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Photosynthesis & Plant Structure

Exam — Plant Biology

Pre-med/IB-level practice on chloroplast structure, light reactions vs Calvin cycle, chemiosmosis in thylakoids, C3/C4/CAM and photorespiration basics, plus core leaf/vascular anatomy (stomata, mesophyll, xylem, phloem) and limiting factors.

50 items — Printable Exam

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Generated February 20, 2026

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1 In chloroplasts, the photosystems (I and II) are embedded primarily in the:



- A Outer chloroplast membrane
- B Stroma (fluid) of the chloroplast
- C Thylakoid membrane
- D Inner chloroplast membrane facing the cytosol
- E Plasma membrane of the plant cell

2 The Calvin cycle (light-independent reactions) takes place in the:



- A Thylakoid lumen
- B Stroma
- C Outer chloroplast membrane
- D Granum (the interior of a thylakoid stack)
- E Cytosol

3 What is the main advantage of grana (stacks of thylakoids) in chloroplasts?



- A To store glucose as glycogen
- B To provide space for DNA replication
- C To separate oxygen from carbon dioxide
- D To increase thylakoid membrane surface area for light reactions
- E To allow ribosomes to attach and translate proteins





4 Which substance is the direct source of the O₂ released during photosynthesis?



- A Water (H₂O)
- B Carbon dioxide (CO₂)
- C Glucose (C₆H₁₂O₆)
- D NADPH
- E ATP

5 Photolysis of water occurs at which part of the light reactions?



- A ATP synthase
- B Photosystem I reaction center
- C NADP⁺ reductase
- D Calvin cycle enzyme RuBisCO
- E Photosystem II (water-splitting complex)

6 During the light reactions, where does the highest concentration of H⁺ build up (in a functioning chloroplast)?



- A Stroma
- B Between the outer and inner chloroplast membranes
- C Thylakoid lumen
- D Cytosol
- E Nucleus





7 In chloroplasts, ATP synthase produces ATP on which side of the thylakoid membrane?



- A Thylakoid lumen side, releasing ATP into the lumen
- B Stroma side, releasing ATP into the stroma
- C Outer membrane side, releasing ATP into the cytosol
- D Inner membrane side, releasing ATP into the intermembrane space
- E It produces ATP equally on both sides

8 Which sequence best represents the overall direction of non-cyclic electron flow in the light reactions?



- A $\text{CO}_2 \rightarrow \text{glucose} \rightarrow \text{O}_2$
- B Photosystem I \rightarrow Photosystem II \rightarrow NADP^+
- C $\text{NADPH} \rightarrow$ Photosystem II \rightarrow O_2
- D Water \rightarrow Photosystem II \rightarrow Photosystem I \rightarrow NADP^+
- E Water \rightarrow Calvin cycle \rightarrow NADP^+ \rightarrow O_2

9 Which set of products is generated directly by the light reactions (non-cyclic) in a chloroplast?



- A ATP, NADPH, and O_2
- B ATP, NADH, and CO_2
- C Glucose and O_2
- D ATP only
- E NADPH and CO_2





10 Cyclic photophosphorylation differs from non-cyclic photophosphorylation mainly because cyclic photophosphorylation:



- A** Produces oxygen from carbon dioxide
- B** Produces NADPH but not ATP
- C** Produces ATP but not NADPH or O₂
- D** Uses photosystem II only
- E** Occurs in the chloroplast stroma, not the thylakoid membrane

11 A chloroplast is making plenty of NADPH but not enough ATP for the Calvin cycle. Which adjustment best helps restore the balance?



- A** Stop photosystem I entirely
- B** Increase water photolysis at photosystem II only
- C** Run the Calvin cycle faster without ATP
- D** Convert NADPH into NADP⁺ by releasing electrons to oxygen
- E** Increase cyclic photophosphorylation around photosystem I

12 Which molecule is the immediate carbon-containing product that leaves the Calvin cycle (as a net gain) and can be used to build glucose?



- A** RuBP (ribulose biphosphate)
- B** G3P (glyceraldehyde-3-phosphate)
- C** 3-PGA (3-phosphoglycerate)
- D** NADPH





E Chlorophyll a

13 Which statement best describes the role of RuBisCO?



- A** It catalyzes the fixation of CO₂ to RuBP in the Calvin cycle
- B** It splits water to release oxygen in the light reactions
- C** It pumps protons into the thylakoid lumen
- D** It produces ATP by allowing protons to flow down a gradient
- E** It is the main pigment that absorbs green light

14 Which condition most strongly favors photorespiration in a typical C₃ plant?



- A** High CO₂ and cool temperatures
- B** Low O₂ and high CO₂
- C** Low light intensity and high CO₂
- D** High temperature with stomata partly closed (low internal CO₂, relatively higher O₂)
- E** Complete darkness

