* Photosynthesis in higher plants

Photo → Light
synthesis → formation

→ Photosynthesis → It is a process
→ Active transportation [uphill transportation]
→ Endergonic [energy conserve]
→ Anabolic process [Energy adding / consuming Process.]

→ Biological organism.
→ Redox reaction.
- $\boxed{\text{only Reduction takes place}}$

* Chemical representation

Root Source — Sunlight + Chlorophyll — As a Product: Glucose — As a Bi-product: Water, oxygen.

$$6CO_2 + 12H_2O \xrightarrow{\text{Chlorophyll}} C_6H_{12}O_6 + 6H_2O + 6O_2$$

from atmosphere

* Photosynthesis contributor → Diatoms > cynobacteria > Dinoflagelates > other plants.

Photosynthesis contributor
- Aquatic plants → 90%
  - Marine water plants - 80%
  - Fresh water plants - 10%
- Terrestrial plant → 10%

* Photosynthesis efficiency.

→ C_4 plant > coral > Tropical rain forest.

→ Joseph priestley experimentally proved presence of air in photosynthesis.

→ Gron Mohl prove that essentiality of CO_2 in photosynthesis.

→ Stephen hels father of plant physiology.

→ In India "Satish Chandra Maheswari" is the father of plant physiology.

→ John Ingen hauze proved that sun light and green colour [chlorophyll] is most for photosynthesis.

→ Von- Nest → pioneer scientist
⇓
Established ⟶ Redox nature
⇓
Reduction

— CO_2 X → source → O_2 - By-product
└ photosynthesis.

$H_2O \longrightarrow H_2 + \frac{1}{2} O_2$

$H_2x \rightarrow H_2 + \frac{1}{2} x_2$

H_2O → $H_2x = x = 0$
└→ $H_2S = S = 0$.

→ Experimentally proof – Ruban & Kanan.

– Radioisotopes.

$$CO_2^{16} + H_2O^{18} \longrightarrow C_6H_{12}O_6^{16} + O_2^{18} + H_2O^{16}$$

⇓ comes from $\boxed{H_2O \text{ source}}$

$O \rightarrow 8$

$^{16}O_8$ $^{18}O_8$

Isotopes of oxygen.

* Julius von Sach.

→ 1st Synthesized product ← Glucose → 1st formed.

1st stable product ← Sucrose → 1st transport.

1st Stored ← Starch → 1st Visible.

Photosynthesis Apparatus.

- Pigment
  - Essential Pigment
    - chlorophyll 'a'
    - use in e^- transfer
  - Accessories pigments
    - Chl b
    - 〃 c
    - 〃 d
    - 〃 e.
- Light.

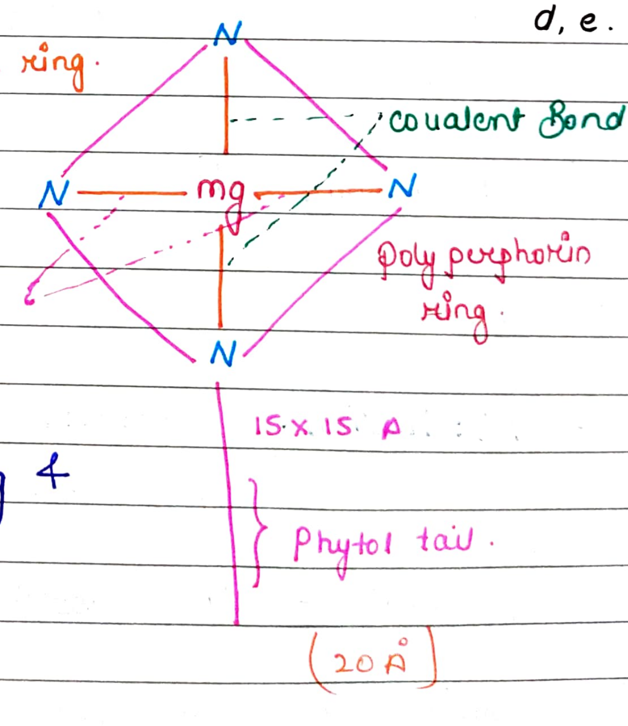
Carotenoid	Caroteins	Xanthophyll
- phycobilins.	α- cartein.	xanthophyll.
		fucoxanthophyll.
- phycocyanin.	β- carteins.	violaxanthophyll.
		Neoxanthophyll.
- use in Energy transfer.	γ- cartein. Lycopein.	Astaxanthophyll.

* Chlorophyll - a

- Pigment - colour - Green or Blue green.
Distribution - All photosynthesis plant.

- General formula = $C_{55} H_{72} O_5 N_4 \underline{Mg}$
  ↳ it is common in all chlor, b, c, d, e.

Tetra Phyrol ring.



Co-ordinate Bond

- it contains of Porphorin ring & phytol tail.

* **Bio-Synthesis of chlorophyll a**

OAA + Succinyl CoA — organic

↓ - presence of light.

photochlorophyll

Pigment ← ↓ - Presence of ligh.

Chlorophyll a

↓ - light observer.

Chl-a.

→ Chlorophyll a is perphorin ring with consist phytol tail

- for maturation of chlorophyll a light is important when chlorophyll absorb maximum light is important when chlorophyll absorb maximum light at that Point it is called absorption Peak.

* $\boxed{\text{Chlorophyll - d}}$

- Colours - . yellow, green.

- Distribution - Chlorophyta, Pteriophyta, Euglenoid (Bryophyta), Angiosperm, Gymnosperm.

- General formula :- $C_{55}H_{70}O_6N_4mg$.

- Wave length :- ~~447.452 nm~~. 430 Nm.

~~Notes~~

* Chlorophyll C

- colour - Brown
Distribution → Diatoms, Dinoflagellates, theophyta - (Brown algae).
- General formula - $C_{35} H_{30} O_5 N_4 mg$
- wave length - 447.452 nm.

Note:- in Chl - C tail is absent

- chlorophyll - d
- Colour - Red.
- Distribution - Rhodophyta . [Red algae] only.
- General formula :- $C_{54} H_{70} O_5 N_4 mg$.
- Wave length :- 710 nm.

CAROTENOIDS

- Made up of - Carbon, Hydrogen, Oxygen.
- Consist of Isoprene ring / Terpene.
- water insoluble .
- fat derivatives.
- light is not essential for their maturation.

- Colour – Except Green
  ↓
  yellow
  yellow orange
  Blue.

✱ Carotenoids

Carotein

→ Made up of carbon & Hydrogen.
→ $C_{40}H_{56}$
→ α- carotein.
- β- carotein → $\boxed{\text{Vit. A}}$ - Precursor of
- γ carotein.
- Lycopein – Red.
  ↓
  Antioxidant.

Xanthophyll

- carteinol
- xanthene

- Made up of – Carbondioxide
  Hydrogen.
  oxygen.

- Zeaxanthophyll – Maize, Golden / yel
- fucoxanthophyll – Brown algae - Gr
- Violaxanthophyll – ABA formed.
- Astaxanthophyll – Strong Antioxidants.
- Neoxanthophyll – Photoxidation increase

✱ Phycobilins.

- consists of tetra Pyrol ring.
- complex type of protein.
- light is not essential for their maturation.
- type – 3 type
-
-

* Phycobilins:

Phycocyanin	Phycoerythrene	Alophycocyanin.
Blue	Red	Blue
Red algae → r phocoeyanin cynobacteria - c phyeocyanin	r- phyoerythrene c phycoerythrene	Both organisms red algae & cynobacteria.

Present in all phycobilins.

* Phytochromes.

