoenzyme

Coenzymes: They are low molecular weight, non-protein organic compounds that binds with an enzyme to catalyze a reaction

$$CH_3CH_2OH + NAD^+ \xrightarrow[\text{dehydrogenase}]{\text{Alchol}} CH_3CHO + NADH^+ + H^+$$

Alcohol — coenzyme.

NOTE: coenzyme cannot function alone, but can be reused several times when paired with an enzyme.

* Most of the coenzymes are derived from water soluble vitamins A

Metabolic roles in given in the following table.

	coenzyme	vitamin present	Bio function
1)	NAD & NADP	Nicotinic ā	Hydrogen / electron carrier
2)	flavin mono nucleotide	Riboflavin-B_2	—11—
3)	pyridoxal Phosphate	pyridoxine-B_6	Amino transfer Racemization
4)	Coenzyme B_{12}	cobalamine	Alkylation
5)	Lipoic ā	Lipoic ā	oxidoreduction

Co-factors: A cofactor is a non protein chemical compound (or) metallic ion that is required for an enzymes activity. cofactors can be considered "helper molecule" that assist in Biochemical transformations

The metal ion in such enzyme play imp role as.

1. The primary catalytic centre.
2. A bridging group to bind substrate & enzyme
3. An agent stabilizing the conformation of the enzyme

Vitamin properties of Enzymes.

* Most of the coenzymes are made of H_2O soluble vitamins B & C.
  Ex: Thiamine, riboflavin & pyridoxine.
* coenzyme TPP made up of vitamin B_1 helps in oxidative decarboxylation
* coenzyme FAD made up of vitamin B_2 helps in oxd^n (or) red^n rxn
* CoA made up of vitamin B_3 helps in acyl group transfer.
* coenzyme NAD^+ made up of vitamin niacin helps in oxd^n (or) red^n
* coenzyme Biotin made up of vitamin biotin helps in carboxylation process.

Mechanism of Enzyme action.

The basic mechanism by which enzyme catalyse chemical rxn begins with the bonding of the substrate to the active site on the enzyme. the active site is the specific region of the enzyme which combines with the substrate. It causes changes in the distribution of e in the chemical bonds of the substrate. & ultimately that lead to the form^n of

products.

Enzyme kinetics:

In 1913, michaelis & menten proposed an intermediate enzyme substrate complex is formed during the enzyme activity. The following scheme may be written to a illustrate concept

$$E + S \underset{k_2}{\overset{k_1}{\rightleftharpoons}} (ES)\ complex \xrightarrow{k_3} E + P.$$

Enzymes are biological catalyses which accelerate the rate of rxn by altering the kinetic properties. Thus the enzyme (E) excerpts its catalytic rou on the substrate (S) by forming an enzyme. Substrate complex (ES) by a vereuible reaction.

Each enzyme - catalyzed rxn has a characteristic Km value, which is the michaelis menten constant, which is a measure of the tendency of the enzyme & substrate to combine with each other.

$$K_m = \frac{k_2 + k_3}{k_1} = \frac{[E][S]}{[ES]}$$

Models for Enzyme action.

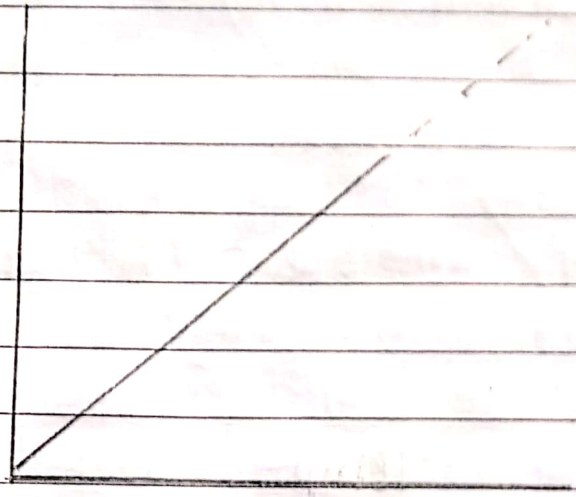
2 models have been proposed to account for the specificity & mode of enzyme action.

1) Lock & key model
2) Induced fit model.

factors affecting enzyme activity

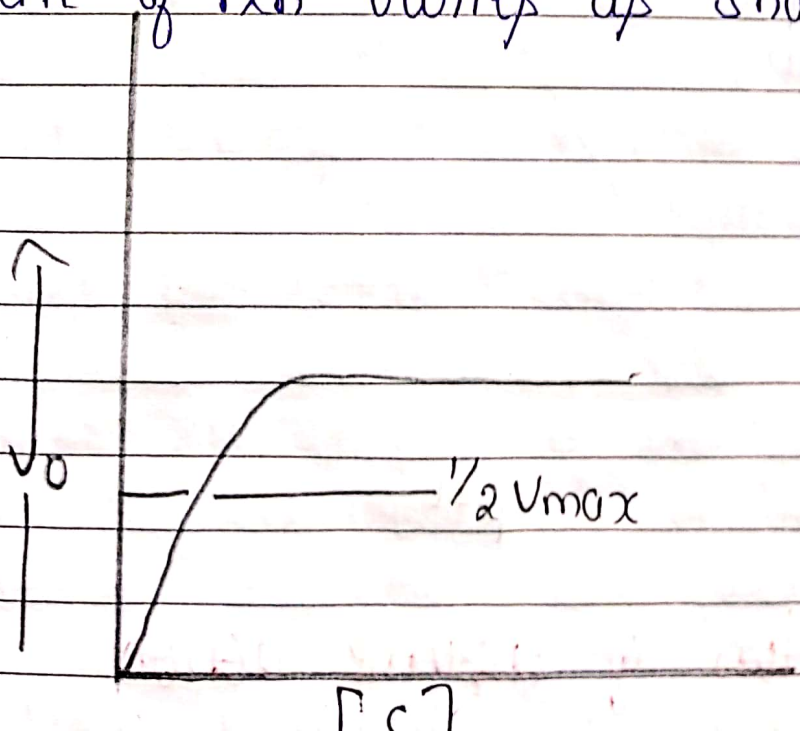
1) Enzyme conc.

The rate of enzyme catalyzed reaction is $\propto$ to the enzyme conc. the greater the conc. of enzyme. the faster will be the reaction.

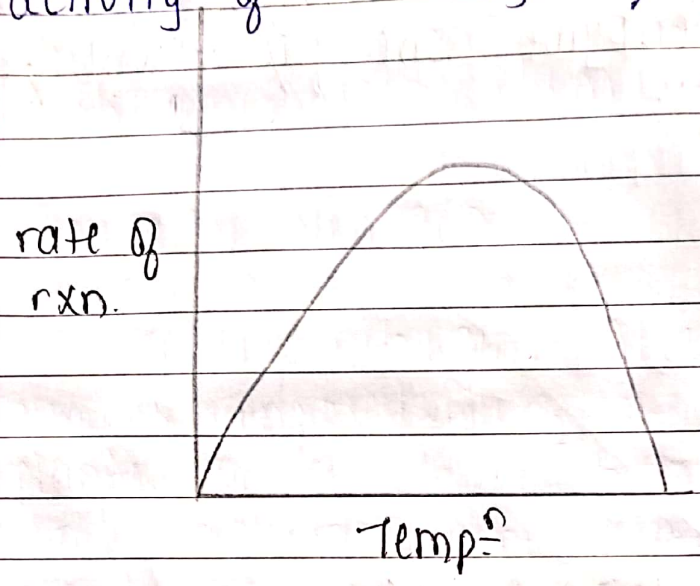


2) Substrate conc.

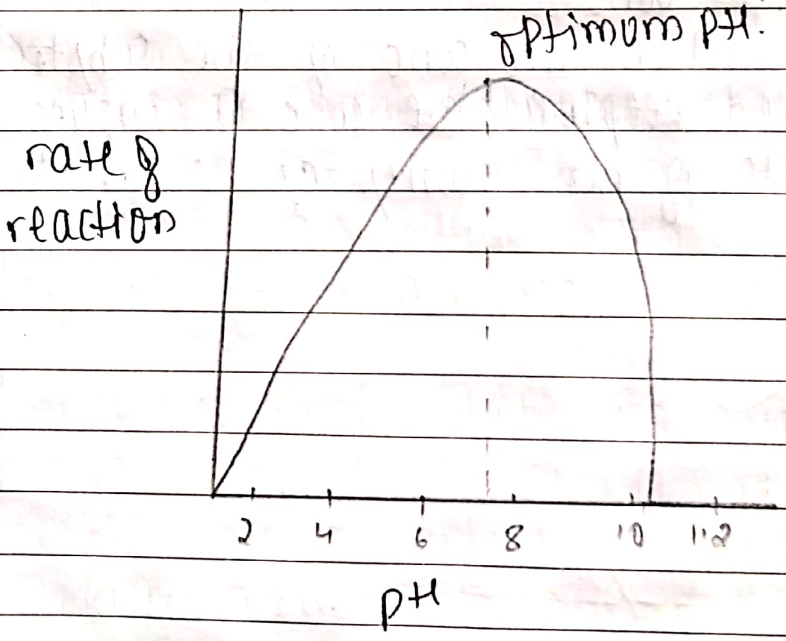
When the conc of the substrate alone is varied keeping the conc of enzyme const. the rate of rxn varies as shown below.



3) Temperature:
Usually the activity of the enzyme is optimum at normal body temp^{n}. At very low temp^{n} (i.e about 0°C) the activity of the enzyme is minimum.



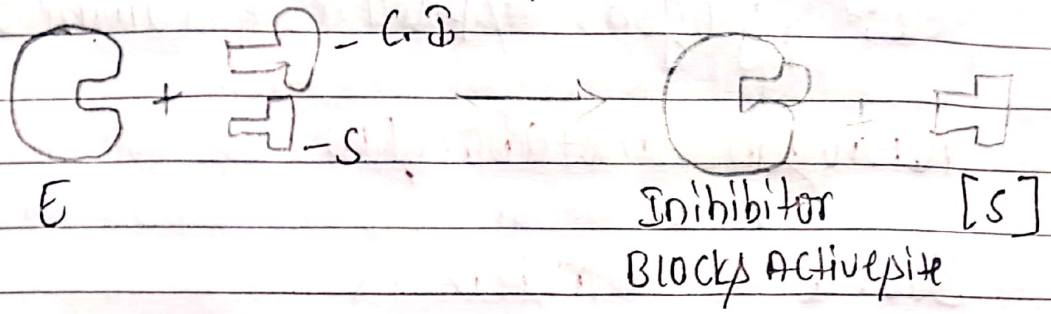
4) pH. Hydrogen ion concentration



Inhibition of enzyme action.

It is a substance which binds the enzyme & decrease the catalyzed activity is known as enzyme inhibition.

ii) Competative Inhibitor: In this type of inhibitor closely resembles the substrate in str hence it is completes the substrate binding to active site.



iii) Non-competitive Inhibitors: They are usually poisions which do not compete for the active sites but destroy the str of the enzyme & causes permenant inhibition of the activity of the enzyme.

iii) feed Back Inhibition: End products of a rxn are not removed from the system that accumulate & brings about inhibition of enzyme action.

Allosteric enzymes: It tend to be multi-subunit proteins. the reversible binding of an allosteric modulator affects the substrate binding site

* The end product which binds to the allosteric site is called modulator & enzyme itself is known as allosteric enzymes

* It is dif from non-competative inhibition in that life end product that pathway which blocks the enzyme action

* It need not always be inhibition of enzyme action. In many case end product may be activate the 1st enzyme of the series.
Exs: Glycogen, Aspaeate, Glucamine etc

Nitrogen metaboilsm.

Source of Nitrogen.

1) Atmospheric nitrogen:- About 78% of earths atm is composed of n_2 the majority of the plants cannot utilize from of nitrogen. only some bacteria, some BGA, legumindus plants etc, can fix atmospheric nitrogen.
- Atmospheric N_2 is converted to NO_3^- by lightening.

2) Geological source: Nitrogen present in the rock. Nitrogen in rock originates as organically bound n_2 associated with sedimebt, mantel (stone) & metealc (solid) source of N_2.

3) Agriculture land: These are associated with major nutrient source & sinks at the land surface major surface includes fertilizer application to crop, N_2 fixation by legumi-nous crops & livestock waste

4) Livestock & poultry operations: Nationwide approximately 7 billion farm animal generate millions of tons of manure containing

Some 6.5m tons of nitrogen

6) urban waste Industrial emissions & fossil fuel combustion contribute gaseous nitrous oxide & nitrate as nitric a from nitrogen source.

Nitrogen fixation

N_2 fixation.

Non Biological — Biological

Asymbiotic — Symbiotic.

1) Non-Biological

a) Natural N_2 fixation:- under the influence of lightening & thunder N_2 & O_2 of the air react to form NO. the NO are again oxidises with O_2 to form NO_2.

$$N_2 + O_2 \longrightarrow 2NO$$
$$2NO + O_2 \longrightarrow 2NO_2$$

During the rains, NO_2 combines with rain water to form nitrous acid (HNO_2) & HNO_3 After the rain water react with alkaline radicals to form soluble nitrates (NO_3^-) & (NO_3^-).

$$2NO_2 + H_2O \longrightarrow HNO_2 + HNO_3$$
$$3NO_2 + H_2O \longrightarrow 2HNO_3 + NO.$$
$$HNO_3 + Ca\ (or)\ K\ salts \longrightarrow Ca\ (or)\ K\ nitrates$$

b) Industrial N_2 fixation.