15 Which enzyme helps C₄ plants reduce photorespiration by fixing CO₂ initially into a 4-carbon compound?



- A** RuBisCO
- B** PEP carboxylase





- C ATP synthase
- D NADP⁺ reductase
- E Lactate dehydrogenase

16 Which statement correctly describes CAM plants?



- A They open stomata mainly at night, storing CO₂ in organic acids, and release CO₂ for the Calvin cycle during the day
- B They open stomata only at midday to maximize CO₂ intake
- C They use PEP carboxylase only during the day and RuBisCO only at night
- D They perform the Calvin cycle in the thylakoid lumen
- E They cannot perform the light reactions

17 In a standard leaf cross-section, which tissue layer usually contains the highest density of chloroplasts?



- A Upper epidermis
- B Lower epidermis
- C Palisade mesophyll
- D Xylem
- E Phloem





18 Which leaf structure directly regulates gas exchange (CO₂ entry and water vapor loss)?



- A Cuticle
- B Xylem vessel
- C Palisade mesophyll
- D Stomata (with guard cells)
- E Phloem sieve tube

19 Stomata open when guard cells become turgid. The most direct cause of this turgor increase is typically:



- A Loss of K⁺ from guard cells, causing water to enter
- B Uptake of K⁺ (and other solutes) into guard cells, causing water to enter by osmosis
- C Active pumping of water out of guard cells
- D Conversion of ATP into glucose inside guard cells
- E Breakdown of chlorophyll

20 Abscisic acid (ABA) is most directly associated with which response during drought?



- A Increased stomatal opening to maximize CO₂ uptake
- B Activation of RuBisCO to speed the Calvin cycle
- C Photolysis of water to generate more O₂
- D Increased cyclic photophosphorylation in all chloroplasts
- E Stomatal closure to reduce water loss





21 Which vascular tissue primarily transports water and dissolved mineral ions from roots to leaves?



- A** Xylem
- B** Phloem
- C** Epidermis
- D** Guard cells
- E** Spongy mesophyll

22 Which vascular tissue primarily transports sucrose from a photosynthesizing leaf to a growing root tip?



- A** Xylem only
- B** Tracheids
- C** Phloem
- D** Palisade mesophyll
- E** Cuticle

23 Which statement best explains why leaves often have large internal air spaces in the spongy mesophyll?



- A** To store starch granules away from chloroplasts
- B** To increase the strength of the leaf against wind
- C** To house xylem and phloem vessels
- D** To allow CO₂ to diffuse efficiently to photosynthesizing cells and O₂ to diffuse out





- E To prevent any water vapor loss by trapping air

24 Which pigment is the primary reaction-center pigment in both photosystems of plants?



- A Chlorophyll a
- B Chlorophyll b
- C Carotene
- D Xanthophyll
- E Anthocyanin

25 Why do most leaves appear green to human eyes?



- A Leaves produce green light during photosynthesis
- B Leaves absorb green light more strongly than other wavelengths
- C Leaves reflect and transmit more green light than red or blue light
- D Leaves contain only chlorophyll b, which is green
- E Green light cannot pass through the atmosphere

26 A key protective role of carotenoids in chloroplasts is to:



- A Fix CO₂ into sugars when RuBisCO is absent
- B Pump protons across the thylakoid membrane





- C Convert O₂ into CO₂ to keep photosynthesis running
- D Dissipate excess light energy and reduce damage from reactive oxygen species
- E Replace chlorophyll as the reaction-center pigment

27 Which statement about the 'dark reactions' is most accurate?



- A They occur only at night and stop immediately in daylight
- B They do not require light directly, but depend on ATP and NADPH made by the light reactions
- C They generate ATP and NADPH for the light reactions
- D They take place in the thylakoid lumen
- E They are identical to fermentation

28 If a leaf is placed in bright light but CO₂ is removed from the surrounding air, which immediate effect is most likely?



- A Light reactions stop instantly because they require CO₂
- B Photolysis increases indefinitely, producing unlimited O₂
- C Calvin cycle speeds up because there is more light
- D NADPH and ATP are no longer produced by light reactions
- E Calvin cycle slows due to lack of CO₂; NADPH may accumulate and electron flow can become limited if NADP⁺ is not regenerated





29 In many plants, stomata are more numerous on the lower leaf surface mainly to:



- A Reduce water loss by placing pores in a cooler, less exposed area
- B Increase absorption of sunlight by the epidermis
- C Prevent CO₂ from entering too quickly
- D Allow xylem to empty into the atmosphere
- E Keep the leaf interior completely airtight

