FREE NOTES · NCERT + NEET LEVEL

Photosynthesis in Higher Plants

Purane experiments, photosynthesis ki jagah, pigments, light reaction (Z-scheme, photophosphorylation, chemiosmosis), Calvin cycle, C4 pathway, photorespiration aur factors.

01 Purane experiments
02 Jagah aur pigments
03 Light reaction
04 Chemiosmosis aur Calvin cycle
05 C4 pathway aur photorespiration
06 Photosynthesis ke factors
07 Extra + tricks
08 Important Q&A
09 Common mistakes
10 Practice (NEET style)
11 Quick revision

01 Purane experiments

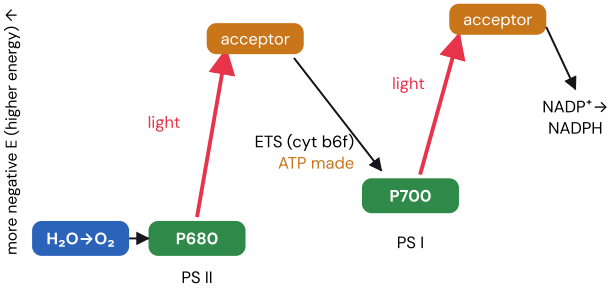
Scientist	Khoj
Joseph Priestley (1770)	Pudina ka paudha mombatti/chuhe se kharab hawa theek karta
Jan Ingenhousz	Dhoop zaroori; sirf hare parts O_2 chhodte
Julius von Sachs (1854)	Glucose banta, hare parts me starch ke roop me
T.W. Engelmann	*Cladophora* + aerobic bacteria se action spectrum: neeli aur laal roshni sabse asardaar
Cornelius van Niel	Purple/green sulphur bacteria; O_2 paani (H_2O) se, CO_2 se nahi

Equation: $6CO_2 + 12H_2O \rightarrow C_6H_{12}O_6 + 6H_2O + 6O_2$ (light, chlorophyll).

02 Jagah aur pigments

- Mesophyll cells; chloroplast ke **grana** (light reaction: roshni pakadna, ATP, NADPH) aur **stroma** (dark reaction: enzymes CO_2 fix karte).
- Leaf pigments ki chromatography: chlorophyll *a* (chamakdaar neela-hara; mukhya pigment, reaction centre), chlorophyll *b* (peela-hara), xanthophylls (peela), carotenoids (peela se orange).
- Accessory pigments zyada roshni pakadte aur chlorophyll *a* ko photo-oxidation se bachate.
- Action spectrum chlorophyll *a* ke absorption spectrum se milta: neele aur laal pe peak.

03 Light reaction

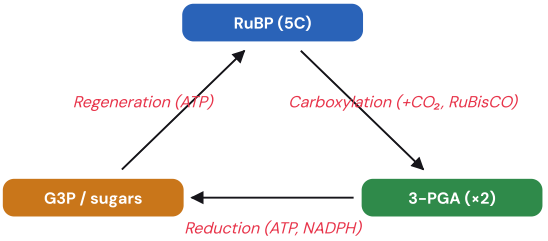


Z-scheme (non-cyclic electron flow)

- Light harvesting complexes (antennae) reaction centres ke saath: **PS I** (P700) aur **PS II** (P680).
- PS II pe paani ka **photolysis** (thylakoid membrane ke andar ki taraf, Mn, Ca, Cl): $2H_2O \rightarrow 4H^+ + O_2 + 4e^-$.
- **Non-cyclic photophosphorylation**: dono PS, ATP + NADPH. **Cyclic**: sirf PS I (stroma lamellae, jisme PS II aur NADP reductase nahi), sirf ATP; jab sirf 680 nm se zyada wali roshni ho.

04 Chemiosmosis aur Calvin cycle

- **Chemiosmotic hypothesis**: thylakoid membrane ke aar-paar proton gradient (photolysis se lumen me H^+, cyt b6f se pumping, aur NADP reduction se stroma ka H^+ kam).
- H^+ wapas stroma me **ATP synthase** se (CF_o channel, CF_1 ATP banata).
- Calvin (^{14}C se): C3 plants me pehla product **3-PGA**. CO_2 acceptor RuBP; enzyme **RuBisCO**.
- **1 glucose ke liye: 6 CO_2, 18 ATP, 12 NADPH** (6 chakkar; har CO_2 pe 3 ATP + 2 NADPH).