Ammonia is produced industrially by

direct combination of N with H at high temp & pressure later, it is converted into various kinds of fertilizer such as urea etc.

2) Biological Nitrogen fixation.

=> BNF occurs when atm nitrogen is converted to ammonia by an enzyme called Nitrogenase

=> The Biological fixation of Nitrogen may be asymbiotic & symbiotic

a) Asymbiotic N_2 fixation:

Many bacteria such as clostridium, Agobacteria etc, live independtly in soil, man BGA posses certain specialized cells called Heterocysts.

b) Nif genes in relation to symbiotic fixation in Rhizobium.

Term coined be debory.

* nif:- Nitrogen inducing fixing gene.
* It is brought about by bacteria Rhizobium
* The rhizobia are gram-ve, non-spore producing aerobic, rod-shaped bacteria ranging blw 1.2 - 30.0 x 0.5 - 0.9 M in size.
* Their symbiotic relationship with leguminose members in species specific.
* The free living rhizobia lying on the soil particle surface infect the leguminous plant through their root hair

* The roots of their host plants secretes some growth substance which cause of rhizobia around them.
* The bacteria produces curling factor which brings about twisting & partial deformation of root hairs.
* The infection thread passes through the cortex & reaches the pericycle.
* The inner cortical cells now d/f the nodule primordium.
* cell division occurs in the cells of endodermis & pericycle
* The uninfected cortical cells from the nodule whereas the inner core contains the bacteria
* The nodule contains a red color pigment called leghaemoglobin (LHB).
* The fixation of nitrogen is brought about by the enzyme nitrogenase.

Synthesis of Amino acid:

Amino a are a group of organic Compounds containing 2 - functional groups - amino ($-NH_2$) & - carboxyl ($-COOH$)

* Amino a are the building blocks of proteins
* Ammonia is very quickly incorporated into organic seeds to produce various amino a & amides
* Amino acid are synthesized in plant by 2 - Biosynthetic pathway.
  1) Reductive amination
  2) Transamination.

1) Reductive amination:

Organic acid gets directly converted into amino ā by reacting with ammonia in presence of $NADH_2$ under the influence of the enzyme dehydrogenase

Organic ā + NH_3 + $NADH_2$ $\xrightarrow{\text{dehydrogenase}}$ Amino ā.

The amination of a ketoglutaric ā to produce glutamic ā is a key importance as it provides a link blw respiration & protein synthesis in plant metabolism.

Synthesis of Glutamic ā takes place when NH_3 is accepted by α-ketoglutaric ā in the presence of $NADH_2$ & glutamic dehydrogenase

oxaloacetic ā + NH_3 ⟶ Aspartic ā

fumasic ā + NH_3 ⟶ Aspartic ā

pyruvic ā + NH_3 ⟶ Alanine.

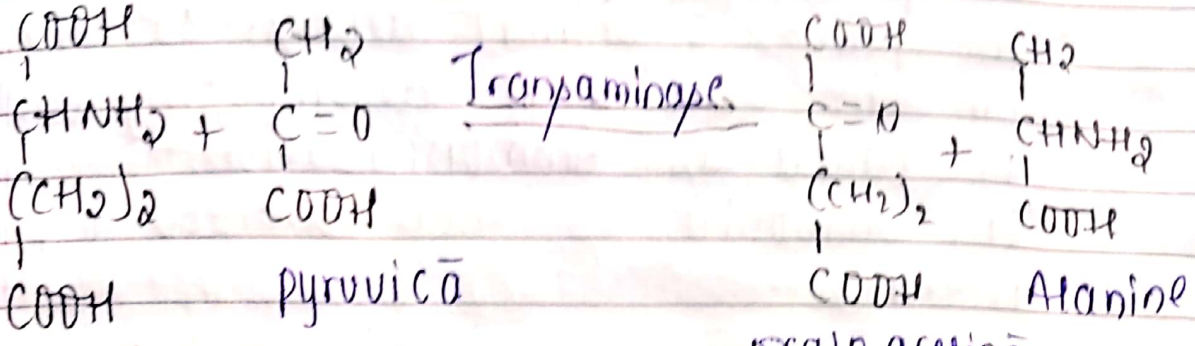
α-ketoglutaric ā + NH_3 + $NADH_2$ $\xrightarrow[\text{dehydrogenase}]{\text{Glutamic}}$ Glutamic ā

2) Transamination

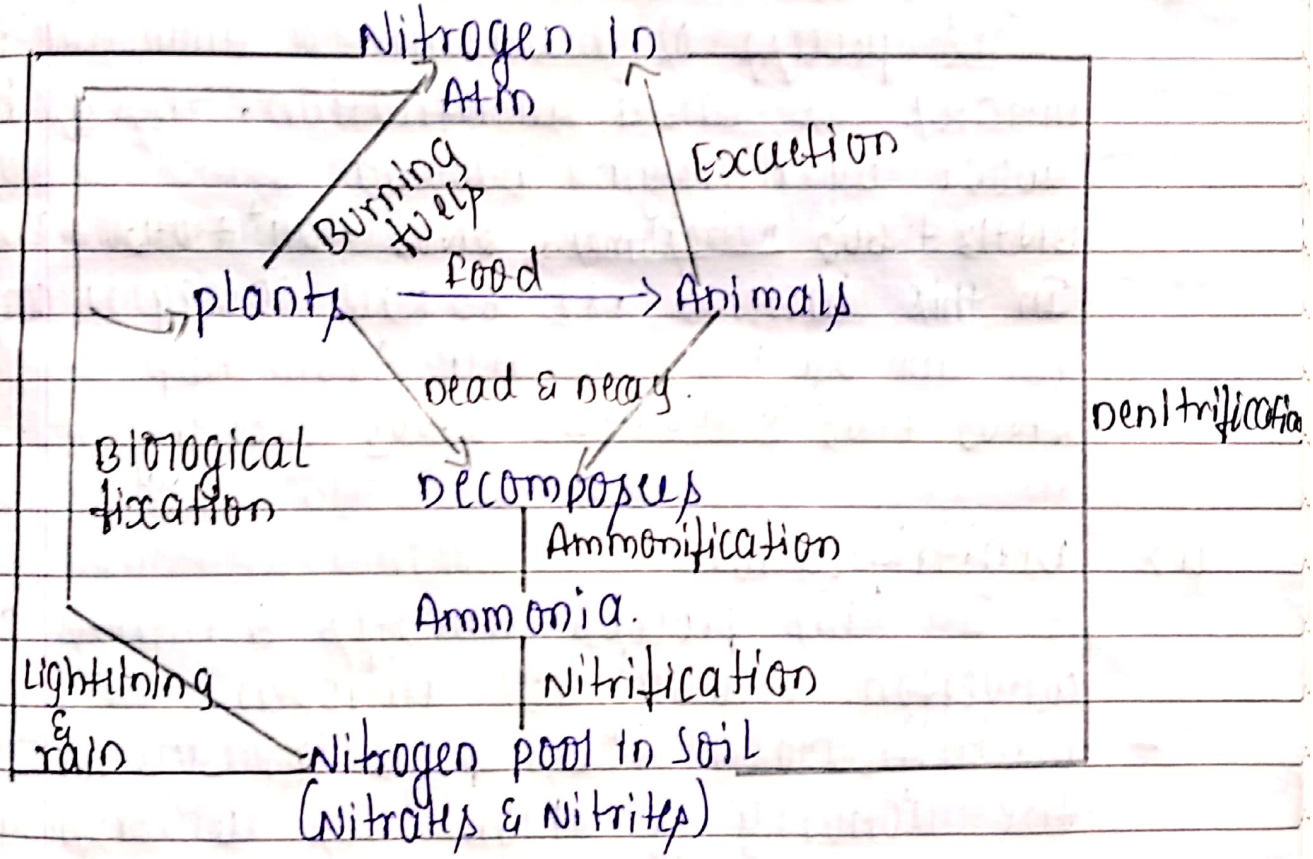
It is defined as the transfer of amino group from an amino ā to a COOH ā & in this process, the amino ā becomes a COOH ā & the COOH ā becomes an amino ā

* When once the key amino ā, glutamic ā is produced it produces a no of amino ā by the transamination rxn
* Transamination is catalyzed by the

enzyme transaminase.



Nitrogen cycle.



The nitrogen cycle can be conveniently discussed under the following 4-heads
1) N_2 fixation
2) Ammonification
3) Nitrification
4) denitrification

2) Ammonification.

The process of production of ammonia from the plant & animal debris, excreta etc. by the activity of decomposing bacteria is called as Ammonification.

- The ammonia is then oxidized to produce nitrates
- many saprophytic fungi are also known to produce ammonia from plant & animal remains.

3) Nitrification.

The process of conversion of ammonia into nitrates is called nitrification. this is brought about by nitrifying bacteria.

$3NH_3 + 3O_2 \xrightarrow{\text{Nitrosomes}} 2NO_2^- + 2H^+ + 2H_2O + \text{Energy}$.

In this bacteria rxn 65 kcal energy is consumed for the synthesis of ATP from ADP.

$2NO_2^- + O_2 \xrightarrow{\text{Nitrobacter}} 2NO_3^- + \text{Energy}$.

4) Denitrification.

In this process nitrates & nitrites are converted into gaseous nitrogen.

- Denitrification takes place in soil through the activity of thiobacillus denitrificans, pseudomonas denitrificans etc.
- Thiobacillus converts nitrates into sulphate & N_2 in presence of Sulphur & H_2O some amt of energy released during the process

$6KNO_3 + 5S + 2H_2O \longrightarrow K_2SO_4 + 4KHSO_4 + 3N_2 + \text{Energy}$

Bio Energetics.

photosynthesis.

The synthesis of food materials like carbohydrates in the green parts of the plant body by using CO_2 & H_2O in the presence of sunlight.

$$6CO_2 + 12H_2O \xrightarrow[\text{chloropyll}]{\text{light}} C_6H_{12}O_6 + 6H_2O + 6O_2\uparrow$$

* 1^0 source for the all food on the earth.
* Responsible for the release of O_2 in to the atm by green plants.

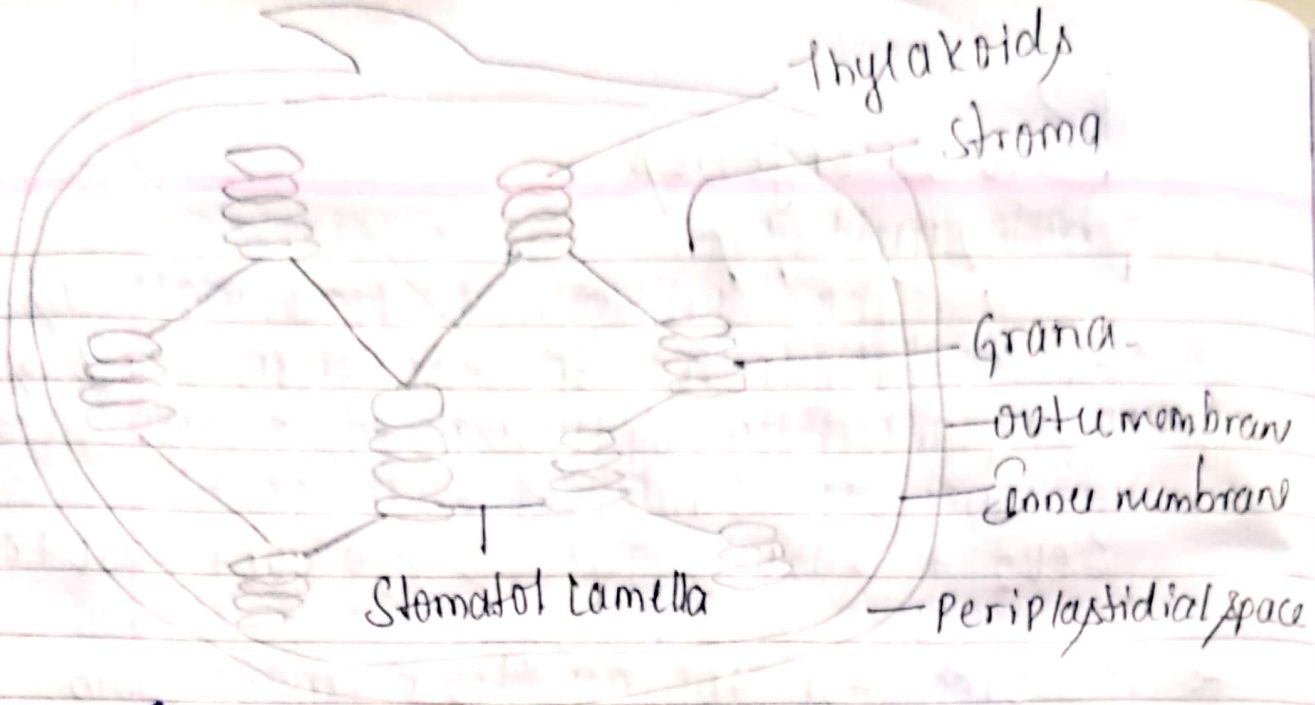
Significance of photosynthesis.

* It most important natural process which sustains life on earth.
* It produce food to all living organisms including Humans
* All useful plant products are derived from the process of photosynthesis.
* productivity of agriculture crops depends upon the rate of photosynthesis.