30 Which statement correctly compares chemiosmosis in chloroplasts and mitochondria?



- A In both, protons are pumped into the cytosol and flow back into the nucleus
- B In chloroplasts, ATP is produced in the thylakoid lumen; in mitochondria, ATP is produced in the intermembrane space
- C In chloroplasts, oxygen is consumed as the final electron acceptor; in mitochondria, oxygen is produced from water splitting
- D In chloroplasts, protons are pumped into the thylakoid lumen; in mitochondria, protons are pumped into the intermembrane space
- E In both, the proton gradient is built across the outer membrane

31 Which best describes the overall purpose of the light reactions?



- A To assemble glucose directly from CO₂
- B To convert light energy into chemical energy stored in ATP and NADPH
- C To convert glucose into CO₂ and water
- D To transport sucrose through phloem
- E To synthesize RuBisCO on ribosomes





32 Which statement best describes the role of NADP⁺ in photosynthesis?



- A** It is the enzyme that fixes CO₂
- B** It is the gas released as a byproduct
- C** It is the main pigment that absorbs light
- D** It is the sugar exported through phloem
- E** It is the final electron acceptor in the light reactions, forming NADPH

33 A student claims: "The Calvin cycle produces oxygen." Which correction is best?



- A** Correct—oxygen is produced when CO₂ is reduced in the stroma
- B** Correct—oxygen is produced when RuBP is regenerated
- C** Incorrect—oxygen is produced by splitting water in the light reactions, not by the Calvin cycle
- D** Incorrect—oxygen is produced only in mitochondria during respiration
- E** Incorrect—oxygen is released from glucose breakdown during glycolysis

34 In a typical C₃ plant, what is the first stable product formed after CO₂ fixation by RuBisCO?



- A** Glucose (6C)
- B** Oxaloacetate (4C)
- C** Malate (4C)
- D** 3-phosphoglycerate (3-PGA, 3C)





E Pyruvate (3C)

35 Which statement best explains why C4 plants are often more successful than C3 plants in hot, sunny environments?



- A They can perform photosynthesis without any water
- B They concentrate CO₂ around RuBisCO, reducing photorespiration and improving efficiency at high temperatures
- C They do not need chlorophyll to capture light
- D They use mitochondria instead of chloroplasts for carbon fixation
- E They stop transpiration entirely by sealing their stomata permanently

36 In CAM plants, carbon fixation and the Calvin cycle are separated primarily by:



- A Time (night vs day)
- B Different organs (root vs leaf)
- C Different membranes (outer vs inner chloroplast membrane)
- D Different cellular organelles (chloroplast vs mitochondrion)
- E Different plant generations (sporophyte vs gametophyte)

37 Which factor is most likely to be limiting the rate of photosynthesis at very low light intensity (with plenty of CO₂ and suitable temperature)?



A RuBisCO concentration





- B Stomatal density
- C Light intensity (photon availability)
- D Leaf cuticle thickness
- E Amount of xylem tissue

38 At very high light intensity, the rate of photosynthesis often plateaus because:



- A Chlorophyll stops absorbing light
- B Oxygen stops diffusing out of the leaf
- C Water can no longer enter the roots at all
- D ATP synthase is destroyed by light
- E Another factor (such as CO₂ availability or enzyme capacity) becomes limiting

39 The light compensation point is best defined as the light intensity at which:



- A Photosynthesis reaches its maximum rate
- B Net CO₂ exchange is zero because CO₂ uptake by photosynthesis equals CO₂ release by respiration
- C Stomata are fully closed
- D Only cyclic photophosphorylation occurs
- E Chlorophyll a is replaced by chlorophyll b





40 Which plant cells are a common exception to the rule that epidermal cells contain few chloroplasts?



- A Xylem vessels
- B Phloem sieve tubes
- C Palisade mesophyll cells
- D Guard cells
- E Root hair cells

41 Which structure is most directly responsible for reducing water loss from the leaf surface?



- A Waxy cuticle
- B Stroma lamellae
- C Bundle sheath cells
- D Thylakoid lumen
- E Grana

42 A plant is kept in darkness for several hours after being in bright light. Which change is most likely in a typical leaf?



- A Starch content increases because photosynthesis continues
- B O₂ production increases because photolysis continues
- C Starch content decreases because respiration continues while photosynthesis stops
- D CO₂ fixation increases because RuBisCO is activated by darkness
- E ATP and NADPH production increases because there is no Calvin cycle demand





43 Which statement about the overall photosynthesis equation is most accurate?



- A It shows that oxygen atoms in O₂ come from CO₂
- B It shows that carbon atoms in glucose come from water
- C It shows that photosynthesis is identical to respiration run backward in every step
- D It shows that photosynthesis requires mitochondria rather than chloroplasts
- E It summarizes that CO₂ is reduced to carbohydrate using energy from light, while water is oxidized to O₂