- it is also ~~called~~ a type of Phycobilins for higher plants only.
- Photomorphogenesis - light dependant development

Plants → flowering.
Stomata opening & closing.
- photoblastic Germination of seed.

Photosynthetic apparatus;

Light - Source - Sun.
⇓ unit
Quanta

1) Quantum yield ⇒ O_2 - Quanta.

- Through unit quanta how many molecules of O_2 is formed ie quantum yeild.

* It is also called Rate of photosynthesis.

* 1 unit of quanta = $\frac{1}{8} O_2$ = $12.5\ O_2$

  ⇓ in %

  12.5% ≠ 12%.

② Quantum requirement.

- The no of Quanta used to produce one molecules of oxygen.

- 8 quanta is required to produced one molecules of O_2

$$2H_2O \xrightarrow[\text{OEC}]{\text{8 Quanta}} 4H^+ + 4e^- + O_2$$

OEC ↓ oxygen evolving centre.

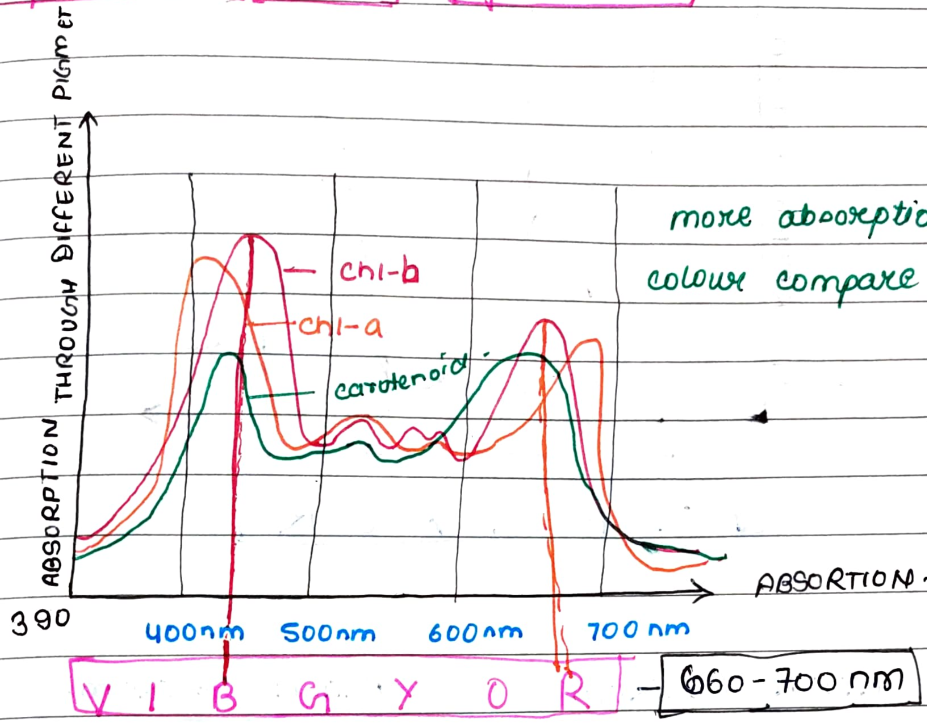
factors → mg^{2+} & Cl^-

* Quantum conversion.

- The amount of energy present in photo exited electron is called quantum conversion.

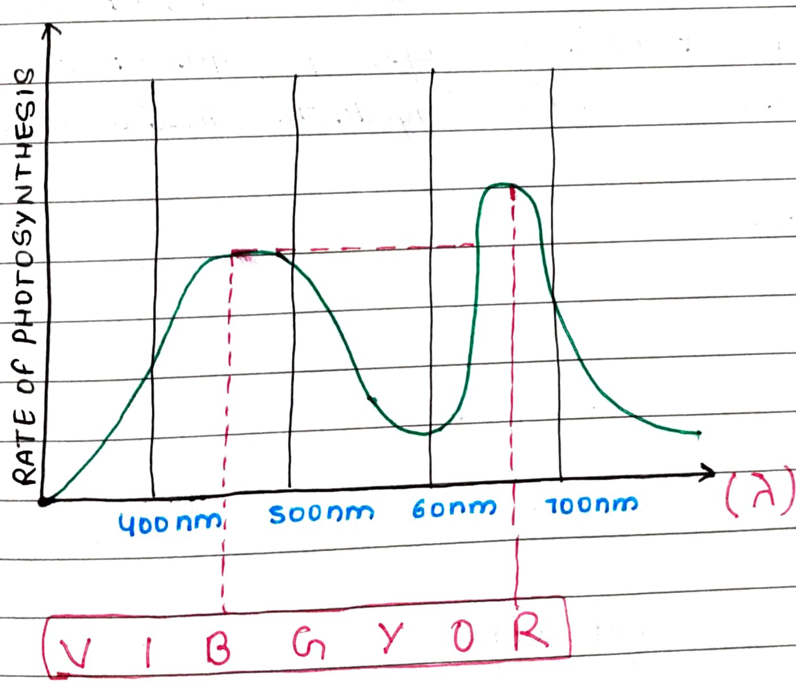
Energy converts into light energy.

* Absorption & Action Spectrum.



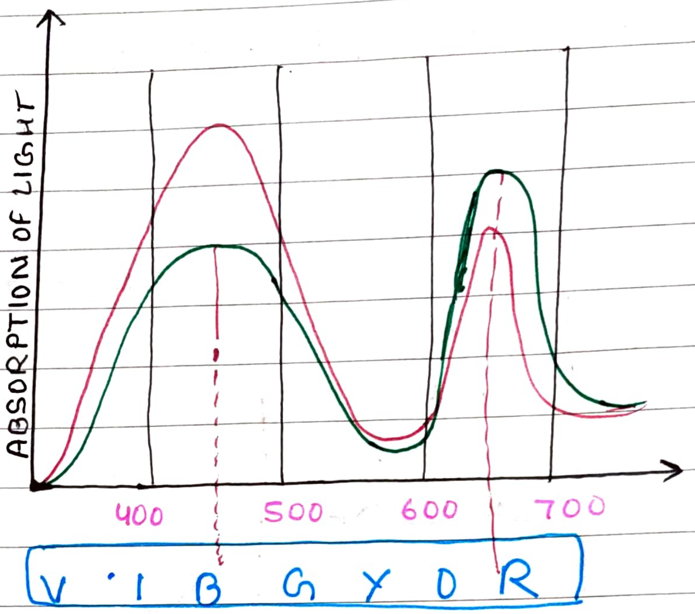
more absorption in Blue colour compare to red.