Ultra structure of chloroplast

Chloroplast is green plant constitue the photosyntetic apparatus & and act as site of photosynthesis chloroplast. ellipsoidal in Shape 4-6 μ in length & 1-2 μ in thickness The tichness of 2 membranes including periplastidial space is approximately 300 A°

p.T.O



Ground substance of chloroplast is filled with a hydrophilic matrix known as stroma. It contains DNA, RNA, plastoribosome, enzyme for CO_2 assimilation, proteins. In stroma are embedded a no of flattened membranous sacs known as thylakoids. Each thylakoids encloses a space called aploculos. end disc shape thylakoid called as margin.
Aggregation of thylakoids to form stacks of coin like structure called geana. Some of grana lamella are connected with thylakoids of other geana by stroma lamella.

photosynthetic apparatus.
It grouped into 3 categories.

a) chlorophyll: chlorophyll it is the main pigment concerned with traping the light energy (or) sonar energy.
chlorophyll is classified into 9 types
chl-a, chl-b, chl-c, chld, chl-e, bacteriophyll bac. chl-b, Chl 650, chl-660.

chlorophyll - a [$C_{55}H_{72}O_5N_4Mg$].
Bluish green pigment present in all green plants.
chlorophyll b: [$C_{55}.H_{70}.O_6.N_4Mg$]
yellowish green pigment present in green algae & higher plants.

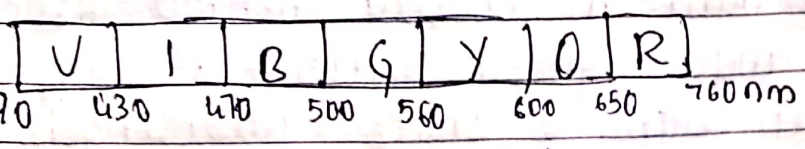
Carotenoids: It is a accessory pigments
2 types: orange coloured carotenes.
yellow coloured xanthophyles.
They are not soluble in water.

phycobilins: H_2O soluble pigments in red algae & blue green algae
Common phycobilins are pycoerthrin & phycocyans.

Quantasome: A group of pigment molecule required to a photochemical reaction.
It is present in membrane of the thylakoids.

principle of light absorption

The electromagnetic radition from the sun will be in form of a stream of minute particles called photons.
Light shows wave nature also. wavelength of visible light ranges from 390nm to 760nm & it consists of seven colors. [VIBGYOR].

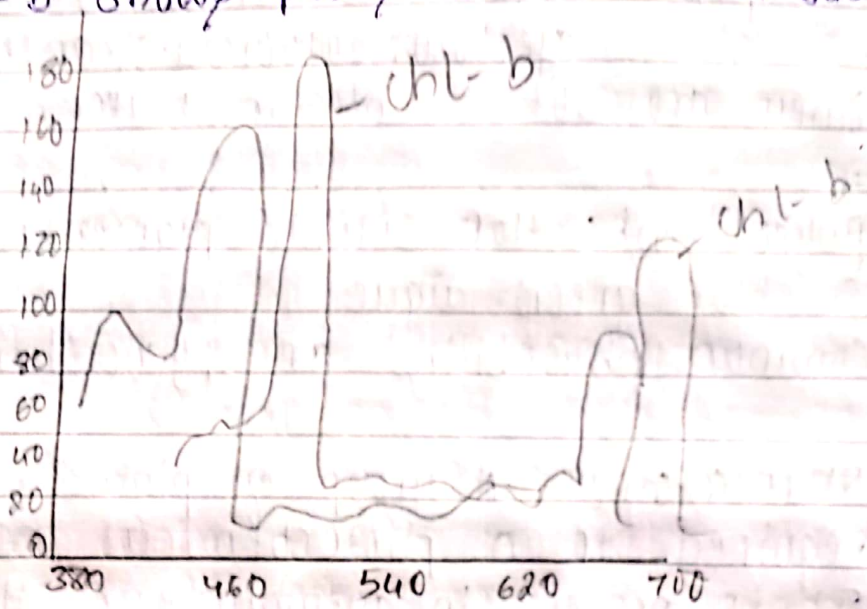


A particle of light containing a packet of energy is called quantum - hv.

Ex: 70K cal aprox for blue light & 40K cals approx for red light

A Graph showing the absorption of light by pigments at dif wavelength is called absorption spectra

* chl-a shows peaks of absorption at 430nm & 662 nm
* chl-b shows peaks at 453nm & 642nm



Absorption spectra of chl a & chl-b.

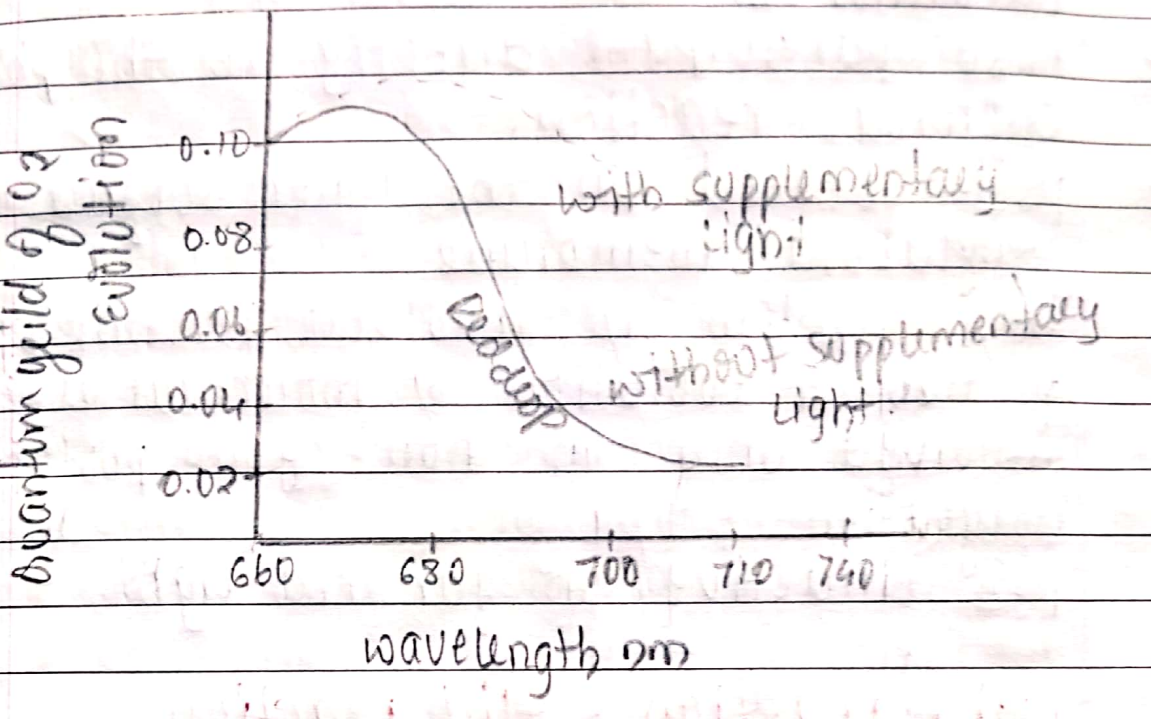
Emerson's-Enhancement Effect

R. Emerson & Lewis (1903) while determining the quantum yeild of photosynthesis in chlorella by using monochromatic light of dif wavelength

Emerson found that the inefficient for red light in chlrea behind 680nm could be made fully efficient it supplemented with light of short wavelength.

The quantum yeild from the 2 combined beams was found in greate than the

effect of both beams when used seperately this enhancement of photosynthesis is called Emerson - Enhancement effect.



photosystem.

1. photosystem - I

* It comprises about 200 - 400 chlorophylls & 50 carotenoids
* A single molecule of chla reaction centre P700
* ps-I located on the outersurface of thylakoid membrane
* molecular oxygen is not evolved
* Involved in both cyclic & non-cyclic photophosphorylation
* ps-I is active in both red & far red light.

photosystem - II

* It comprises about 200 chlorophylls & 50 carotenoids.
* P_{680} participate directly in the photo chemical reaction.
* PS II located on the inner surface of thylakoid membrane
* This system is involved for the splitting of H_2O & evolution of molecular oxygen
* Involved only in non-cyclic photophosphorylation.
* PS II inactive in far red light.

Light reaction - Hill reaction

It is also called photochemical rxn takes place in thylakoid membrane & it is complutely depend on light. the raw materials for this rxn are pigments, H_2O & sunlight.

* It is involved in 3 steps

a) Excitation of chlorophyll:

It is 1st step of light rxn. when P_{680} (or) P_{700} of 2 pigment system receives quantum of light then it becomes excited & releases electrons.

b) Hill rxn:

Hill observed that chloroplasts extracted from leaves of stellaria media & lamium album when suspended on a testtube containing suitable $\bar{e}$ acceptor oxygen

evolution took place due to photochemical splitting of H_2O
Mn, Ca & Cl ions play prominent role in the photosynthesis of H_2O. this rxn is called Hill reaction

$$4H_2O \xrightarrow{light} 4H^+ + 4OH^-$$
$$4OH^- \longrightarrow 4(OH) + 4\bar{e}$$
$$4(OH) \longrightarrow 2H_2O + O_2\uparrow$$
$$2H_2O \longrightarrow 4H^+ + 4\bar{e} + O_2\uparrow$$

The evolved O_2 contains heavy isotope. if photosynthesis is allowed to proceed in presence of CO_2 & normal water then heavy oxygen is not evolved.

$$6CO_2 + 12H_2O^{18} \xrightarrow[\text{Chlorophyll}]{\text{Sunlight}} C_6H_{12}O_6 + 6H_2O + 6O_2^{18}$$

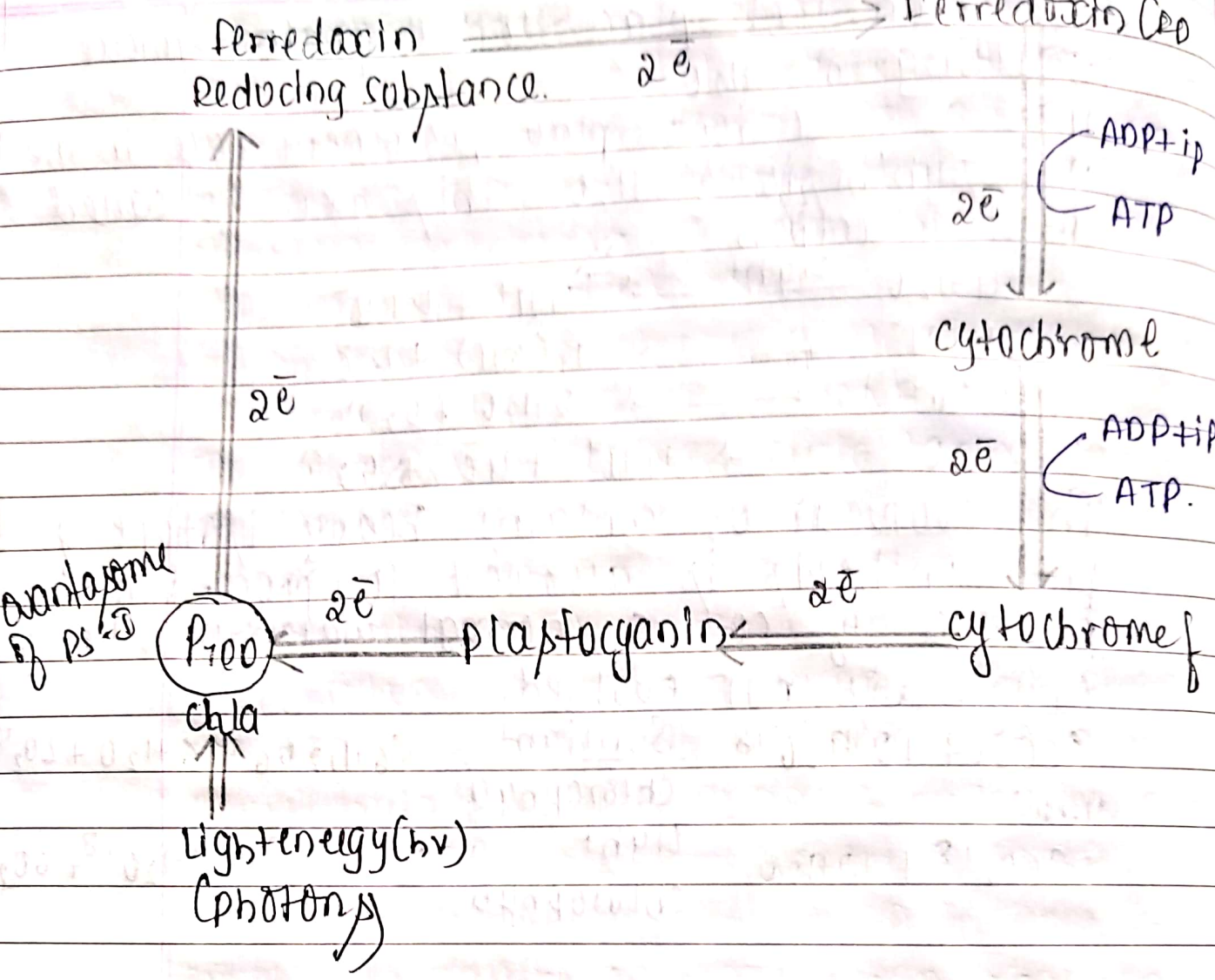
$$6CO_2^{18} + 12H_2O \xrightarrow[\text{chlorophyll}]{light} C_6H_{12}O_6^{18} + 6H_2O^{18} + 6O_2$$

photophosphorylation.

Synthesis of ATP from ADP & ip in presence of light in chloroplast is called photophosphorylation.
It has 2 types.

1. cyclic photophosphorylation.

