

Photosynthesis: practice questions

11 questions • 41 marks • mark scheme at the back

For Pearson Edexcel International AS Biology XBI11 and International A Level Biology YBI11. **A Level only** is IA2 content (Units 4 to 6), not needed for the International AS.

Name

Total / 41

1 UNIT 4 STYLE [1 mark]

Which statement correctly describes where the light-dependent and light-independent reactions of photosynthesis take place in a chloroplast?

- A. ☐ Light-dependent: stroma. Light-independent: thylakoid membranes.
- B. ☐ Light-dependent: thylakoid membranes. Light-independent: stroma.
- C. ☐ Light-dependent: chloroplast envelope. Light-independent: thylakoid space.
- D. ☐ Light-dependent: thylakoid membranes. Light-independent: thylakoid membranes.

2 UNIT 4 STYLE [3 marks]

Describe the overall reaction of photosynthesis in terms of the fate of the hydrogen from water.

3 UNIT 4 STYLE [3 marks]

Explain why ATP is described as an immediate source of energy and why the formation of ATP in photosynthesis needs light energy.

UNIT 4 STYLE

[4 marks]

Compare and contrast cyclic and non-cyclic photophosphorylation.

[illegible]

UNIT 4 STYLE

[4 marks]

A student grew algae in a flask in the light, then in the dark. The concentrations of two compounds in the Calvin cycle were measured. Explain the changes in the concentrations of GP and RuBP after the light was turned off.

Relative concentrations of two compounds in the Calvin cycle (arbitrary units)		
Condition	GP	RuBP
Light	100	50
Dark (2 minutes after light turned off)	180	10

[illegible]

UNIT 4 STYLE

[5 marks]

Describe how carbon dioxide is converted into sugars and into other biological molecules in the light-independent reactions.

[illegible]

7 UNIT 4 STYLE

[4 marks]

Explain how the structure of a chloroplast is adapted for photosynthesis.

8 UNIT 4 STYLE

[4 marks]

The table shows the percentage of light absorbed by a leaf extract and the relative rate of photosynthesis at four wavelengths of light. Compare the absorption of light with the rate of photosynthesis at these wavelengths, and explain what the comparison shows.

Light absorption and rate of photosynthesis		
Wavelength / nm	Light absorbed / %	Relative rate of photosynthesis
450	90	85
550	20	25
650	80	75
700	30	20

9 UNIT 6 STYLE

[3 marks]

A student separated the pigments in a leaf extract by paper chromatography. The solvent front moved 8.0 cm from the origin. One pigment moved 6.2 cm and a second pigment moved 2.4 cm. Calculate the R_f value of each pigment and suggest which is more soluble in the solvent.

Answer = ...

Describe how you would investigate the effect of temperature on the rate of photosynthesis of a named aquatic plant. Include how you would control other variables and how you would obtain a reliable rate.

In an investigation into light intensity, a lamp was placed at different distances from an aquatic plant. The volume of oxygen released in 10 minutes was measured. Calculate the rate of oxygen release, in cm³ min⁻¹, at each distance, and explain the relationship between the distance and the rate shown by these results.

Oxygen released at different lamp distances	
Distance from lamp / cm	Volume of oxygen released in 10 minutes / cm ³
10	4.0
20	1.0
40	0.25

Answer = ...

Mark scheme

One mark for each point unless a maximum is given. Words in brackets are not needed for the mark.

1. [1]

B B: the light-dependent reactions occur on the thylakoid membranes and the Calvin cycle occurs in the stroma.

2. [3]

- light energy used to split / photolysis of water (1)
- hydrogen (from the water) combined with carbon dioxide (1)
- to form glucose / a fuel (that stores the hydrogen) (1)
- oxygen is released (into the atmosphere) (1)
- Max 3

3. [3]

- hydrolysis of ATP to ADP and Pi releases energy in one step / quickly (1)
- in small usable amounts / only where it is needed (1)
- photophosphorylation is the addition of phosphate to ADP (1)
- which needs energy / is an endergonic reaction, supplied by light (1)
- Max 3

4. [4]

- similarity: both make ATP / both involve excited electrons passing along an electron transport chain / both use chemiosmosis (1)
- non-cyclic uses photosystems I and II but cyclic uses photosystem I only (1)
- non-cyclic: electrons come from water, cyclic: electrons return to the same chlorophyll (1)
- non-cyclic produces reduced NADP but cyclic does not (1)
- non-cyclic produces oxygen (by photolysis) but cyclic does not (1)
- Max 4. At least one similarity and one difference are needed.