Blue > Red



Action - Red > Blue

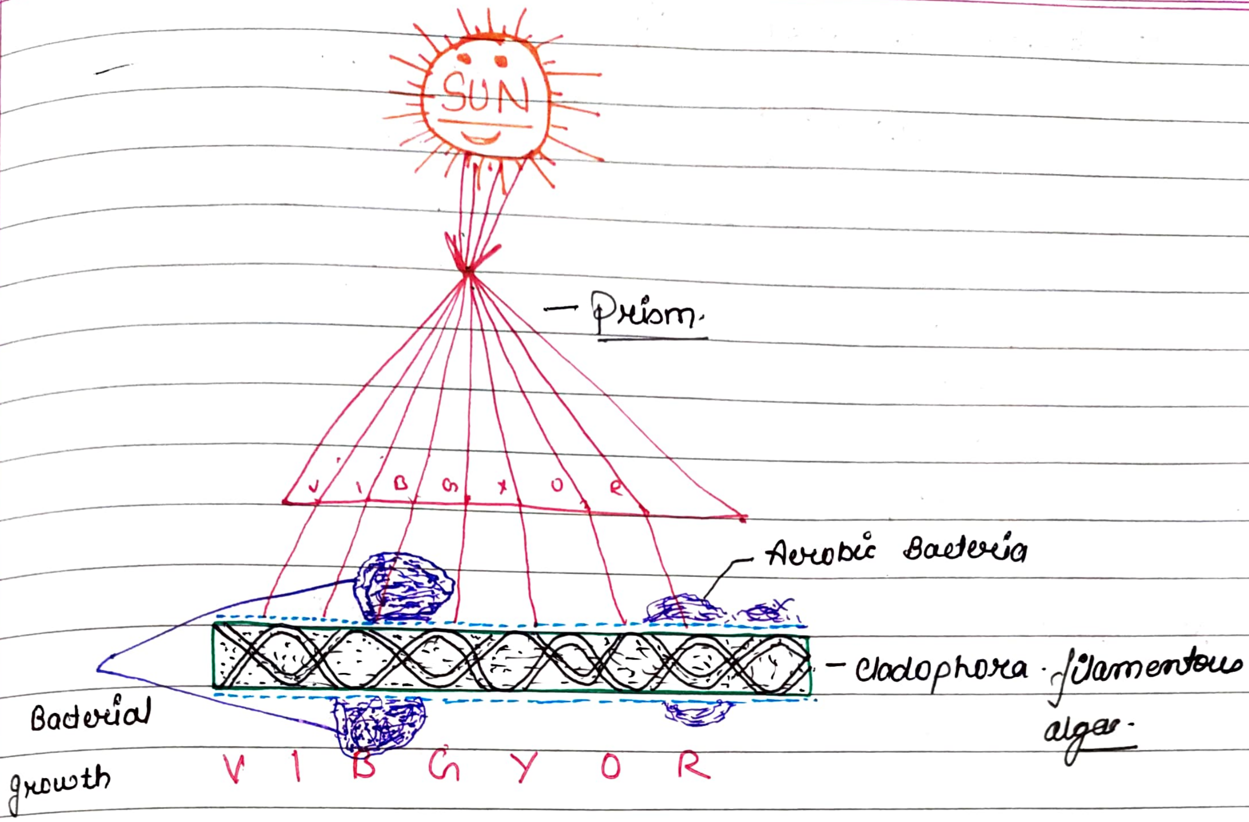
Date:



ABSORTION SPECTRUM	ACTION SPECTRUM.
- It is graphycally represented of absorption of light through different pigment having different wave length.	- It is graphical of different type of pigment showing different type of pigment showing photo synthetic effectiveness.
- In absorption $\boxed{B > R}$	

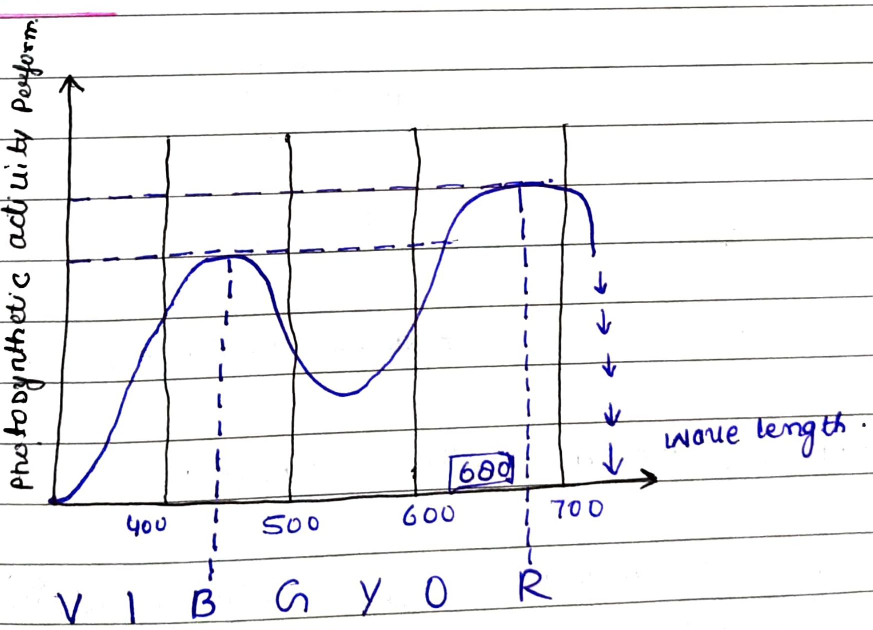
* Engelmann Experiment on Photosynthesis "Action Spectrum"

- Resources - light ray.
- Prism.
- Aerobic bacteria.
- Green algae [cladophora filamentous]

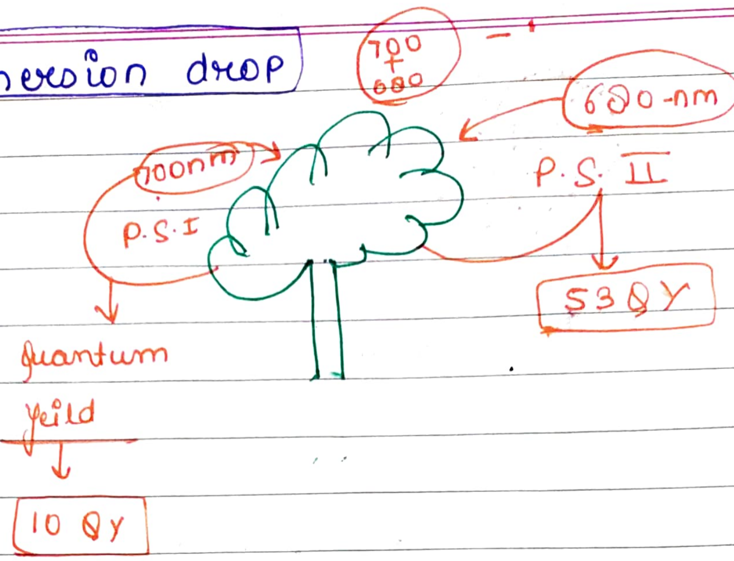


* Red drop and Emerson Enchance effect.

Decrease



- Emersion drop



* Conclusion of Emersion enhancement effect

- it is the two type of Photo system / Reaction centre is present.

i.e Photosystem I[st] P.S.I - 700 nm.

Photosystem II[nd] P.S.II - 680 nm.

* Difference between P.S.I & P.S-II

P.S-I	P.S-II
Reaction centre - 700nm	Reaction centre - 680 nm.
Site - Granna & Stroma	Site :- Granna.
Process - cyclic & non cyclic Phosphorylation.	Process - only found in cyclic Phosphorylation -
O_2 evolved - NO O_2 evolved	O_2 Evolved - yes.
Since - NO OEC - present	Since OEC is Present

PHOTOSYNTHESIS

- **LIGHT PHASE**
  - photophysical Phase.
    - It is only used till e^- exitment.
  - Photochemical Phase
    1) Photophosphorylation → Produce → $\boxed{ATP}$
    2) Hydrolysis → Produce → $\boxed{O_2}$
    3) Reduction of NADP → Produce → $\boxed{NADPH_2}$
- **Dark PHASE** ← No need direct light
  - also called Biosynthetic phase.
  - main path → C_3 cycle
  - Alternative path. → C_4 cycle, Cam cycle.

→ Photosynthetic phase.

photophosphorylation is of two type.

① Cyclic photophosphorylation.
② Non cyclic photophosphorylation.