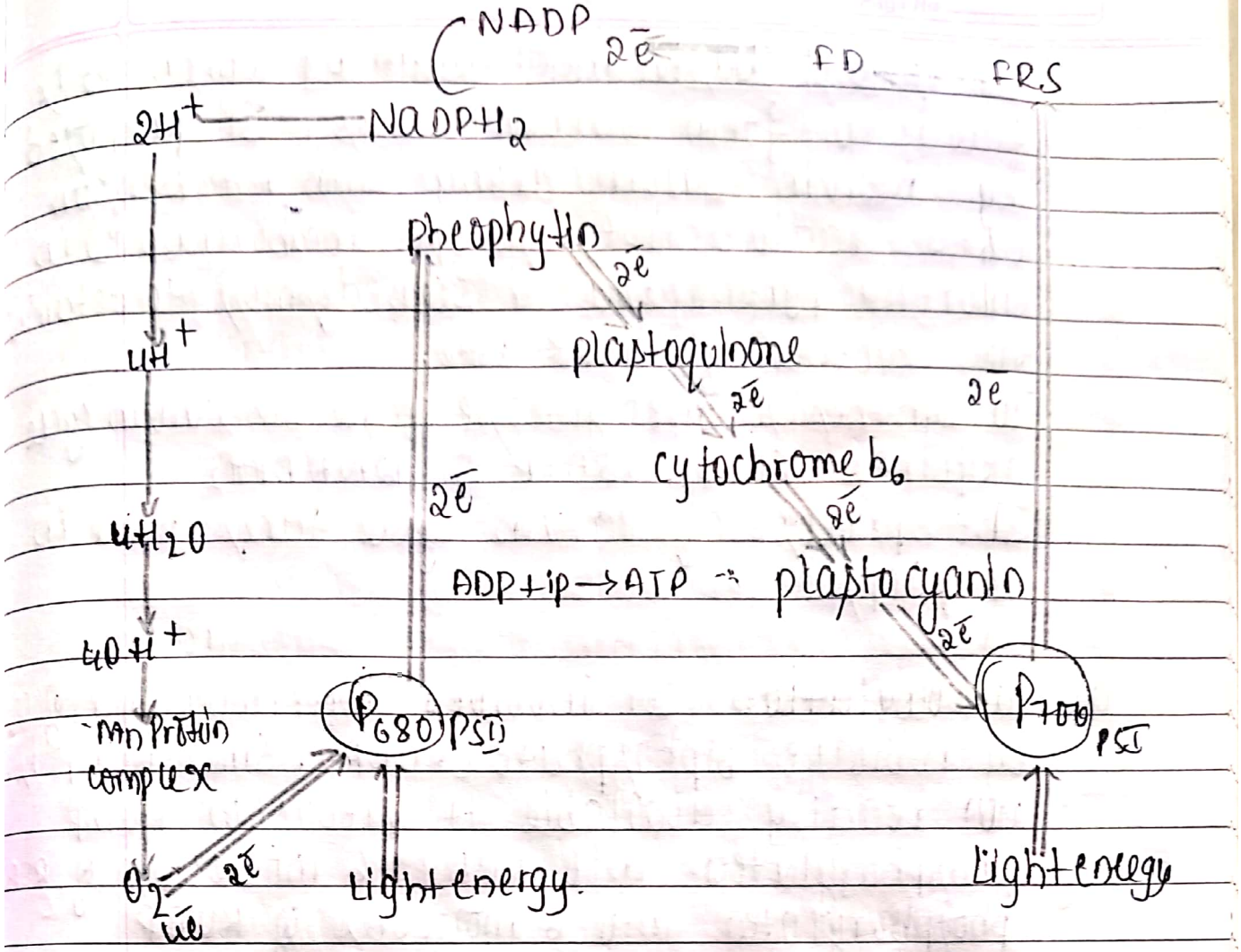
* A series of $\bar{e}$ carriers. It occurs under cond^n of low light intensity.
* only PS I is involved
* primary acceptor of electrons is A_1
* Not accompained with photolysis of H_2O
* The only product is ATP



2) Non-cyclic photophosphorylation.

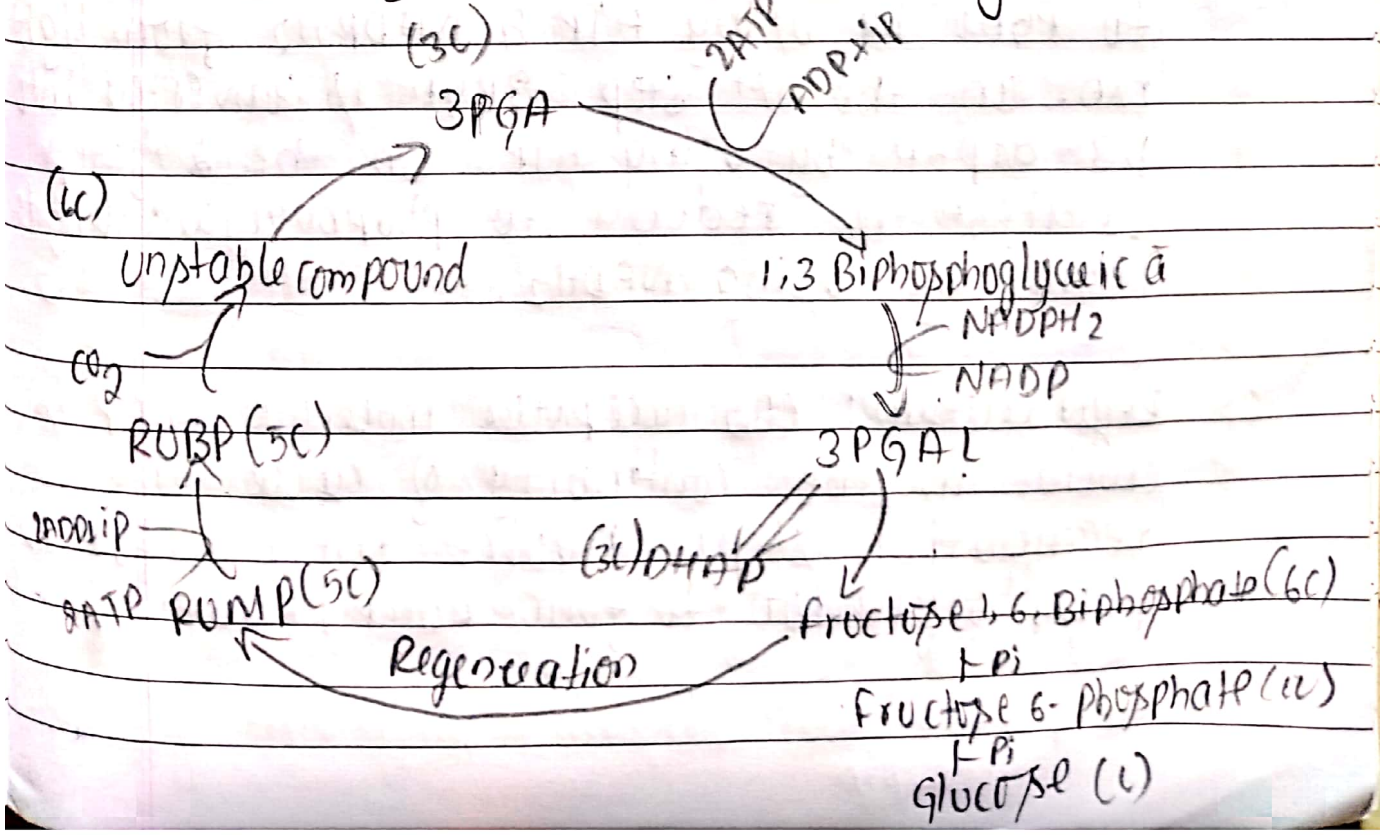
* Electron releasing in non-cyclic
* Both PS I & II are involved.
* primary acceptor of electrons is phaeophytin
* It is accompained with photolysis of water
* The products produced are ATP, $NADPH_2$, O_2 & H_2O.

P. T. O.



Carbon reactions

a) calvin cycle (or) C_3 pathway.



It is the basic mechanism by which CO_2 is fixed to form carbohydrates. It proposed by melvin. calvin along with A A Benson used radioactive isotope tocarbon (C^{14}) in chlorella pyrenoidsa & scenedesmos to determine the sequence of dark rxn.

To synthesis one glucose molecule calvin cycle requires $6CO_2$, 18ATP & $12NADPH_2$

The process of calvin cycle takes place in 3 steps:

a) carboxylation: It involves the acceptance of CO_2 by rubisise biphosphate (RUBP). Since RUBP is not readily available it precussor RUMP phosphorylated into RUBP. 6 molecules of RUMP phosphorylated into 6 molecules of RUBP.

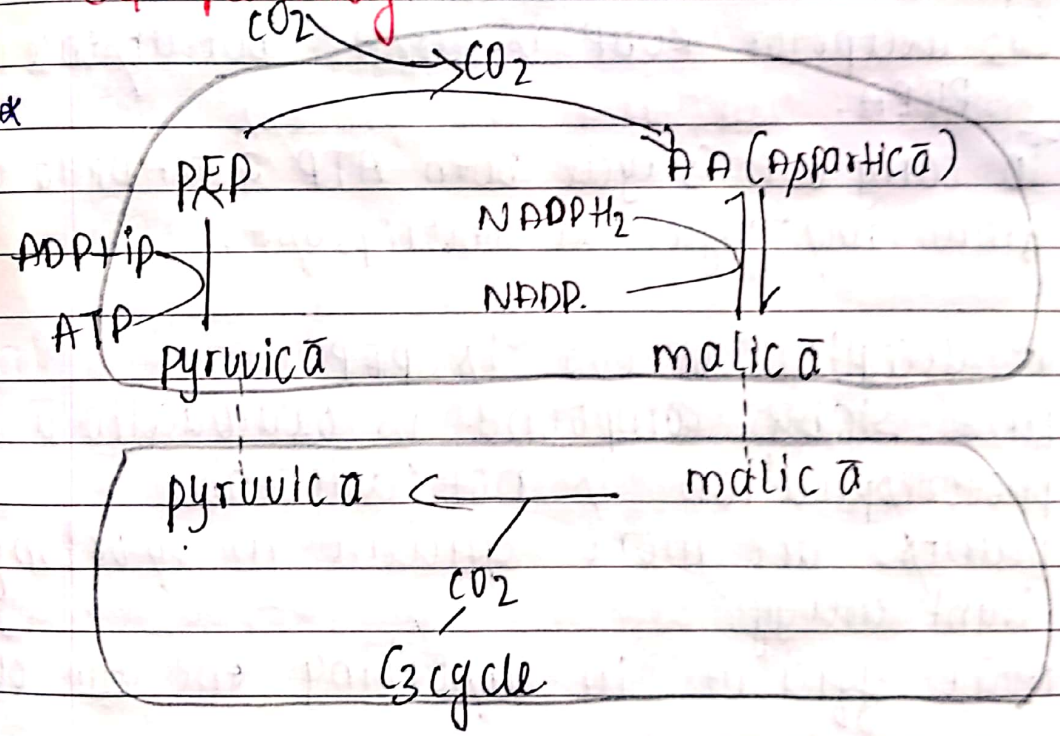
The fixation of CO_2 by RUBP to form 6-carbon compound called carboxylation reaction.

b) Reduction: during this phase 3 PGA reduced to PGAL by using ATP & $NADPH_2$ from Light rxn. In the 1st step 3PGA is converted into 1,3-dipGA by using ATP. In the 2nd step 1,3 dipGA is reduced to phophoglycealdehyde (PGAL) by using $NADH_2$.

c) Regeneration: CO_2 accepetor molecule RUBP is crucial in the continuity of cycle. the regeneation steps require one ATP for phosphorylation to form RUMP / RUBP

Light rxn	Dark rxn
* It takes place in sunlight	* Takes place in the absence of sunlight.
* It occurs in grana region of chloroplast	* It occurs in stroma region of chloroplast
* photosystem Involved	* PS-I & II not involved.
* ATP & NADPH2 are synthesized	* ATP & NADPH2 are utilized
* free molecular O2 is liberated	* free molecular O2 is not liberated.
* Electro transfer is involved	* Electron transfer is not involved.

C4 pathway



* It occurs mostly in tropical & sub-tropical region.
* Kranz anatomy is absent
* Dimorphic chloroplast is present
* Hatch-stack cycle occurs in mesophyl cell & calvin cycle occur in bundle sheet cell.

In mesophyll cell.

* chloroplast is small in size.
* well developed geanum & loss developed stroma
* Non cyclic photophosphorylation takes place.
* ATP & $NADPH_2$ produces
* final stable product OAA produces

In Bundle sheath cell.

* chloroplast is large in size.
* Stroma is more developed but grana is poorly developed.
* Non cyclic photophosphorylation doesn't takes place
* CO_2 accepter RuBP is present but absence of PEPA.
* To carry out C_3 cycle both ATP & $NADPH_2$ comes from mesophyll cell chloroplast.

* 1° acceptor of CO_2 is PEP
* first stable compound is oxaloacetic ā
* photorespiration is not detectable
* plants are more efficient in absorbing light energy
* more efficient in absorbing the atm CO_2.

Significance of C_4 cycle.

* C_4 plants requires atleast 5ATP & 2 molecules of reduced NADP to fix one molecules of CO_2
* C_4 plants have 2-3 times more yeild as compared to C_3 plants.
* C_4 plants can perform a high rate of photo-synthesis

(AM (Crassulacean Acid metabolism) pathway

It is a mechanism of photosynthesis which occurs in succulents & some other plants of dry habitats when the stomata remain closed during day time & open only at night. the stroma of mesophyll chloroplasts but at different times, night & day.

