

Photosynthesis in Higher Plants — NEET MCQs with Solutions

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Q1. The green colour of leaves is due to:

- (A) Absorption of green wavelength by chlorophyll
- (B) Emission of green fluorescence by carotenoids
- (C) Total transmission of all visible wavelengths
- (D) Reflection of green light by chlorophyll

Q2. Which of the following correctly pairs an organism with the type of photosynthesis it performs?

- (A) Cyanobacteria — anoxygenic photosynthesis
- (B) Purple sulphur bacteria — oxygenic photosynthesis
- (C) Green plants — oxygenic photosynthesis
- (D) Green sulphur bacteria — oxygenic photosynthesis

Q3. In the light reactions of photosynthesis, the immediate (terminal) electron acceptor from PS I is:

- (A) Molecular oxygen (O_2)
- (B) $NADP^+$
- (C) Ferredoxin only, with no further transfer
- (D) Carbon dioxide

Q4. Ingenhousz also showed that oxygen evolution occurs mainly from:

- (A) Root hair cells in soil
- (B) Woody stem tissue
- (C) Floral reproductive organs
- (D) Green parts of the plant

Q5. The first action spectrum of photosynthesis was experimentally demonstrated by:

- (A) Joseph Priestley using bell jar and mint
- (B) Julius von Sachs using iodine staining
- (C) T.W. Engelmann using prism and aerobic bacteria
- (D) Robert Hill using isolated chloroplasts

Q6. The "Red Drop" phenomenon, where photosynthetic efficiency drops sharply beyond 680 nm wavelength, was observed by:

- (A) T.W. Engelmann studying action spectra
- (B) Julius von Sachs using starch iodine test
- (C) Robert Emerson studying quantum yield
- (D) Robert Calvin studying CO_2 fixation rates

Q7. A stack of thylakoids within the chloroplast is termed:

- (A) Stroma
- (B) Cisterna
- (C) Matrix
- (D) Granum

Q8. The internal aqueous space enclosed within the thylakoid membrane is called the:

- (A) Stroma
- (B) Thylakoid lumen
- (C) Intermembrane space
- (D) Chloroplast matrix

Q9. The DNA found within chloroplasts is best described as:

- (A) Linear and associated with histone proteins
- (B) Circular and naked (not associated with histones)
- (C) Double-stranded RNA resembling viral genome
- (D) Single-stranded and associated with non-histone proteins

Q10. The reaction centre chlorophyll of Photosystem II, which drives water splitting, is designated as:

- (A) P680
- (B) P700
- (C) P660
- (D) P640

Q11. Which carotenoid pigment is orange in colour and protects chlorophyll from photooxidative damage?

- (A) Chlorophyll b
- (B) Xanthophyll (yellow carotenoid)
- (C) Phycocyanin
- (D) β -Carotene

Q12. The action spectrum of photosynthesis is broader than the absorption spectrum of purified chlorophyll a because:

- (A) Chlorophyll a alone drives all photochemical reactions
- (B) Green light is most efficiently used by accessory pigments
- (C) Photosynthesis rate increases linearly with all wavelengths equally
- (D) Accessory pigments absorb additional wavelengths and transfer energy to the reaction centre

Q13. The reducing power generated during non-cyclic photophosphorylation, used directly in the Calvin cycle, is in the form of:

- (A) ATP (adenosine triphosphate)
- (B) O_2 released from water splitting
- (C) NADPH (reduced nicotinamide adenine dinucleotide phosphate)
- (D) Glucose directly synthesised during light reaction

Q14. The non-cyclic electron flow from PS II to PS I via electron carriers, when plotted on a redox potential scale, is called the:

- (A) Non-cyclic electron transport chain
- (B) Z-scheme
- (C) Photophosphorylation pathway
- (D) Emerson two-photosystem pathway

Q15. Cyclic photophosphorylation exclusively involves:

- (A) Photosystem II only
- (B) Both PS II and PS I with linear electron flow
- (C) Photosystem I only
- (D) Both PS I and PS II with ferredoxin recycling electrons to PS II

Q16. In C4 plants, the initial fixation of atmospheric CO_2 by PEP carboxylase occurs in:

- (A) Bundle sheath cells
- (B) Guard cells
- (C) Mesophyll cells
- (D) Epidermal cells

Q17. The enzyme responsible for primary CO₂ carboxylation in mesophyll cells of C4 plants is:

- (A) RuBisCO (present in bundle sheath only)
- (B) Carbonic anhydrase
- (C) Malate dehydrogenase
- (D) PEP carboxylase

Q18. The chloroplasts of bundle sheath cells in C4 plants characteristically:

- (A) Have well-developed grana like mesophyll chloroplasts
- (B) Are identical in structure to C3 mesophyll chloroplasts
- (C) Completely lack DNA and ribosomes
- (D) Have poorly developed (agranal) or no grana

Q19. The 2-phosphoglycolate formed by RuBisCO oxygenase activity contains how many carbon atoms?