→ Cyclic phosphorylation

Non cyclic phosphorylation.

to perform | plant have

Photosystem / Pigment System

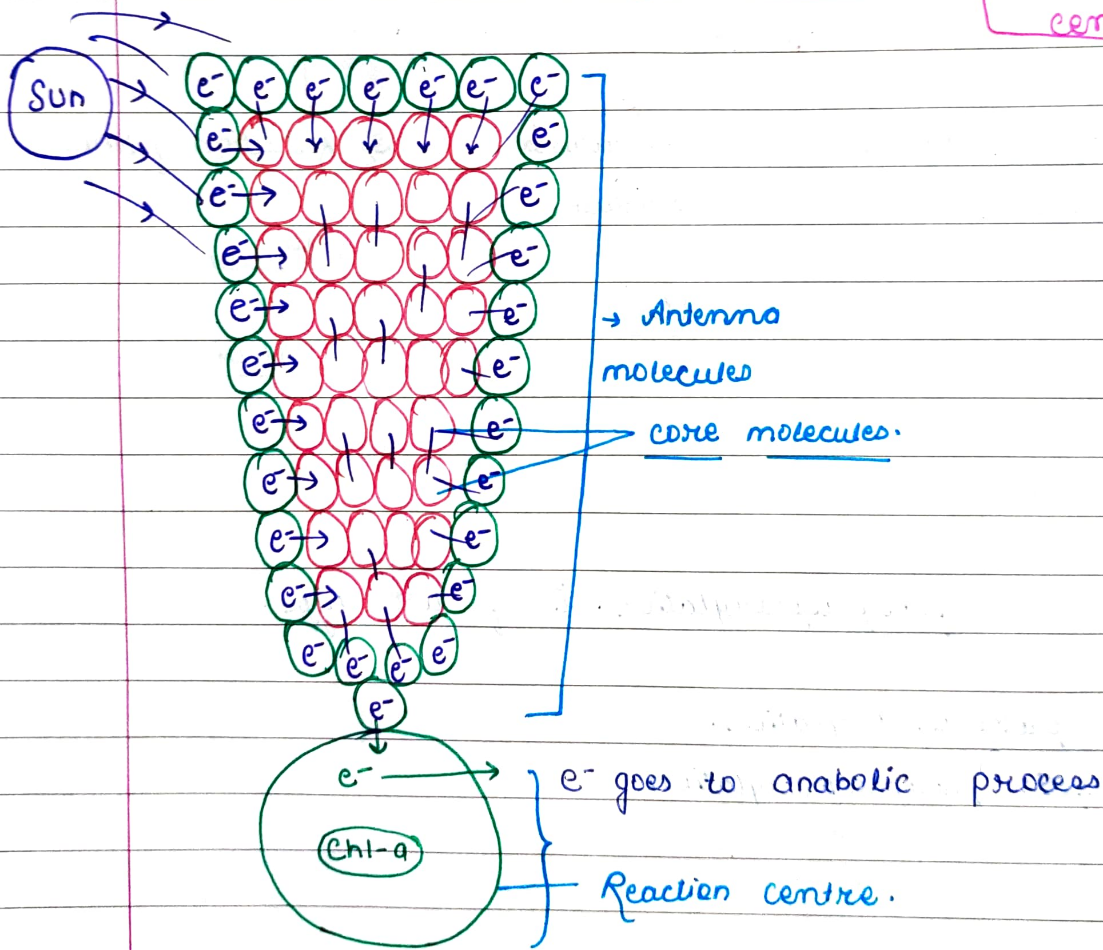
L.H.S / Light harvesting centre

Essential Pigment — Reaction centre

Antenna molecules

Core molecules

Single ch-a used as reaction centre



① cyclic photophosphorylation – Energy for ATP formation comes through cyclic moment of (e^-)

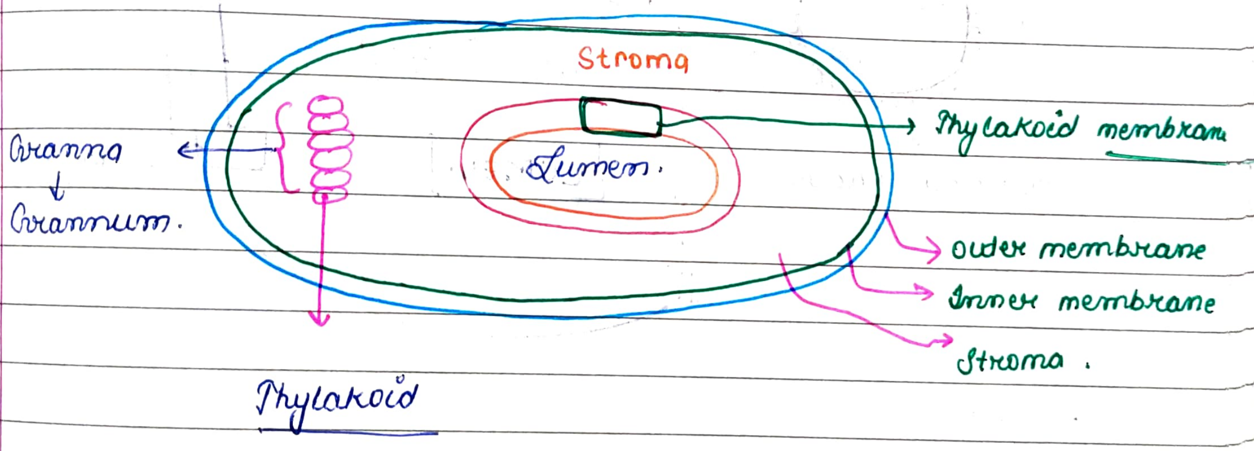
Site :- Thylakoid membrane.

- Primary electron acceptor :- FeS / FRS
  Iron Sulpher.