Ex:- Sedum, kalanchae, opuntia, pineapple etc.

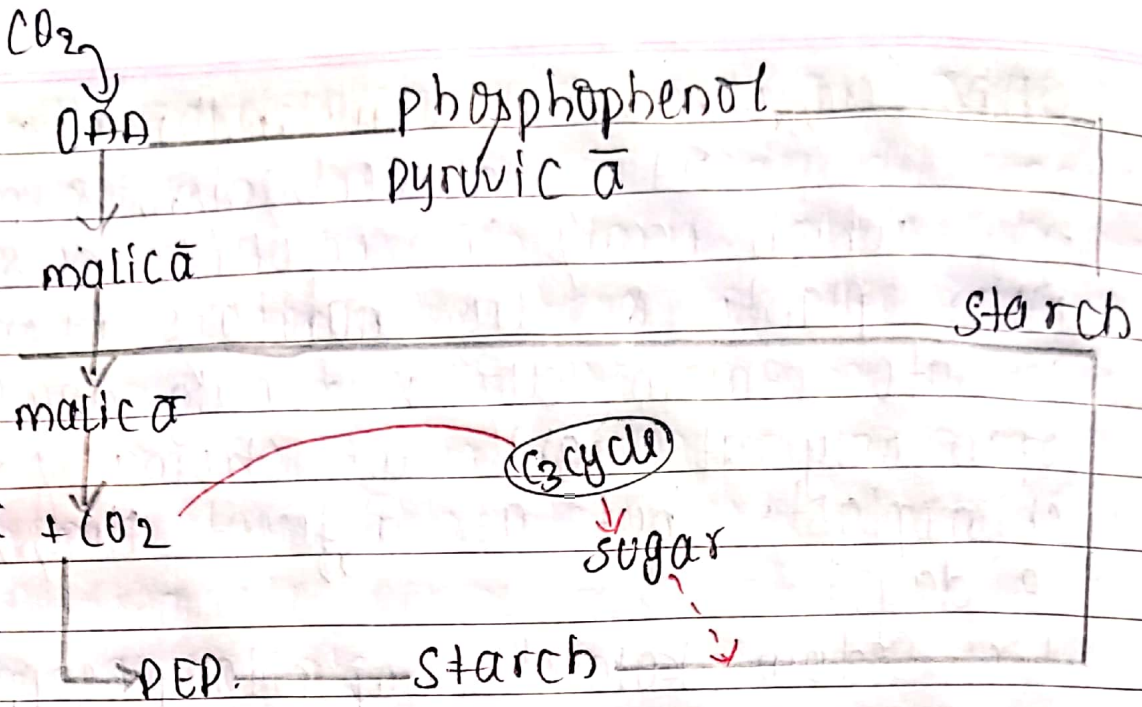
Characters of CAM plants.

* Stomatal movement of scoto-active
* Presence of monomorphic chloroplast
* Absence of kranz anatomy.
* It is more similar to C4 plants than C3 plants.
* In these plant pH decrease during night time & increase in during day time

Mechanism of CAM Pathway

→ During Night: Stomata of crassulaceae plants remains at night. CO_2 is absorbed from outside with the help of phosphenol pyruvate carboxylase enzyme. the CO_2 is immediately fixed & here the acaptor molecule is PEP. malic ā is the end product of dark rxn of CO_2. It stored inside cell vacuole.

→ During day: In this time the stroma in crassulaceae plant remain closed to check transpiration But photosynthesis does not take place in the presence of sunlight. maleic a moves out of the cell vacuoles. it is decarboxylated with the help of malic enzyme. pyruvate is produced



Significance of CAM.

* CAM plants increas their water use efficiency
* CAM plants can also obtain a CO2 compensation point of zero at night.

factors affecting the process.

a) External factor.
   i) Light
   ii) CO_2
   iii) Temp
   iv) H_2O
   v) O_2
   vi) mineral elements [mg, fe, co, mn, a].

b) Internal factor.
   i) chlorophyll
   ii) End products
   iii) protoplasmic factors

photorespiration.

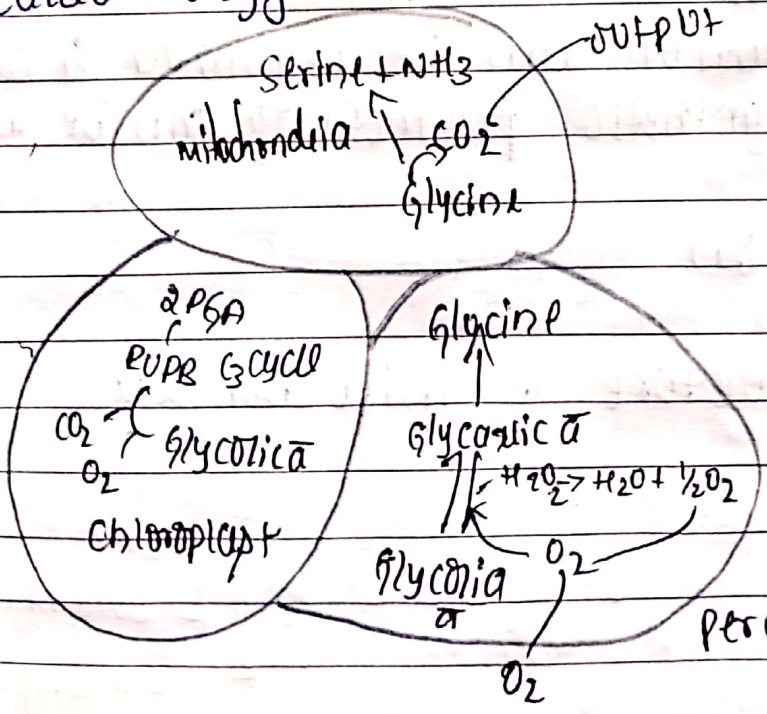
It can be defined as "the respiration that occurs in green cells in the presence of light resulting in the evolution of excess CO_2.

Organelles involved:

It involves three cell organelles viz chloroplast, peroxisome & mitochondria for its completion, perioxisome the actual site of photorespiration contains enzyme like Glycolate oxydase, Glutamate glyoxylate aminotransfease, peroxidase.

Mechanism of photorespiration

The enzyme RUBISCO catalyses the carboxylation reaction where CO_2 combines with RUBP for calvin cycle to initiate. But this enzyme RUBISCO under intense light has the ability to catalyse the combination of O_2 with RUBP a process called oxygenation



In other words the enzyme RUBISCO can catalyse

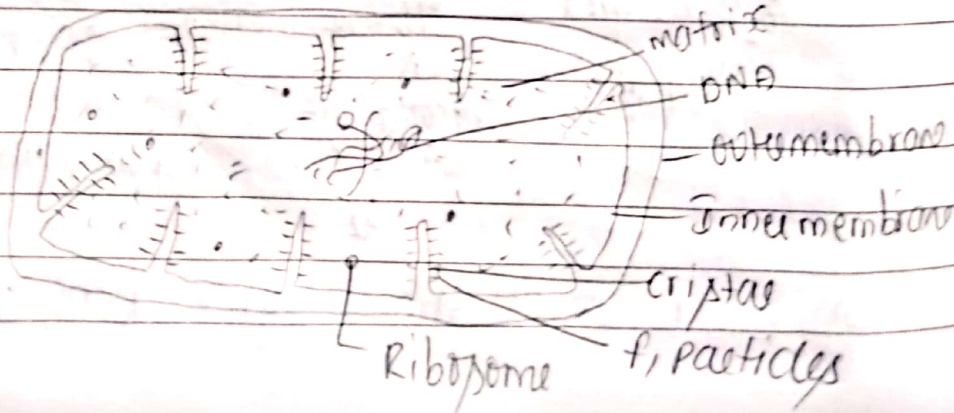
both carboxylation as well as oxygenation rxn in green plants under dif condition of light & O_2 / CO_2 ratio. photorespiration occurs essentially bcoz of the fact that the active site of the enzyme ru-bisco is the same for carboxylation & oxygenation from the chloroplast the glycolate is diffused to peroxisome where it is oxidised to glyoxylate.
The PGA enters C_3 cycle to make carbohydrates but one CO_2 molecule released in mitochondria during photorespiration has to be refixed.

Significance of photorespiration:

* It has been estimated that during photosynthesis by algae & C_3 plants.
* Glycolate metabolism undoubtly serves a scavenging function
* photorespiration can be regulated & consequently the photosynthetic productivity can be increased

Respiration

Ultra structure of mitochondria.



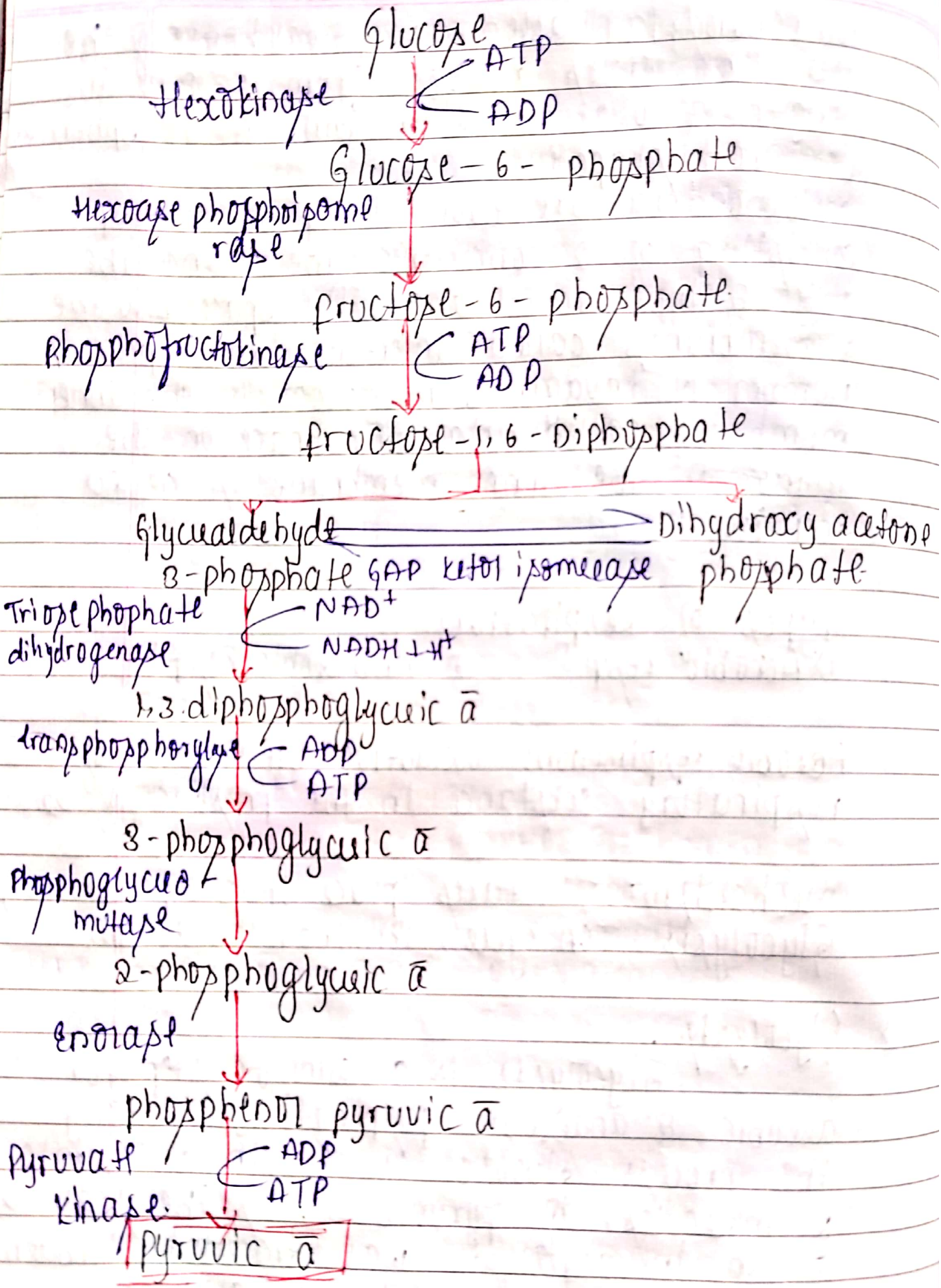
mitochondria called as powerhouse of the cell. The sizes ranges from 2 - 8 mm in length & 0.3 to 1.0 in dm. it is spherical (or) rod shaped
mitochondria are bounded by an envelop consisting of 2 concentric membrane the outer & inner membrane. The space b/w the 2 membranes called inter-membrane space. A number of invaginations occur in the inner membrane called cristae. the space on the interior of the inner membrane is called matrix.

Types of Respiration
1) Aerobic resp^{n} 2) Anaerobic resp^{n}

1) Aerobic respiration: oxidative breakdown of respiratory substance in the presence of O_2.