- (A) 6 (same as glucose)
- (B) 5 (same as RuBP)
- (C) 3 (same as 3-PGA)
- (D) 2

Q20. In the peroxisome, glycolate is oxidised to glyoxylate, which is then transaminated to form:

- (A) Glyoxylate (end product retained in peroxisome)
- (B) Glycine
- (C) Serine
- (D) Malate

Q21. In the mitochondria during photorespiration, two molecules of glycine are converted to:

- (A) Serine and CO₂ only (NH₃ reassimilated immediately)
- (B) Malate, O₂, and ATP
- (C) Serine, CO₂, and NH₃
- (D) RuBP, which re-enters the Calvin cycle

Q22. Which of the following is correctly classified as an internal (plant) factor affecting photosynthesis?

- (A) Light intensity incident on leaf surface
- (B) Atmospheric CO₂ concentration
- (C) Ambient temperature
- (D) Chlorophyll content of the leaf

Q23. Temperature primarily affects photosynthesis by directly influencing:

- (A) Rate of light absorption by chlorophyll pigments
- (B) Stomatal density and leaf morphology
- (C) Stability of thylakoid membrane lipids only
- (D) Activity of enzymes catalysing dark reactions (Calvin cycle)

Q24. At very high light intensities, photosynthetic rate may decline because:

- (A) Photooxidation damages chlorophyll molecules
- (B) Stomata open excessively, losing too much CO₂
- (C) RuBisCO is directly inhibited by excess photon flux
- (D) Light reactions become too fast for dark reactions to balance

Answer key and explanations

Q1. Answer: (D) Reflection of green light by chlorophyll

Chlorophyll absorbs red (660–700 nm) and blue (430–450 nm) wavelengths most efficiently and reflects green wavelengths, which we perceive as the leaf colour. It does not absorb green light — absorption of green would make leaves appear red or blue.

Q2. Answer: (C) Green plants — oxygenic photosynthesis

Green plants and cyanobacteria perform oxygenic photosynthesis using water as hydrogen donor, releasing O_2 . Purple and green sulphur bacteria perform anoxygenic photosynthesis using H_2S , releasing sulphur instead of oxygen.

Q3. Answer: (B) NADP⁺

In non-cyclic photophosphorylation, electrons from PS I are passed via ferredoxin to NADP⁺ reductase, which reduces NADP⁺ to NADPH. NADP⁺ is the terminal electron acceptor, not CO_2 (which is reduced later in the stroma using NADPH).

Q4. Answer: (D) Green parts of the plant

Oxygen was evolved only from green (chlorophyll-containing) parts of the plant exposed to light — non-green parts such as roots, stems, and flowers did not release O_2 .

Q5. Answer: (C) T.W. Engelmann using prism and aerobic bacteria

Engelmann's 1883 experiment split light with a prism onto *Cladophora* and used aerobic bacteria as O_2 sensors, producing the first action spectrum. Julius von Sachs demonstrated starch production — a common mix-up trap.

Q6. Answer: (C) Robert Emerson studying quantum yield

Emerson observed that quantum yield of photosynthesis drops dramatically when wavelength exceeds 680 nm (far-red) — the "Red Drop." This led to his discovery of the Emerson Enhancement Effect and the concept of two photosystems.

Q7. Answer: (D) Granum

A granum (plural: grana) is a stack of thylakoid discs. Stroma is the surrounding matrix; cisterna is a Golgi term; matrix is the mitochondrial equivalent of stroma — all serve as effective distractors.

Q8. Answer: (B) Thylakoid lumen

The thylakoid lumen is the space enclosed within the thylakoid membrane. It is distinct from the stroma (which surrounds grana) and the intermembrane space (between the two envelope membranes).

Q9. Answer: (B) Circular and naked (not associated with histones)

Chloroplast DNA is circular and histone-free, closely resembling prokaryotic (bacterial) DNA — supporting the endosymbiotic theory. Option A describes eukaryotic nuclear DNA; Option C is a trap referencing viral nucleic acids.

Q10. Answer: (A) P680

PS II reaction centre is P680, absorbing maximally at 680 nm and providing the energy to oxidise water. P700 is PS I. P660 and P640 are not recognised reaction centre designations in NCERT.

Q11. Answer: (D) β -Carotene

β -Carotene is the orange-coloured carotenoid that quenches singlet oxygen and dissipates excess excitation energy, protecting the photosynthetic apparatus from photooxidative damage. Xanthophylls are yellow, not orange. Phycocyanin is a phycobilin found in cyanobacteria.

Q12. Answer: (D) Accessory pigments absorb additional wavelengths and transfer energy to the reaction centre

The action spectrum includes contributions from chlorophyll b, carotenoids, and xanthophylls — all of which absorb wavelengths that purified chlorophyll a does not, and transfer that energy to the reaction centre, making photosynthesis effective across a wider spectrum.

Q13. Answer: (C) NADPH (reduced nicotinamide adenine dinucleotide phosphate)

NADPH provides the reducing equivalents (electrons + protons) required to reduce 3-PGA to G3P in the Calvin cycle. ATP provides energy but not electrons. O_2 is a byproduct, not used in carbon fixation. Glucose is produced in the Calvin cycle, not the light reactions.