5. [4]

- GP increases and RuBP decreases in the dark (accept figures: GP 100 to 180, RuBP 50 to 10) (1)
- no ATP / reduced NADP is made in the dark (since the light-dependent reactions stop) (1)
- so GP cannot be reduced to GALP, so GP accumulates (1)
- carbon dioxide is still fixed by rubisco for a short time, so RuBP is still used up / GP is still made (1)
- RuBP is not regenerated (from GALP, which also needs ATP) (1)
- Max 4

6. [5]

- carbon dioxide combines with RuBP (1)
- catalysed by rubisco (1)
- to form two molecules of GP (1)
- GP reduced to GALP using ATP and reduced NADP (1)
- GALP used to make glucose / hexose sugars / regenerate RuBP (1)
- (carbon skeletons from) GP / GALP used for amino acids, lipids (accept glycerol / fatty acids) (1)
- sugars used to make polysaccharides / nucleic acids (accept starch, cellulose) (1)
- Max 5

7. [4]

- thylakoids stacked into grana give a large surface area for pigments / photosystems / electron carriers / ATP synthase (1)
- pigments in photosystems absorb a range of wavelengths of light (1)
- stroma contains enzymes / rubisco for the Calvin cycle (1)
- stroma surrounds the grana so ATP / reduced NADP made on thylakoids are used close by (1)
- small thylakoid space allows a proton gradient to be built up quickly (1)
- envelope controls what enters and leaves (1)
- chloroplast has own DNA / ribosomes to make some proteins (1)
- Max 4

8. [4]

- absorption spectrum shows the amount of light absorbed at each wavelength; the action spectrum shows the rate of photosynthesis (1)
- most light absorbed at 450 and 650 nm / least at 550 nm (1)
- rate of photosynthesis is highest where absorption is highest / the two vary together (1)
- so the light absorbed (by pigments) is used in photosynthesis / pigments such as chlorophyll absorb in the blue and red regions (1)
- rate slightly lower than the absorption at 650 nm / not all absorbed light is used in photosynthesis (accept any one comparison with figures) (1)
- Max 4

9. [3]

- $R_f = \text{distance moved by pigment} \div \text{distance moved by solvent front}$ (1)
- $6.2 \div 8.0 = 0.78$ (accept 0.775) (1)
- $2.4 \div 8.0 = 0.30$ (1)
- the pigment with R_f 0.78 is more soluble (in the solvent) (1)
- Max 3 (calculation marks: correct working with the wrong answer is credited once)

10. [6]

- named plant (for example Cabomba / Elodea) cut under water, placed in a boiling tube with the cut end upwards (1)
- water bath at a range of temperatures (for example 10 to 40 °C) with a thermometer / set temperature each time (1)
- let the plant equilibrate / adjust to each new temperature (1)
- measure rate as number of bubbles / volume of oxygen per minute (accept volume of gas collected in a capillary / gas syringe) (1)
- light intensity controlled by keeping lamp at a fixed distance and a heat shield / LED lamp used (1)
- carbon dioxide supply controlled (for example same concentration of sodium hydrogencarbonate solution) (1)
- same plant / same length / mass of plant used each time (1)
- repeat at each temperature and calculate a mean (1)
- Max 6

11. [4]

- rate at 10 cm = $4.0 \div 10 = 0.40 \text{ cm}^3 \text{ min}^{-1}$ (1)
- rate at 20 cm = $0.10 \text{ cm}^3 \text{ min}^{-1}$ and at 40 cm = $0.025 \text{ cm}^3 \text{ min}^{-1}$ (accept 0.025 or 0.03) (1)
- light intensity is proportional to $1 \div \text{distance}^2$, so doubling the distance reduces intensity to one quarter (1)
- the rate is proportional to light intensity here, so light is the limiting factor (accept rate falls to a quarter each time the distance doubles) (1)