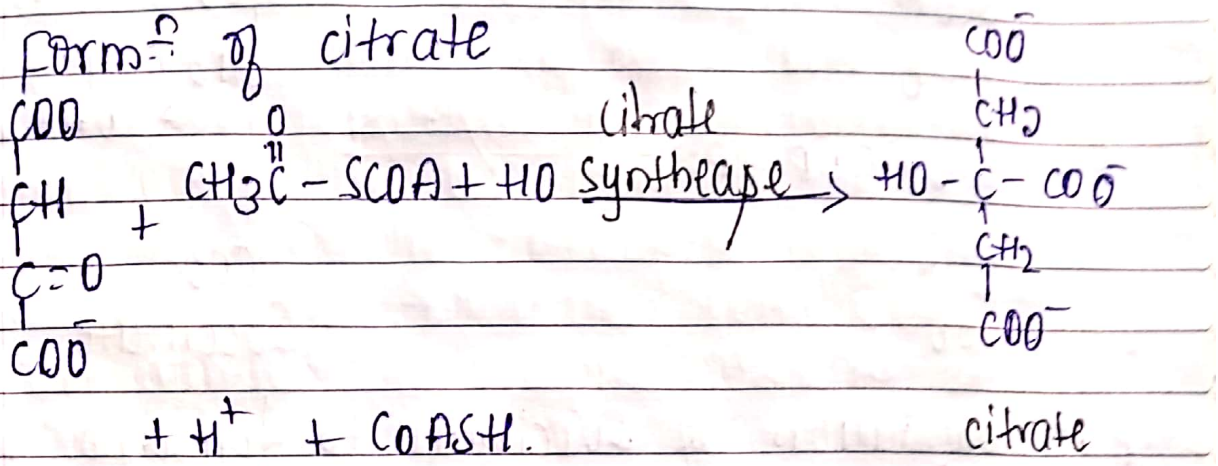
Mechanism: It takes place in 3 types, namely Glycolysis, TCA cycle, Terminal oxidation.

1) Glycolysis.
Glycolysis is a common step for aerobic & anaerobic respirations. during the process glucose is broken down into 2 molecules of pyruvic a. As the sequence of rxn in glycolysis was traced by Embden meyerhof & parnas it is also called Emp pathway. occurs in the cytoplasm & it needs no oxygen.

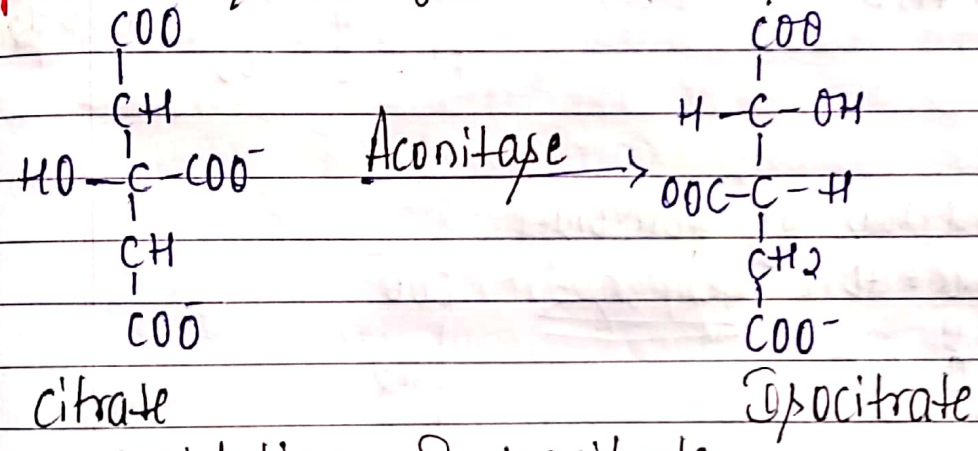


Kreb's cycle.

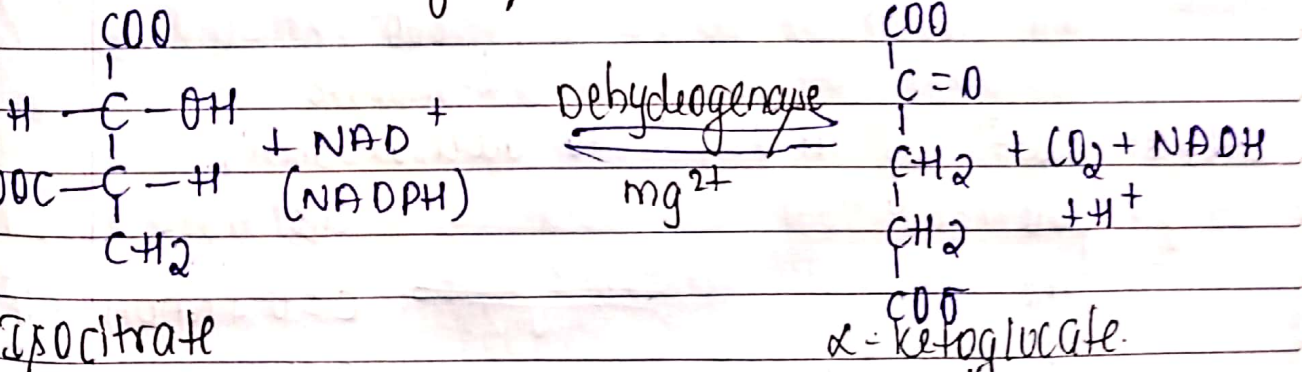
Step 1 Formation of citrate



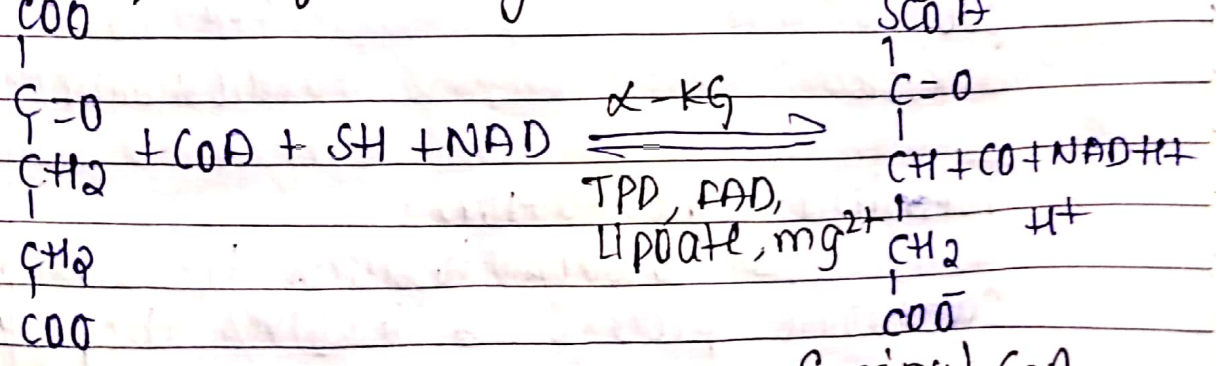
Step 2: Conversion of citrate to isocitrate.



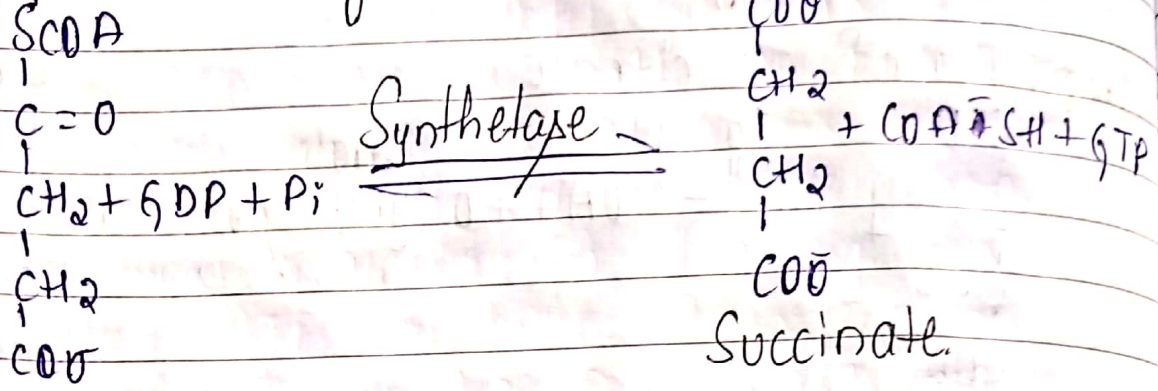
Step 3: Oxidation of isocitrate.



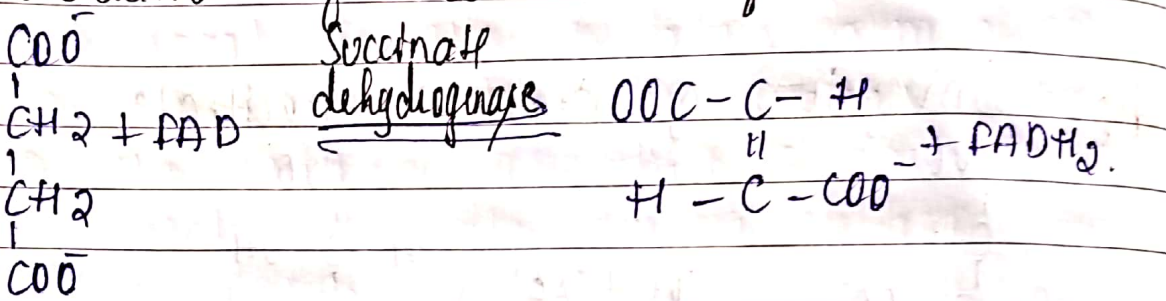
Step 4: Conversion of α-ketoglotrate to Succinyl-CoA.



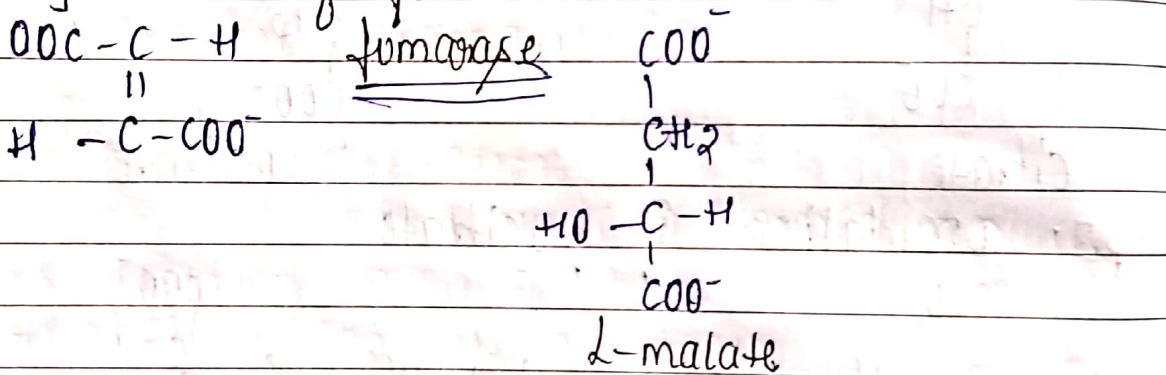
Step 5: formation of succinate.



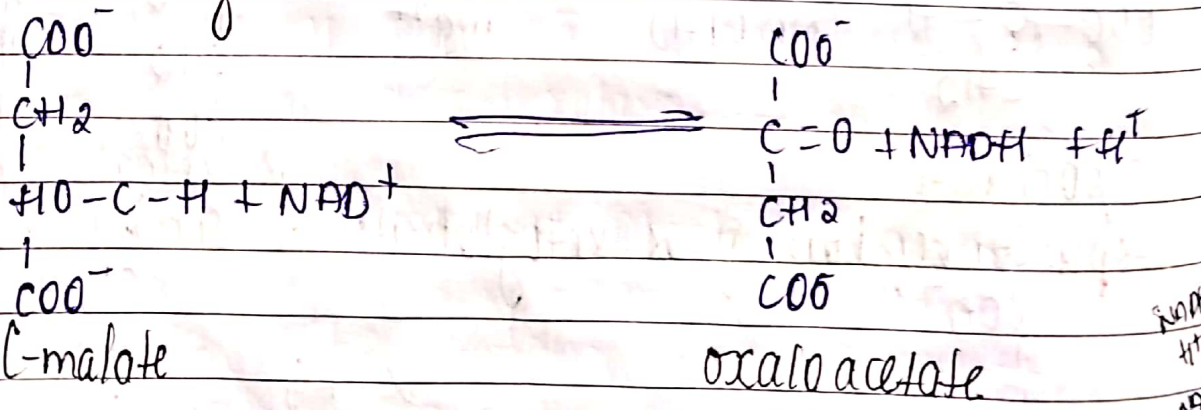
Step 6: oxidation of succinate to fumarate.



Step 7: Hydration of fumarate.



Step 8: oxd? of malate to oxaloacetate.



Terminal oxidation.

It occurs towards the end of catabolic process & involves the passage of

both ē & protons of reduced co-enzymes to O_2. it produces H_2O.
It consists 2 process.

1) Electron transport system.