Q14. Answer: (B) Z-scheme

The Z-scheme (named by Hill and Bendall) describes the energetics of non-cyclic electron flow — when plotted with redox potential on the Y-axis, the path from water through PS II, electron carriers, and PS I to NADP⁺ traces a Z-shaped curve.

Q15. Answer: (C) Photosystem I only

Cyclic photophosphorylation involves only PS I — electrons excited from P700 pass to ferredoxin, then cycle back through the Cyt b6f complex and plastocyanin to P700 itself. No PS II, no water splitting, no NADPH production — only ATP is generated.

Q16. Answer: (C) Mesophyll cells

PEP carboxylase is localised exclusively in mesophyll cells. It fixes CO₂ into OAA, which is converted to malate and transported to bundle sheath cells. Bundle sheath cells receive CO₂ indirectly via malate decarboxylation, not directly from atmosphere.

Q17. Answer: (D) PEP carboxylase

PEP carboxylase catalyses CO₂ fixation to PEP in mesophyll cells. Crucially, RuBisCO is present only in bundle sheath cells in C4 plants — not in mesophyll. This reciprocal distribution (PEP carboxylase in mesophyll, RuBisCO in bundle sheath) is a frequent NEET trap.

Q18. Answer: (D) Have poorly developed (agranal) or no grana

Bundle sheath chloroplasts are agranal (lacking stacked grana) — they are specialised for the Calvin cycle (stroma reactions) rather than light reactions. The absence of grana reflects reduced PS II activity and minimal light reaction function in these cells.

Q19. Answer: (D) 2

2-phosphoglycolate is a 2-carbon compound — the phosphate group does not contribute carbon atoms. It cannot enter the Calvin cycle directly (which requires 3C or 5C intermediates) and must be metabolised through the costly photorespiratory C2 pathway.

Q20. Answer: (B) Glycine

Glyoxylate is transaminated (amino group added) to form glycine in the peroxisome. Glycine then moves to the mitochondria. Serine is formed later in mitochondria from two glycine molecules — not in the peroxisome.

Q21. Answer: (C) Serine, CO₂, and NH₃

Two glycine molecules (2×2C = 4C) are converted to one serine (3C) + one CO₂ + one NH₃ by the glycine decarboxylase complex in mitochondria. This is the step where photorespiratory CO₂ is released. NH₃ is subsequently reassimilated in the chloroplast — it is released, not retained.

Q22. Answer: (D) Chlorophyll content of the leaf

Internal factors are intrinsic to the plant — chlorophyll content, leaf anatomy, leaf age, and enzyme concentration. Light intensity, CO₂ concentration, and temperature are all external (environmental) factors. This classification is directly from NCERT.

Q23. Answer: (D) Activity of enzymes catalysing dark reactions (Calvin cycle)

The dark reactions (Calvin cycle) are enzyme-mediated and highly temperature-sensitive ($Q_{10} \approx 2$). Light reactions are photochemical and relatively temperature-independent. RuBisCO and other Calvin cycle enzymes show optimal activity within a specific temperature range and are denatured at high temperatures.

Q24. Answer: (A) Photooxidation damages chlorophyll molecules

Excess light energy exceeds the capacity of photoprotective mechanisms (carotenoids, xanthophyll cycle), leading to photooxidative damage to chlorophyll — a process called photoinhibition. Option C is a trap: RuBisCO is not directly light-inhibited; it is indirectly affected via substrate supply.

Photosynthesis facts to remember

Topic	Key fact
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Joseph Priestley (1770)	Candle, mouse and mint plant in a bell jar — plants restore the air
Jan Ingenhousz	Sunlight is essential; only green parts release oxygen
Julius von Sachs (1854)	Green parts make glucose, stored as starch; chlorophyll is in chloroplasts
T.W. Engelmann	First action spectrum using a prism, Cladophora and aerobic bacteria — blue and red regions
Cornelius van Niel	Oxygen released in photosynthesis comes from water, not CO ₂
Pigments	Chlorophyll a (bright or blue-green), chlorophyll b (yellow-green), xanthophylls (yellow), carotenoids (yellow to orange)
Reaction centres	PS I: P700; PS II: P680
Splitting of water	Linked to PS II, on the inner side of the thylakoid; releases H ⁺ , O ₂ and electrons
Z-scheme	Non-cyclic electron flow PS II → PS I → NADP ⁺ ; cyclic flow uses PS I only and makes ATP, no NADPH
Chemiosmosis	Protons build up in the thylakoid lumen; ATP synthase (CF ₀ -CF ₁) makes ATP
Calvin cycle	Carboxylation (RuBisCO), reduction, regeneration; one glucose needs 6 turns, 18 ATP and 12 NADPH
C4 pathway (Hatch-Slack)	Kranz anatomy; PEP carboxylase in mesophyll; first product oxaloacetic acid (4C); e.g. maize, sorghum
Photorespiration	RuBisCO acts as oxygenase in C3 plants; no ATP or NADPH made; absent in C4 plants
Law of limiting factors	Blackman (1905)