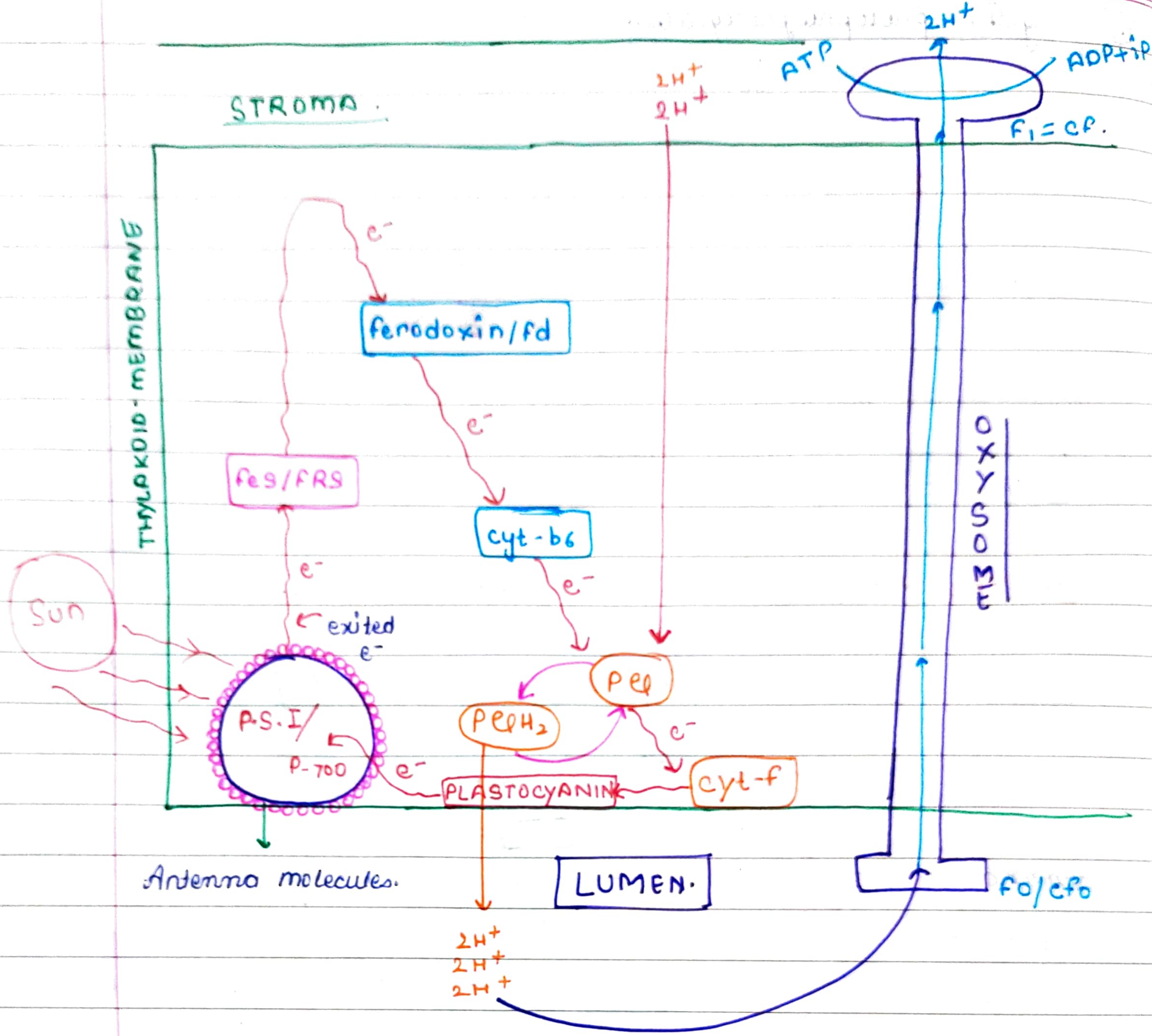
- Output :- ATP

* NADPH$_2$ Not Produced.

- OEC :- Oxygen Evolving centre are absent.



CHLOROPLAST



PROCESSES.

- Site :- Thylakoid membrane.

Pigment → P.S.I / P-700

output → only ATP produced.

OEC → Absent.

NON CYCLIC PHOTOPHOSPHORYLATION.

P.S - II & P.S - I

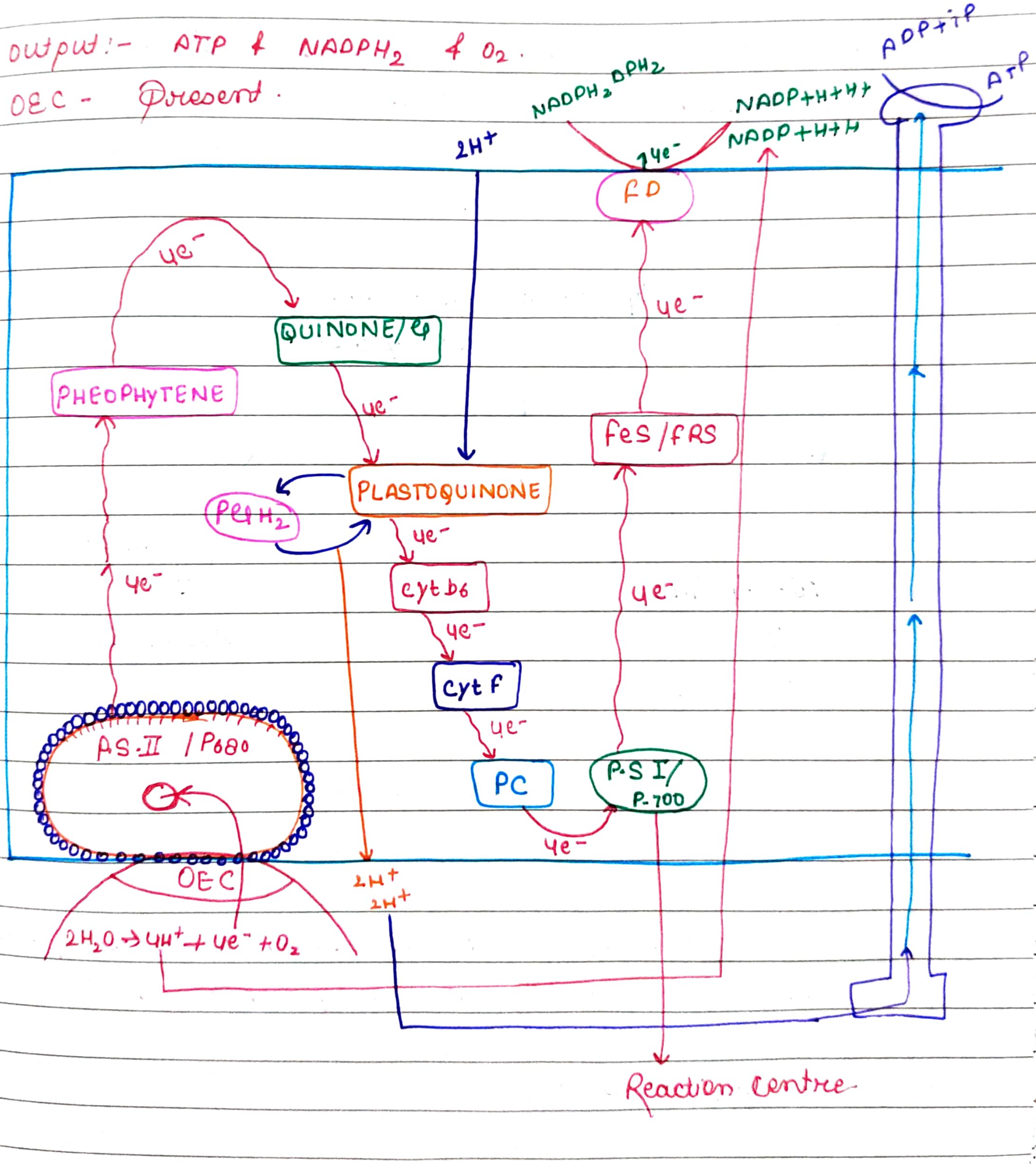
P - 650 P. 700.

Site :- Thylakoid membrane.

Photosystem / Pigment S/m } - P.S. I - P_{700}
P.S. II - P_{680}.

output :- ATP & $NADPH_2$ & O_2.

OEC - Present.



DARK PHASE

Main path → C_3 cycle

Alternative / 2 path
- C_4 cycle.
- CAM cycle.

C_4 cycle / Hatch and Slack pathway.

- C_4 plants are native of tropical - region.
- They adapted to grow into
  - x High temperature.
  - x High ligh exposure.
  - x High salinity.