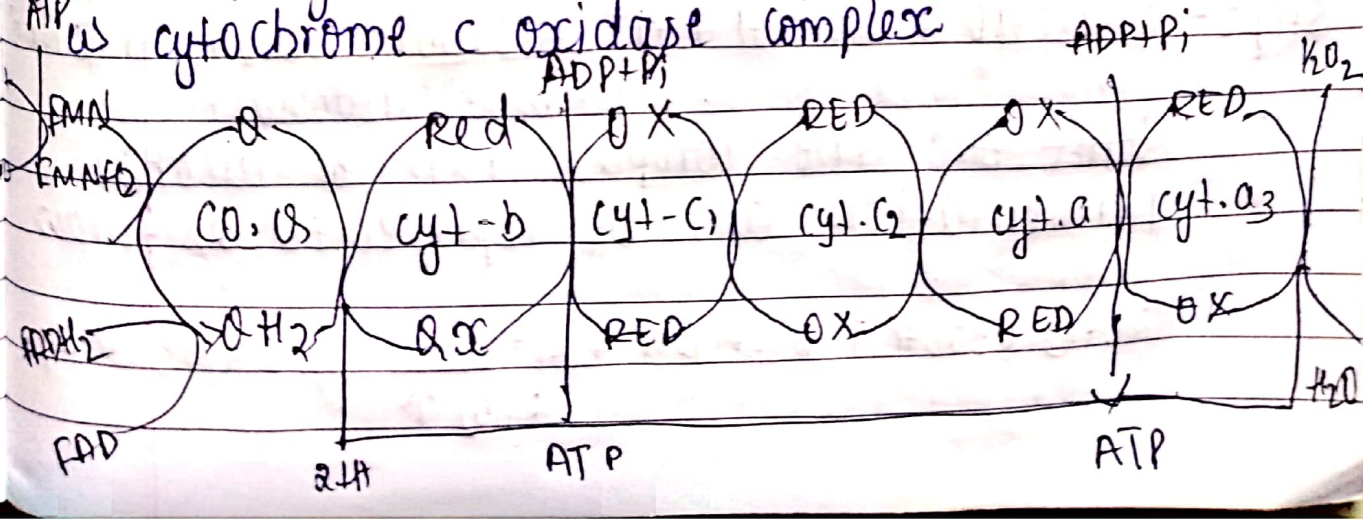
Inner mitochondrial membrane contains group of ē & proton transporting enzyme. In each group the enzymes are arranged in a specific series called electron transport system. It is a series of a co-enzymes & cytochromes that take part in this passage of electrons from a chemical to its ultimate acceptor.

The passage of ē from one enzyme / cytochromes to the next is a down hill journey with a loss of energy with a loss step. At each step the ē carriers includes flavins, iron-sulphur complexes, quinones & cytochromes.

Inner mitochondrial membrane posses five Complexes. complex - V is connected with ATP Synthesis

Complexes I to IV are involved in ē transport.

1) NADH - Q - reductase
2) Succinate - Q - reductase complex
3) QH_2 - cytochrome c reductase complex
4) cytochrome c oxidase complex



Oxidative phosphorylation.

It is the synthesis of energy rich ATP molecules with the help of energy liberated during oxidation of reduced Coenzymes produced in respiration. the enzymes required for this synthesis called ATP synthase. it is considered to be 5th complex of electron transport chain

Transport of the electrons from NADH over ETC in pushing of 3 pairs of proton of the outer chain while 2 pairs of proton are sent outwardly during electron flow from $FADH_2$

Anaerobic respiration

Alcohol fumentation:

The pyruvic a formed in glycolysis is decorboxylated & then reduced to Ethyl alcohol & CO_2 in 2 steps.

Step 1: $2CH_3COCOOH \xrightarrow[\text{decarboxylase}]{\text{pyruvic a}} 2CH_3CHO + 2CO_2\uparrow$

Step 2: $2CH_3CHO + 2NADH + H^+ \xrightarrow[\text{NAD oxidoreductase}]{\text{Alcohol}} 2C_2H_5OH + 2NAD^+$

~~Some bac~~ The complex rxn of alcohol fermentation can be represented as follow.

$$2CH_3COCOOH + 2NADH + H^+ \xrightarrow[2CO_2\uparrow]{} 2C_2H_5OH$$

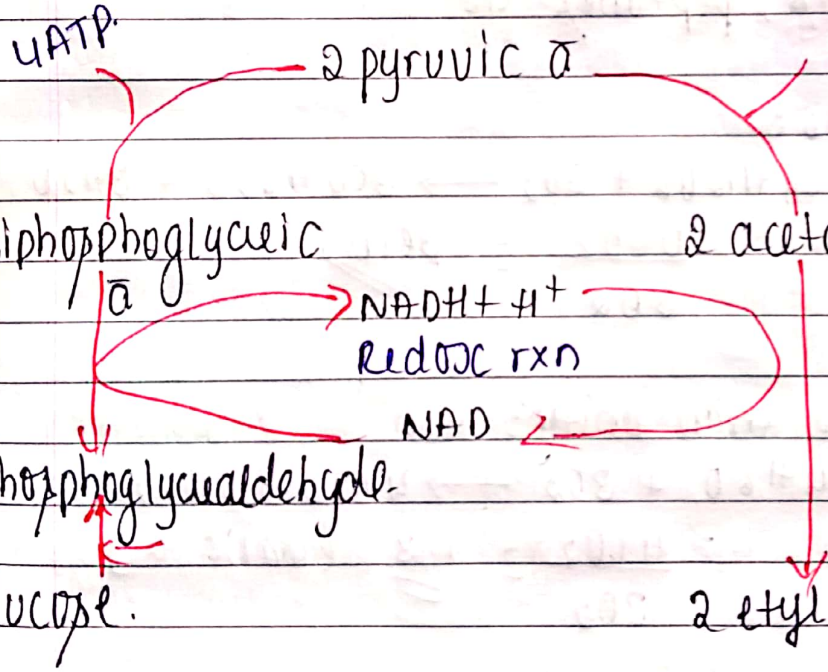
Some bacteria produce lactic ā (or) acetic ā (or) butyric ā instead of ethyl alcohol.

a) pyruvic ā + NADH + H^+ $\xrightarrow[\text{dehydrogenase}]{\text{lactic ā}}$ lactic ā

b) pyruvic ā ⟶ Acetaldehyde ⟶ Acetic acid.

c) pyruvic ā ⟶ Acetoacetic ā ⟶ Butyric ā.

Anaerobic respiration is not efficient when compared to aerobic resp^n the net gain is only 2 molecules of ATP formed during glycolysis.



Anaerobic resp^n during to alcohol fumentation.

Respiratory quitient: The ratio of the vol of CO_2 liberated to the volume of O_2 absorbed during respiration

RQ = $\frac{\text{vol of } CO_2 \text{ evolved}}{\text{vol of } O_2 \text{ absorbed}}$

If having diff values of RQ on oxd^n

1) RQ equal to unity: Aerobic resp^n

$C_6H_{12}O_6 + 6O_2 \longrightarrow 6CO_2 + 6H_2O$

$RQ = \frac{6CO_2}{6O_2} = 1$ // Carbohydrates

2) RQ less than unity. Aerobic resp^n

$C_{57}H_{104}O_6 + 80O_2 \longrightarrow 57CO_2 + 52H_2O$

$= \frac{57CO_2}{80O_2} = 0.71$ // triolein.

* proteins, peptones etc.

3) RQ zero:

$2C_6H_{12}O_6 + 3O_2 \longrightarrow 3C_4H_6O_5 + 3H_2O$

$= \frac{0CO_2}{3O_2} =$ zero //

4) RQ more than unity:

$C_4H_6O + 3O_2 \longrightarrow 4CO_2 + 3H_2O$

$= \frac{4CO_2}{3O_2} = 1.3$ (malic a)

Importance of respiratory quotient

* Knowledge of RQ helps in determining respiratory substrate.
* It helps in knowing the type of resp^n being performance.

- It provides some information about major transformation of food materials.

Factor affecting respiration.

External factors.

a) Temp
b) Light
c) Oxygen
d) CO_2
e) H_2O
f) minerals

Internal factor.

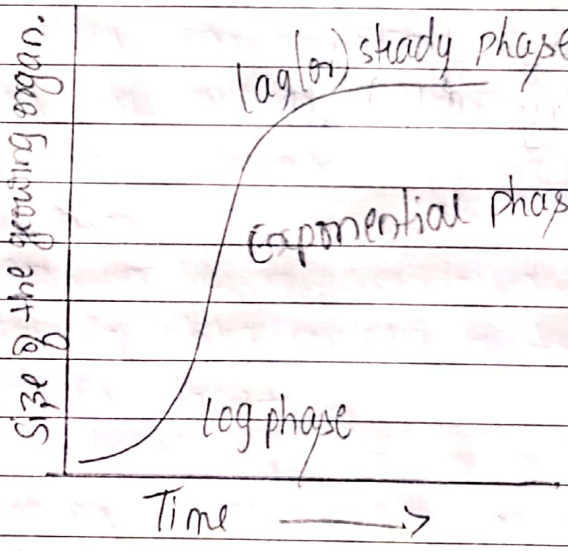
a) protoplasmic factor
b) Respiratory Substrate

Plant Growth & Growth regulations.

Definitions of Growth: It defined as a permanent & invesible change in the size of a cell organ usually accompanied by an increase in dry weight

Kinetics of Growth (or) sigmoid curve

The sigmoid curve represents the integrated sum of the curve for each growing organ & cell & presents the changing size of these parts similarly when dry weight is measured as an index of growth before maturity of curve takes the well known sigmoid curve



The ratio of the change in cell number (dn) over the time interval (dt) is called as absolute growth curve

$$AGR = \frac{dn}{dt}$$

The AGR when divided when ÷ by total no of cells present in the medium gives relative growth rate (RGR)

$$RGR = \frac{AGR}{N}$$

factors affecting growth.

Growth is affected by the factor which affect the activity of protoplasm. it is affected by a large number of factors both environmental & physiological factor. The effect of these factors on one region of the plant are also transmitted by the other region.

* Food supply
* oxygen supply
* Light intensity
* water supply
* Tempreture
* Growth hormones

phytochromes. It is defined as organic substance produces naturally in higher plants. controlling growth (or) other physiological fun at a site remote from its place of production & active minute amounts.

phytochromes classified into Growth promiting substances & growth inhibiting substances.
GBS:- Auxins, Gibberllins & cytokinins.
GIS: Ethylene & Abscipic a

1) Auxins:- The term auxin includes all those chemical substances which promote growth of stem.
The principle naturally accuring auxin is IAA - Indole-3-acetic a.
* Discovered by charles darwin & his son.
* This observed in coleoptile of canor geam
* coleoptile has a chemical which foreseeds light.

* The auxins generally move from stem apex downward to the base & from root upwards to the shoot through living cells. A movement of auxin is known as polar transport.
* polar movements of auxin is mainly inhabited by three antiauxins - 2,3,5 - Triiodobenzoic a, Napthyl - thalamine a.

Biosynthesis of auxins.
* It initiates lateral root formation.
* It shows Apical dominance.
* It promotes flowering in pineapple.
* It induces parthenocarpy in tomatos.
* It helps in xylem differentiated.

Application:
* It used in tissue culture.
* It used to obtain plants from stem cutting
* It seduces fruit

free Auxins: Extracted from plants.
Bound auxins: Extracted using organic solvent
Anti-Auxins: substance which stops / inhibits the action of auxins.

Gibberllins: It discovered Japanese plant plantologist kurosawa while working in rice fields. He observed that rice seedings grew much taller (6-7") than others & were seedings
* He even observed the growth of fungus Gibberlia fujikoria on such tall plant. He

called the foolish growth of rice seedings as Bakane disease.
* finally they exacted that chemical & called it Gibberlin (Gibberllic a (GA)
* Now the no of Gibberlins stands at 62/25 have been isolated from the fungus.
* Diffuent type of Gibberllins are named as GA_1, GA_2, GA_3 ... GA_{60} & so on. GA_3 is widely used.

physiological effects of Gibberlins.
* Elongation of stem (cabbage)
* Bolting & flowering (sugarbeet)
* production of parthenocarp (Grapes)
* Breaking dormancy (Bulb, tuber, corn)
* Substituting the cold treatment

Cytokinins It proposed by Letham (1963) Skoog & miller discovered cytokinin. It has been obtained from coconut milk, yeast extract apple extract & many other plants extract chemically cytokinin is 6-furfuryl-amino-purine.

* Root tip is an importance site of synthesis.
* However, developing seeds & Cambial tissues are also the site of cytokinin biosynthesis

physiological role of cytokinins.
* cell division
* cell enlargement
* morphogenesis (Tobacco plant)
* contraction of Apical dominance

* Delay of senescence : Richmond - Lang Effect. (xanthium leaves)

Abscisic Acid (ABA)

Discovered carns & Addicott (1963) physiological studies of shedding of cotton-balls & leaves. Earlier it was Dormin ABA is also called ability to promote abscission of leaves, seeds Embryo etc. It produced in all parts of plants.

physiological role of ABA.

* It promotes abscission of leaves, flowers & fruits.
* It prevents the elongation of shoots.
* It acts as stress hormone in plants.
* It promotes senescense of leaves.
* ABA found to decrease RNA & protein.
* It inhibits development of embryo in seeds.

Ethylene. recognised by Prati & Goeschl

It is a gaseous hormone. it is a product of metabolism of amino a methionine & produced in nodes of stem, ripening fruits & Sensing tissue

* Naturally ethylene production has been observed in most fruits, flowers, & fungi

physiological Effects of Ethylene.

* It promotes senescence of leaves
* It stimolates form^n of adventitous roots.
* It inhibits sprouting of potatoes.

* It stimulates fading of some flowers.

Application:
- In Agriculture & Horticulture.

1) Gibberllins:
* Used in Germination of seeds
* used in induction of parthenocarpic fruit.
* It used in bringing about stem elongation
* They are used in beweries in the process of malting.
* It also increase in the sugar content in cane.

2) cytokinins:
* It used in tissue cultures
* It helps in cell division & cell enlargement
* It also promote formation of adventitious roots.
* It also promote leaf form & enlargement.
* promote flowering in some plants.
* It helps in 2° growth.