Calvin cycle ke teen stages

05 C4 pathway aur photorespiration

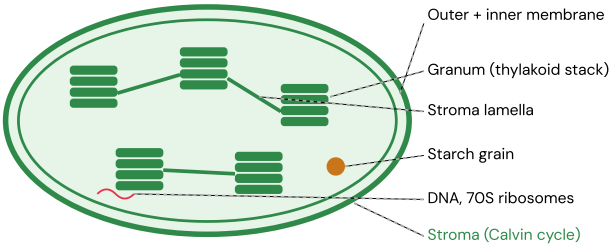
Feature	C3	C4
Pehla product	3-PGA (3C)	OAA (4C)
Primary acceptor	RuBP	PEP (enzyme PEP case, mesophyll me)
Leaf anatomy	Normal	**Kranz anatomy**: bade bundle sheath cells, kai chloroplasts, moti walls, intercellular spaces nahi
Photorespiration	Hota	Nahi (RuBisCO ke paas CO_2 zyada)
Optimum temperature	20–25°C	30–40°C
Examples	Gehun, chawal	Makka, jowar, ganna

Photorespiration: RuBisCO CO_2 ki jagah O_2 se judta (RuBP + O_2 → 1 PGA + phosphoglycolate); na ATP na sugar, bekaar. C4 cycle: OAA → malate → bundle sheath → CO_2 chhodta → Calvin cycle; pyruvate wapas mesophyll.

06 Photosynthesis ke factors

- **Blackman ka law of limiting factors** (1905): rate us factor se tay hoti jo apne minimum ke sabse paas.
- Light: kam roshni pe rate seedhi line me badhti; zyada roshni pe doosre factors limit; bahut tez roshni chlorophyll ko nuksaan.
- CO_2: mukhya limiting factor (hawa me 0.03–0.04%). C3 plants zyada CO_2 pe badhte (greenhouse me tamatar, shimla mirch CO_2 wali hawa me); C4 ~360 µL/L pe saturate.
- Temperature (dark reactions enzymatic) aur paani (kami se stomata band, pattiyan murjhati).

07 Extra + tricks



Chloroplast ki banawat

Feature	C3	C4	CAM
Pehla product	PGA	OAA	OAA (raat me)
CO_2 fixation	Din, mesophyll	Din, mesophyll + bundle sheath (jagah ka antar)	Raat (stomata khule) + din me Calvin (samay ka antar)
Examples	Gehun, chawal	Makka, ganna, jowar, *Amaranthus*	Succulents: *Opuntia*, ananas, *Bryophyllum*

- **Moll ka half-leaf experiment**: aadhi patti KOH (CO_2 sokhta) wali bottle me, usme starch nahi ⇒ CO_2 zaroori.
- Priestley: bell jar me mombatti + chuha; pudina ne hawa theek ki. Ingenhousz: *Hydrilla* sirf roshni me O_2 bulbule.
- Trick: **C4 = "MS-SA"**: Maize, Sugarcane, Sorghum, Amaranthus.

08 Important Q&A

Q1. C4 plants garam, sookhe mausam me zyada efficient kyun?

PEP case O_2 se nahi judta aur bundle sheath me CO_2 zyada, isliye photorespiration nahi; garmi sahte aur paani bachate.

Q2. Photosynthesis me O_2 kahan se aata?

Paani se, PS II pe photolysis dwara (van Niel).

Q3. Ek glucose ke liye kitne ATP aur NADPH?

18 ATP aur 12 NADPH (6 chakkar).

09 Common mistakes

- Kehna ki dark reaction sirf andhere me (light-independent hai, din me hota).
- C4 ka pehla product malate likhna (OAA hai).
- Sochna ki cyclic photophosphorylation NADPH banata.
- PS I (P700) aur PS II (P680) mix karna.

10 Practice (NEET style)

1. C3 me CO_2 acceptor?
2. Kranz anatomy kisme?
3. Photolysis kisse juda?
4. O_2 paani se aata, kisne bataya?
5. Law of limiting factors?

ANSWERS

1) RuBP · 2) C4 plants (maize) · 3) PS II · 4) van Niel · 5) Blackman

11 Quick revision: exam se 5 minute pehle

LIGHT REACTION

- Grana; PS II P680, PS I P700
- Non-cyclic: ATP + NADPH
- Cyclic: sirf ATP

CALVIN

- Stroma; RuBisCO
- Pehla product 3-PGA
- Glucose pe 18 ATP + 12 NADPH

C4

- PEP case, OAA
- Kranz anatomy
- Photorespiration nahi

SCIENTISTS

- Priestley pudina
- Engelmann action spectrum
- Blackman limiting factors

Koi doubt? padhaiadda.netlify.app pe AI Doubt Solver se poocho, ya is chapter ka mock test do.