C_4 Plants (19 families) (1500 species)

- Dicots plants → 16- families ⇓ 600 Species
- Monocots plants. 3 families. ⇓ $\boxed{\text{900 Species}}$

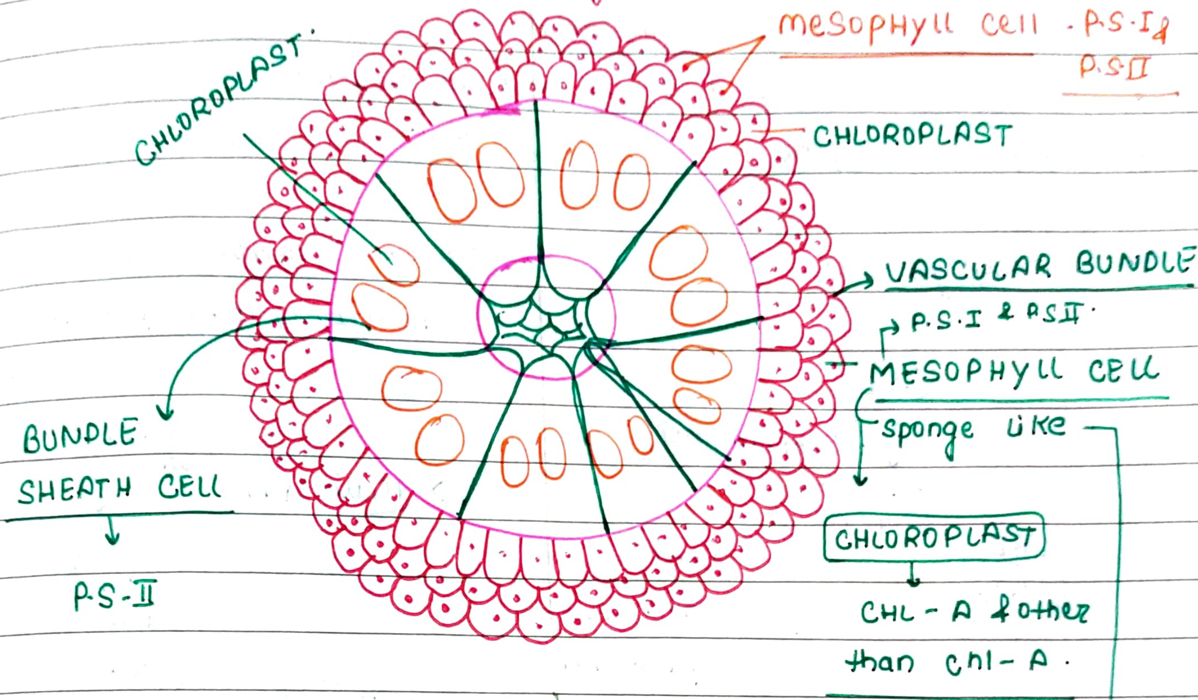
- In actual, C_4 plants are evolved from C_3 - plant to compensate. CO_2 Availability.

Means:- Before C_4 plant ~~are evolved from C_3 plant~~ they were belong to C_3 plant only.

CO_2 ↓ O_2 ↑

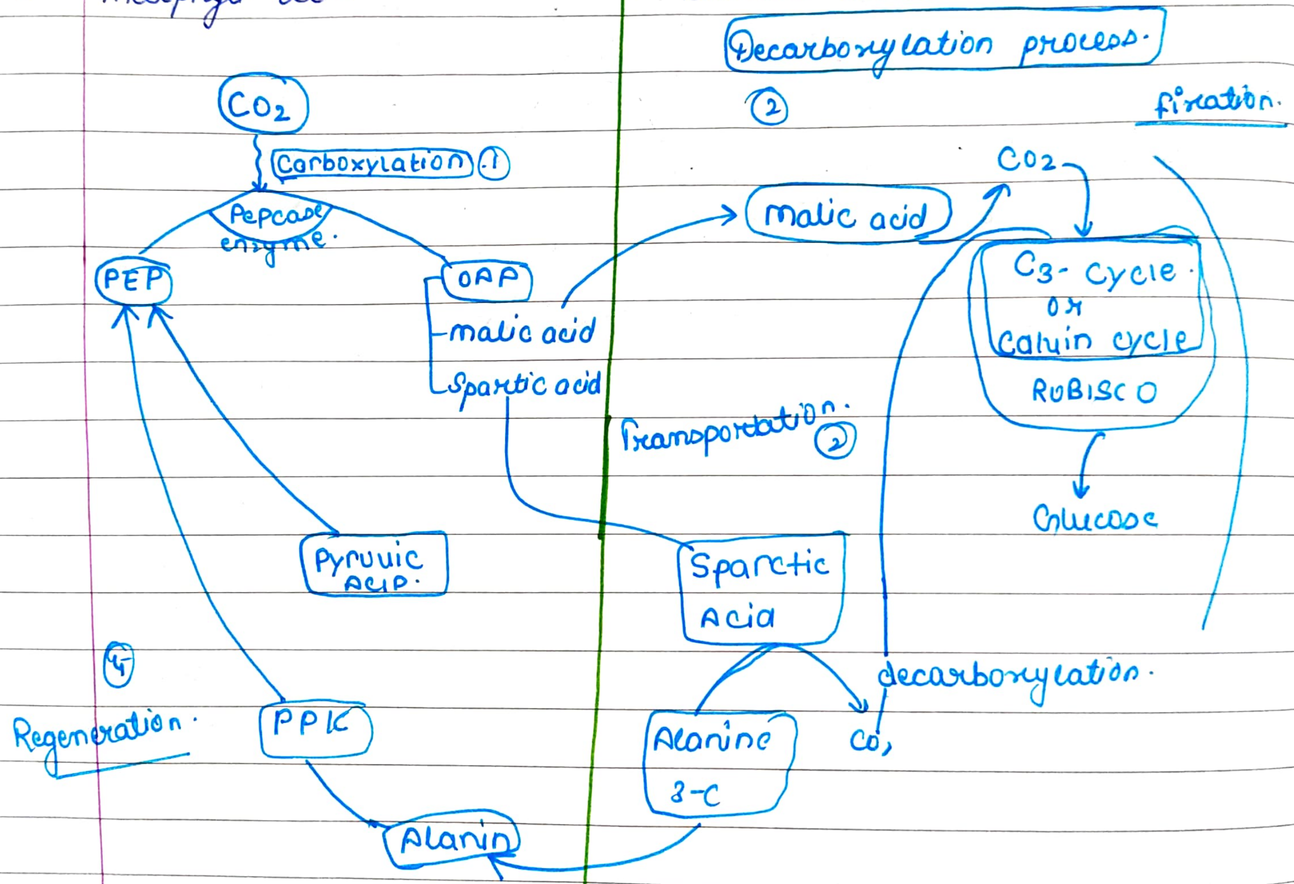
$CO_2 + H_2O \longrightarrow \boxed{C_6H_{12}} + O_6 + H_2O$

- C_4 plants have develop a special type of anatomical changes i.e called ~~Kranz~~- anatomy



Parachymateous cell
↓
concentric ~~cet~~ manner.

Mesophyll	BUNDLE SHEATH.
Small in size	Big in size.
They are more in no	less in no.
chloroplast small.	chloroplast large.
chloroplast shows Dimorphism	
photosystem - P.S I & P.S-II	photosystem - P.S.I
pepcase enzyme.	RUBISCO enzyme.
mesophyll cell.	Bundle sheath cell.



- C_4 cycle.

- carboxylation :- Mesophyll cell.
- De- carboxylation — Bundle sheath cell.

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3- pepcase and PPDK — low light sensitive.

4.> C_4 plant are efficient plant due to absence of photo-respiration process.

5> They grow in high light exoposure & efficient. they have concentric mesophyll cell present.

6) Due to accumulation of organic acid in vacutes, they protect them & make them efficient in high salinity region.

7> In C_4 - plant silica deposited in their leaf so they can control rote of transpiration.

8) C_4 - plants are efficient since photorespiration is absent due to special anatomical arrangement ie. Kranz anatomy.

* CAM cycle :- found in xeophytic or succinic plant.

↓

Crassulaceum → 1st time notice in ↓ Ranson & Thomson.

Acid metabolism

eg:- ← Succinic → jade plant or jade ovata

Plant

Alovera

cactus

means

leaf are thick or flashing.