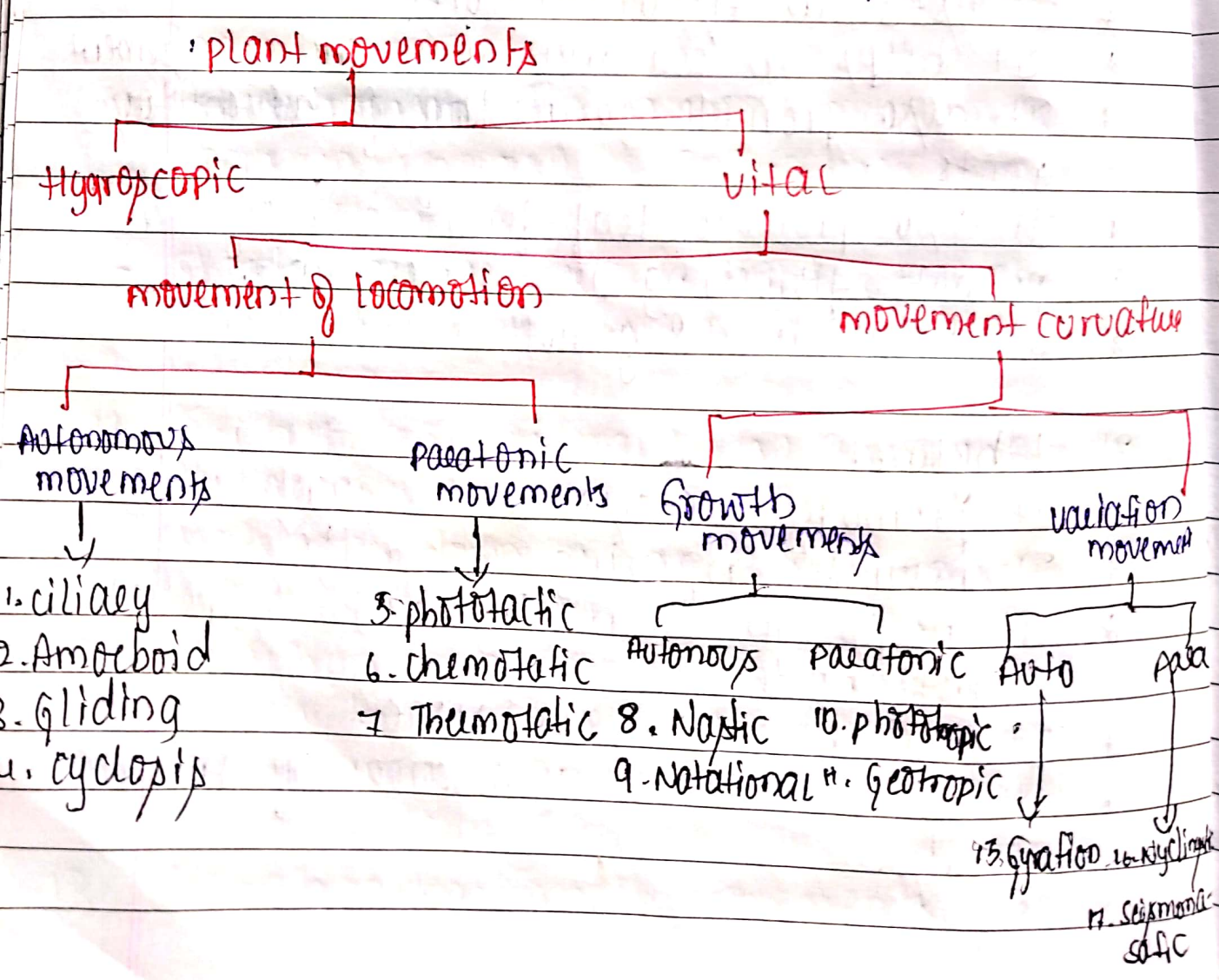
3) Ethylene.
* It promotes senescence in plants.
* It promotes ripening of fruits.
* It helps in increasing length of petiole & Internode.
* It reduces the pest attack
* It increase in yeild & colour of tomato fruits.

4) ABA.

* It promotes sencanpence in plants.
* It helps seed to withstand Avenes condition.
* It inbibits germination of seeds.
* It helps the plants tolerate stress.
* It acts as antigonesial to GA.
* It promotes Bud dormancy

Plant Movements.

Movements are generally considered as a sign of life. However, the larges & more Complex plants are fixed in position, but many of their parts (or) organs.



Autonomous movement & locomotion

1. Ciliary movements: It seen in the members of orde volvocales. (volvox, chlamydomonas, pandorina etc.)

2. Amoeboid movement: The kind of movement which brought about with extension of protoplasm into pseudopodia. (Achyla)

3. Gliding: Oscillatoria exhibit gliding movements due to excretion of mucilage through the cell walls. Diatoms cells exude mucilage through the pores (costae) in the cell wall & move

4. Cyclosis: cyclosis is seen in many of hydeophyte like Elodea, vallisnaria, Hydrilla etc. & is a movement of cytoplasm taking organelles along with it.

paratonic movement of locomotion.

5. Phototaxis: The phenomenon of light induced movement of locomotion is called phototaxis - when light falls on them: the cells move towards the source of light. It seen in zoospores, gamets etc.

6. Chemotaxis: movement of locomotion brought about by the influence of chemical. Gamets of algae, fungi & bryophytes are known to be chemotactic.

7. Thermotaxis: Locomotary movement brought about by the influence of temp^{r}. Gamets, zoospores of many algae & fungi & cells of chlamydomonas

Movements of curvature: Growth hormones
Autonomous G.H:

8) Nastic movements: When growth movements occur in response to an external stimulus which is not unidirectional but diffused. It seen in leaves, sepals & petals.

9. Nutation. This consists of a movement of the tip of a growing stem./organ, describing an irregular path in space.

paratonic G.H.

10. phototropism. The tropical movements which occur in response to an external unilateral light stimulus.
- Shoots grows towards light (+ve phototropic) away the light (-ve phototropic)

11. Geotropism: movement (or) curvature induced by geavity.
Roots grow down (+ve geo), grow up (-ve geo)

12. Hydrotropism: movement or curvature of plant organs towards the source of H_2O found in young root

13 Chemotropism: Growth movements, directed

towards the source of chemical substances

14. Thigmotropism: The movement in plants organ brought about by touch / contact stimulus. (passiflora) climber tree.

Varation movements.

15. Autonomous variation movements movement of curvature, the internal factors of the plant cause movement of organs. (Desmodium gyeans)

paratonic movement of variation.

16. Nyctinastic movement during day time, the plant organ like flower, leaf etc, assume a particular posture & it changes during night (Solanum melongena)

17. Seismonastic movement: sleeping movement exhibited due to touch (mimosa pudica). family mimoceae.

PHOTOBIOLOGY

Breif account of dormancy.

It is a failure of seed germinatio because unsuitable environmental condition required for grapp.

Types of seed dormancy

1. Immature Embryo: The embryo is not fully developed at the time of seed shedding.

The period required by the embryo for its Complete development.

2. After ripening: After shedding the seeds require an interval of ripening before they attain the power to germinate.

3. Impermeability of seed coats: Seed coats are impermable to water, gases (or) chemicals.

4. Tough seed coats: The seed coats are hard & provide mechanical resistance to the growth of Embryo.

5. Inhibitors: The are chemical substance which do not allow the seeds to germinate. they may present inside the fruit

6) Excessive salts: the seeds contain a high conc of solutes do not allow the Embryo to resume the growth.

Natural overcoming of seed dormancy.

* weakening of tough & impermeable seed coats by microbial action
* Rupturing (or) weakening of seed coats by mechanical abrasions
* leaching of inhibitors present in the seed coat.
* production of growth hormones
* Completion of over-ripening period.
* leaching of solutes in Atriplex where dormancy is caused by high osmotic conc inside the seeds.

Artificial overcoming of seed dormancy.

* rupturing of seed coats (or) scarification by absorption through machine, filing etc
* Hydraulic pressure of upto 2000 kg for 5 min for weaking the seed coats.
* Treatment with hot water for dissolution of surface inhibitors, waxes etc.
* Stratification the moist seeds in the presence of oxygen to periods of low (or) high temp^{s}.
* Exposure to alternate temp^{s}, chilling & light depending upon the of seed dormancy.

Biological imp of Seed.

* It helps to storage of seeds for later use by animals & man.
* It highly useful to desert plants. the rainfall ensures the seed a paste.
* It helps the seed to get dispersed over long distances through unfavorable cond^{n}

Photoperiodism:- The plants in order to flower require a certain by length i.e relative length of day & night is called photoperiod. the response of plants to the photoperiod expressed in the form of flowering.

They classified plants into 3 categories:-

1. Short day plants [SDP]:- These plants require a relatively SDP (usually 8-10 hrs) & a Continous dark period of about 14-16 hrs.
   Ex:- Tobaco, soybeans, cocklebur etc,

In SDP the dark period is critical & must be continous. if the dark period is interrupted even with a brief exposure of red light. In SDP will not flower.

2) Long day plants (LDP): These plants requires a longer day light period (14-16hrs) in a 24hrs cycle for subsequent flowers.
Ex: Beetroot, Spinach etc,

3) Day neutral plants: These plants flowre in all photoperiods ranging from 5-24 hrs exposure to light.
Ex: Tomato, cotton, cucumber etc,

During recent yeaes certain intermediate categories of plants have also been recognised. they are:

1. Long-short day plants: These are SDP but must exposed to LPD during early periods of growth for flower.
Ex: Bryophyllum.

2. Short-long day plants: These are LDP but must be exposed to SDP dueing early periods of growth for subsequent flowering.
Ex: Wheat, rice, etc.

photoperiodic Induction: plant reaives induction cydes after intervals of unfavorable photoperiods the persistence of photoperiods

after effect is called photoperiodic induction.

phytochrome & its role

It is a blue proteinaceous plant pigment It is present in the plasmamembrane of the cells of leaves & shoot apex. it was discovered by buttles in 1959.

Role in SDP's :- Rice, cotton, tobacco.

* plants which require less than 10hrs day length initiation of flower is called SDP's
* In many SDP's if dark period interputed with a brief exposure to red light, the pr is converted into Pfr form, pfr is converted into pr & the plant produces flowers
* SDPs require higher Pfr : Ptr ratio of flowering.
* In SDP's darkness is the important for flowering.
* In summer months however the reserve ratio is observed due to more portion reaching earth keep SDPs non-flowering.

Role in LDP's. : pea, radish, cabbage, wheat.

* plant which require more than 14hrs day length initiation of flowering is LDP's
* The LDPs require night 8-10hrs dark period of flowering.
* In LDP's light is important for flowering
* In LDP's the role of phytochrome is more complex so that a blue-light photoreceptor is also required for control flowering.

* LDPs require higher Pr: Pfr ratio.

florigen Concept

florigen is the flowering hormone Synthesized in ordee leaves & transported to growing region. the possibility that effect can be transfued by way of grafting has made many physiological to think of a substance called florigen Concept.

Vernalization.

The cooling of seed during germination in ordee to accelerate flowering when it is planted

Vernilization is the promotion of flowering in response to a prolonged peiod of growth at low temp & it is imp adopt of plants growing at high latitudes.

Works: vernalization simply means that the plant has to experience a peiod of cold before it can produce flowers. it literally chilled in ordee to reproduce. So that it has a winter in blw its 1st growth & flowering stage.

Based on physiological conditions having 3 stages.

1. Thermoptage: It is 1st stage. Exposure to

low temp^{r}, moisture & aeration are necessary for the proper completion of this stage. Annuals & Biennials have only one thermo-stage in their lyt cycle.

2. photostage: It takes over after the thermo-stage & it is photoperiodism.
3. Third stage: It has not been properly identified even though it is necessary for the formation of sex organs & gametes.

Application of vernalization.

* crops can be produced earlier
* crops can be cultivated in places where, they naturally do not grow.
* plant breeding can be accelerated
* It become resistant towards disease.
* It stimulates the photoperiodic flowering response.

Defence Mechanism.

Brief account of secondary metabolism.

→ organic molecules that are not involved in the normal growth & development of the plant
→ Absence of it does not result in immediate death, but in long-term impairment of the organism's survivability often playing an imp role in plant defense.

→ most of the 2° metabolites. such as terpens, phenolic compounds & alkoilds are classified based on Biosynthetic origin.
→ DO not have generally recognised roles in the photosynthesis, respiration, solute transport translocation, nutrient assimilation etc.
→ major role in the adaptation of plants to the changing environment & in overcoming stress constraints.

Example: Salasodine, alkolid, glycoalkoide, Anthocynin, flavonoids, sonanin, Alanine, Tomatidine etc,

class of 2° metabolites:

1) Terpens
2) phenolic compounds
3) Nitrogen Containing Compound.

Defense: The ability (or) capability to fight against the invading pathogens

Mechanism of defense.
There are 2 kinds of mechanism are their:

1. Active mechanism of defense.
2. passive mechanism of defense.

Note: Here, we have to study only the what plant defense plyed role in.

2° metabolites.

Role of 2° metabolites in defense.

* For protect the plant from invading pathogens.
* Help to improve the shelf life of plants.
* Decrease the infection by some disc & pests also.
* Useful in preparation of perfumes or aromatic substances.
* It improves immunity of plant.
* Seed dispersal
* Decrease the use of insectiside, pestide, fungiscide also.
*

Applications.

* production of insectiscide.
* preparation of pesticide.
* In drug development
* In preparation of antibiotics
* It acts as coloring agents itself.
* In plant it regulate the metabolism process.
* useful for defense purposes.
* It widely used in pharmaceutical.