44 If the thylakoid membrane became leaky to protons (H⁺), which outcome is most likely?



- A ATP production by ATP synthase increases because protons move faster
- B ATP production decreases because the proton gradient collapses
- C NADPH production stops immediately because NADP⁺ is in the nucleus
- D CO₂ fixation increases because RuBisCO works better at low pH
- E Water splitting stops because it requires ATP synthase directly

45 Which statement best explains why 'dark reactions' typically slow quickly when a plant is moved into darkness?



- A ATP and NADPH production stops, so the Calvin cycle runs out of these required inputs
- B CO₂ can no longer diffuse into leaves in darkness because stomata lock permanently
- C RuBisCO is destroyed immediately without light
- D Oxygen accumulates and blocks CO₂ binding permanently





- E** Chloroplasts leave the cell at night

46 How many CO₂ molecules must be fixed by the Calvin cycle to produce one net G3P (3-carbon) molecule?



- A** 1
- B** 2
- C** 3
- D** 6
- E** 12

47 For a net production of one G3P in the Calvin cycle, the typical requirement is:



- A** 3 ATP and 2 NADPH
- B** 6 ATP and 3 NADPH
- C** 9 ATP and 12 NADPH
- D** 9 ATP and 6 NADPH
- E** 12 ATP and 6 NADPH

48 A plant mutant has functional photosystems but lacks RuBisCO. In bright light with normal CO₂, which is the best prediction?



- A** It will still produce glucose normally because RuBisCO is only for photorespiration





- B** It will stop producing oxygen because RuBisCO splits water
- C** It will run the Calvin cycle using NADH instead of NADPH
- D** It will convert CO₂ into O₂ in the stroma
- E** O₂ can still be produced initially, but sugar production fails because CO₂ cannot be fixed; eventually linear electron flow may become limited as NADP⁺ regeneration decreases

49 Which statement about xylem and transpiration is most accurate?



- A** Xylem moves sugars from leaves to roots mainly by active transport
- B** Transpiration helps pull water upward through xylem due to cohesion and tension
- C** Water in xylem is pushed upward mainly by gravity
- D** Xylem transport stops whenever stomata are open
- E** Transpiration occurs only at night in all plants

50 Which leaf adaptation most directly increases light capture for photosynthesis without changing pigment chemistry?



- A** A broad, flat leaf blade with large surface area
- B** Having fewer chloroplasts per cell
- C** Closing stomata during the day in all environments
- D** Reducing the number of palisade mesophyll cells
- E** Replacing chlorophyll with hemoglobin







#	Ans	Answer Text
1	C	Thylakoid membrane
2	B	Stroma
3	D	To increase thylakoid membrane surface area for light reactions
4	A	Water (H ₂ O)
5	E	Photosystem II (water-splitting complex)
6	C	Thylakoid lumen
7	B	Stroma side, releasing ATP into the stroma
8	D	Water → Photosystem II → Photosystem I → NADP ⁺
9	A	ATP, NADPH, and O ₂
10	C	Produces ATP but not NADPH or O ₂
11	E	Increase cyclic photophosphorylation around photosystem I
12	B	G3P (glyceraldehyde-3-phosphate)
13	A	It catalyzes the fixation of CO ₂ to RuBP in the Calvin cycle
14	D	High temperature with stomata partly closed (low internal CO ₂ , relativ...
15	B	PEP carboxylase
16	A	They open stomata mainly at night, storing CO ₂ in organic acids, and rel...
17	C	Palisade mesophyll
18	D	Stomata (with guard cells)
19	B	Uptake of K ⁺ (and other solutes) into guard cells, causing water to ente...
20	E	Stomatal closure to reduce water loss
21	A	Xylem
22	C	Phloem
23	D	To allow CO ₂ to diffuse efficiently to photosynthesizing cells and O ₂ to...
24	A	Chlorophyll a
25	C	Leaves reflect and transmit more green light than red or blue light
26	D	Dissipate excess light energy and reduce damage from reactive oxygen spe...
27	B	They do not require light directly, but depend on ATP and NADPH made by ...
28	E	Calvin cycle slows due to lack of CO ₂ ; NADPH may accumulate and electron...
29	A	Reduce water loss by placing pores in a cooler, less exposed area
30	D	In chloroplasts, protons are pumped into the thylakoid lumen; in mitocho...
31	B	To convert light energy into chemical energy stored in ATP and NADPH
32	E	It is the final electron acceptor in the light reactions, forming NADPH
33	C	Incorrect—oxygen is produced by splitting water in the light reactions, ...
34	D	3-phosphoglycerate (3-PGA, 3C)
35	B	They concentrate CO ₂ around RuBisCO, reducing photorespiration and impro...
36	A	Time (night vs day)
37	C	Light intensity (photon availability)
38	E	Another factor (such as CO ₂ availability or enzyme capacity) becomes lim...