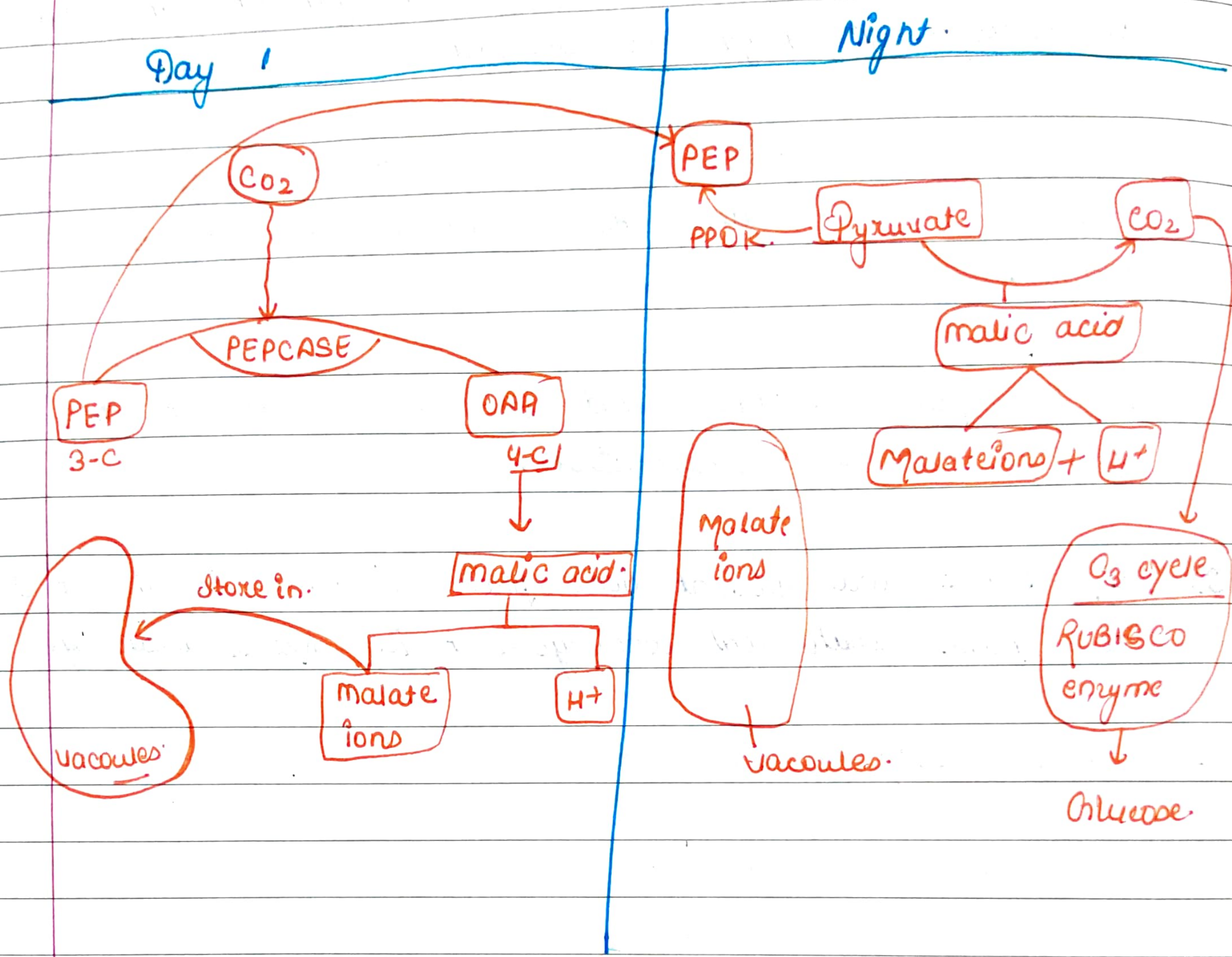
→ CAM plants are in Actual C_3 - plant but for their survial they change themsey & Adopt cam cycle.

→ They compensate low availablity of water (H_2O)

→ CAm plants are not efficient plant since it perform.

photorespiration.

- In cam plant carboxylation takes place during night & de carboxylation ~~day~~ during day time.



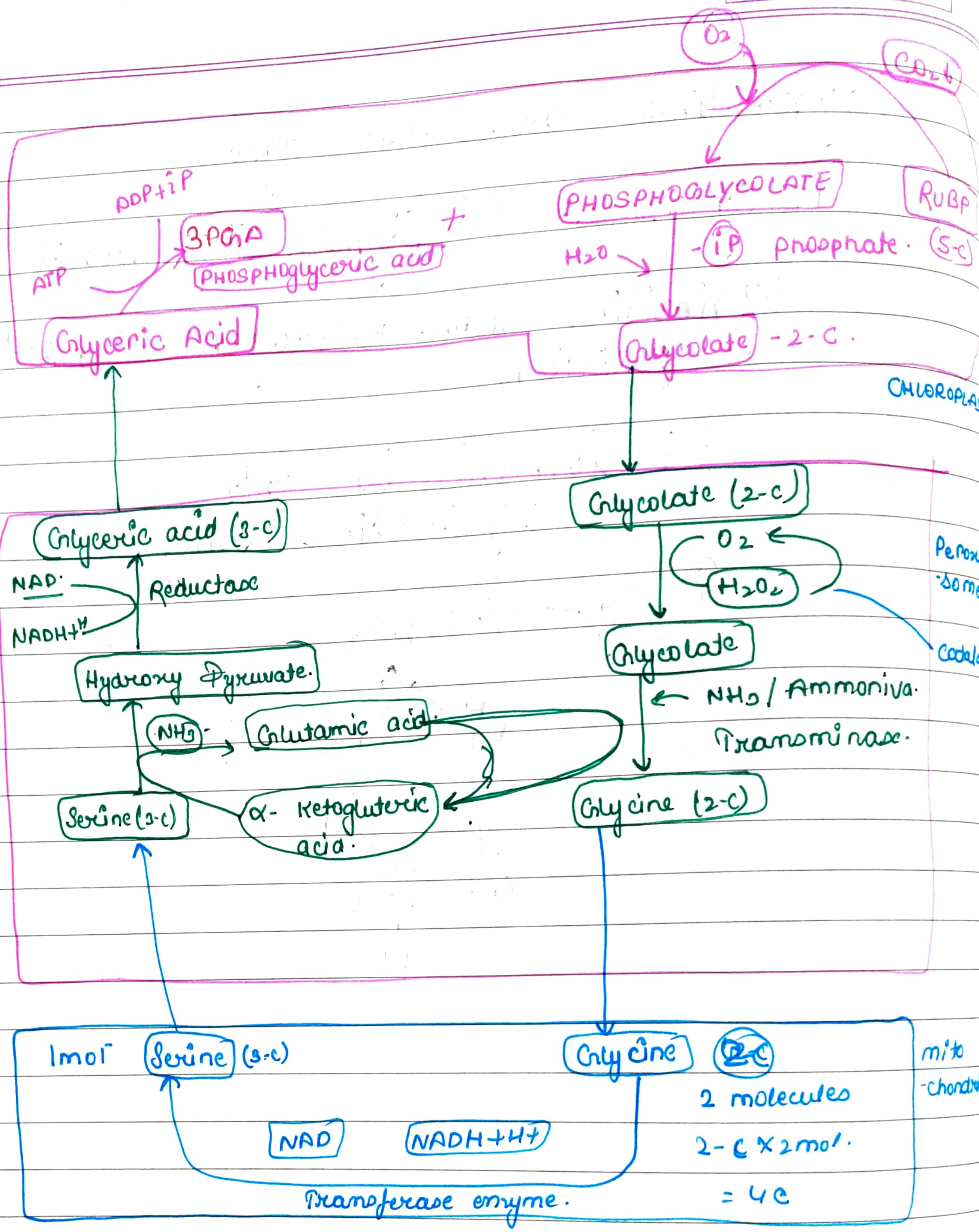
* photorespiration.
↓ light ↓ Biological process. → ATP

Q. why photosynthesis occur?
- If O_2↑ & CO_2↓

(2) condition for occur photorespiration why O_2↑ & CO_2↓
- If abiotic factor or physical condition changes: ↑T / light exposure / intensity ↑ ⇒ O_2↑.

- Site- chloroplast, peroxisome, mitochondria.

Other name- C_2 cycle,



Double waste process.

① ATP – during respiration.
&
② (1/4) carbon can't use

$O_2 \uparrow$

$CO_2 \downarrow$

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Benifits :

- Protect "Chl-a" form Solarization.
- Deception of Surplus energy.
- Synthesised various chemicals like - Amino acids
- Solarization - Distruction of pigments due to high light intensity / Explosure.

- Etiolation - Distruction of pigment due to low light into condition / Symptoms :-
  i) yellow of leaf / leaves.
  ii) Elongated Intense present due to AGF
  Anti Gibberellins flavanids.

factors affecting Rate of photosynthesis :-

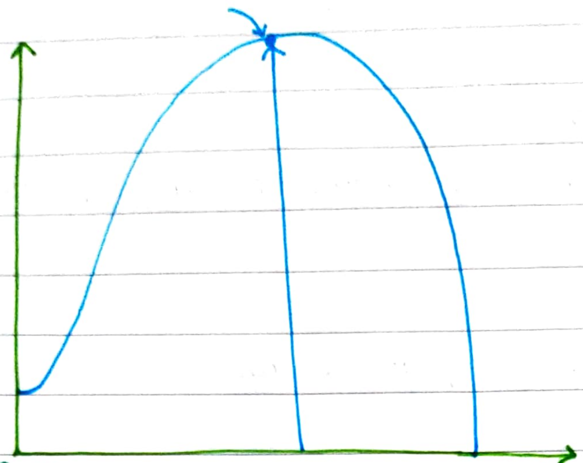
1.) Internal factor / plant factor
- Size,
- Shape.
- No of leaves.
- Orientation of leaves
- Mesophyll cell.
- Chloroplast cell.
- Internal CO_2 concentration.

2. External factor / physical factor.
- light.
- CO_2.
- H_2O.

concept of coordinal point :-

- Among all photosynthetic factor they should be present in crucial value (min, optimum & Max) is consider point.

* Coordinal means fundamental or main or basic.



factors [CO_2, H_2O light]

minm optimum maximum.

∃ law of minimum = "lebig"
- Rate of photosynthesis is determined by those factor which present minimum in amount.

- law of limiting factor "Blackman" 1105

- The rate of Reaction is determined by those factors which shows least participation in reaction.

* factors which shows minimum participation present in least amount:-

organism	least participation.
i) Terrestrial plants. —	CO_2
ii) Aquatic deep plant. —	light.
iii) Aquatic Surface —	minerals.
iv) xerophytic plant —	H_2O
v) Virus infected Plant —	chlorophyll.

External photosynthetic factor

1. Light.
2. CO_2.
3. H_2O.
4. O_2.
5. Temperature.
6. Minerals.
7. Inhibitors.

Internal factor

1. Genetic factors - (I)
2. Gentic factors - (II)

Light :- Intensity.
b). Quality.
c). Duration.

Intensity

1) Heliophyte

→ Light loving plant

↓

It shows

↓

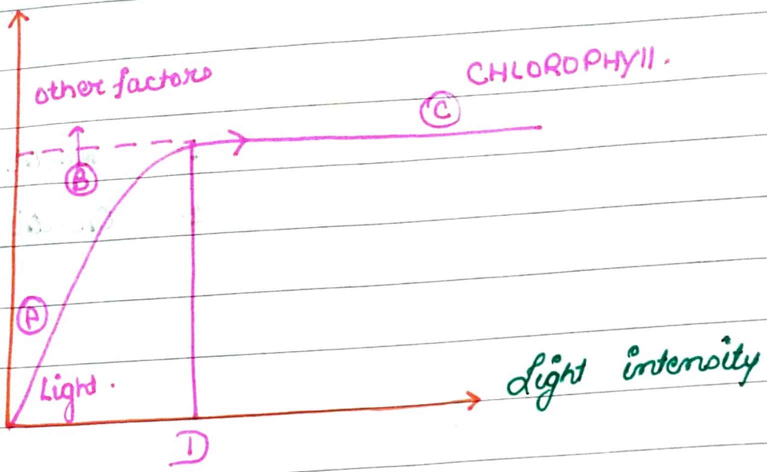
Etiolation

Sciophyte.

$\boxed{\text{Shade loving plant}}$

↓ It shows.

Solarization.



light + Saturation / optimum light Intensity

* Light companpsation point
* light intensity at which rate of photosynthesis is equal to rate of respiration.

$\boxed{\text{photosynthesis = Respiration}}$

→ No gaseous exchange takes place through environment.
- plant will survive for little bit of time.

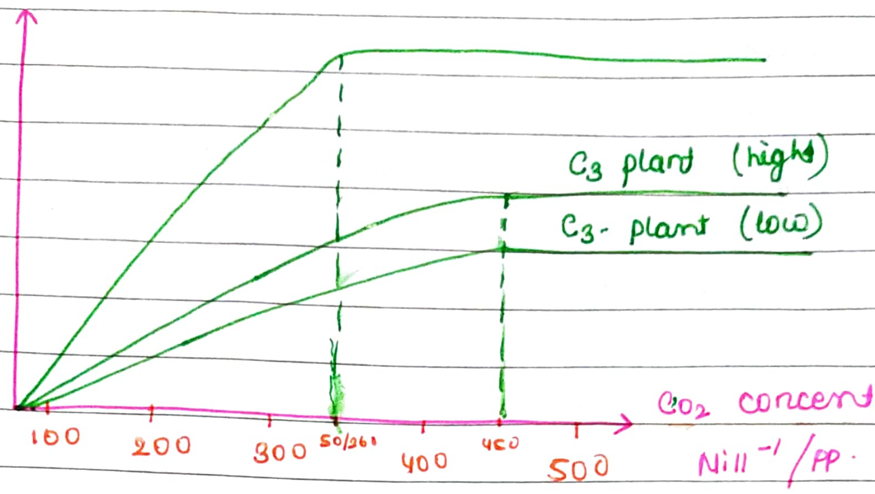
(b) Quality.

White > Red > Blue > Green.

(c) Duration. - It is the rate of photosynthesis

- continuous light - less photosynthesis.
- Discontinuous light - more photosynthesis.

* CO_2.



* oxygen.

- oxygen shows inhibitory effect in photosynthesis i.e consider warberg effect.

- It is occur due to photorespiration and photoxidation.

* water :- water ∝ Rate of photosynthesis.

* Minerals :-

1) chlorophyll synthesis - fe, mg, N.
2) photolysis - ca, Cl, Mn.
3) food transport - B & K.
4) photocyanin - Cu
5) cytochrome - fe.

* Inhibitors.

- P.S.I - fes.

P.S.II - pheophytene.

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1. Triazime.
2. phenylurea.
3. phenyl caramine & phenyl carbonate
4. Nitrite.
5. Benzythiolodozale.

✱ Internal factors:-

1) Chl $\propto$ photosynthesis.

2) Age $\propto \dfrac{1}{\text{Photosynthesis}}$.

3) Leaf $\propto$ photosynthesis.