

This is the **Higher Combined Science** version. Higher Tier questions (★) are included. Some Separate-only content has been omitted.

## Photosynthesis (4.4.1.1)

*Specification reference: 4.4.1.1*

**Q1. Write the balanced symbol equation for photosynthesis.**

[2 marks]

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**Q2. State where in the cell photosynthesis occurs, and describe the role of chlorophyll.**

[3 marks]

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**Q3. List FOUR ways in which plants use the glucose produced by photosynthesis.**

[4 marks]

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## Limiting Factors of Photosynthesis (4.4.1.2)

*Specification reference: 4.4.1.2*

**Q4. Name the THREE main limiting factors of photosynthesis.**

[1 mark]

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**Q5. A student increases the light intensity on a pondweed but the rate of photosynthesis stops increasing after a certain point. Explain this observation and suggest what the student could do to increase the rate further.**

[4 marks]

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★ HIGHER TIER

**Q6. ★ A lamp is moved from 10 cm to 20 cm from a pondweed. Calculate the change in light intensity as a proportion of the original. Explain why this affects photosynthesis rate.**

[3 marks]

**Aerobic and Anaerobic Respiration (4.4.2)**

*Specification reference: 4.4.2*

**Q7. Write the word equation for aerobic respiration and state where in the cell this takes place.**

[2 marks]

**Q8. Write the word equation for anaerobic respiration (a) in human muscle cells and (b) in yeast.**

[2 marks]

**Q9. A sprinter finishes a 100 m race and continues to breathe heavily for several minutes afterwards. Explain this observation using the term oxygen debt.**

[4 marks]

★ HIGHER TIER

**Q10. ★ Compare aerobic and anaerobic respiration in terms of energy released, products and location in the cell.**

[3 marks]



### Photosynthesis (4.4.1.1)

#### Q1 (2 marks)

Write the balanced symbol equation for photosynthesis.

- $6\text{CO}_2 + 6\text{H}_2\text{O} \rightarrow \text{C}_6\text{H}_{12}\text{O}_6 + 6\text{O}_2$  [2] — award 1 mark if correct but unbalanced or missing light energy notation

#### Q2 (3 marks)

State where in the cell photosynthesis occurs, and describe the role of chlorophyll.

- Photosynthesis occurs in the chloroplasts [1]
- Chlorophyll is a green pigment in the chloroplasts [1]
- Chlorophyll absorbs light energy (red and blue light) which drives the photosynthesis reactions [1]

#### Q3 (4 marks)

List FOUR ways in which plants use the glucose produced by photosynthesis.

- Respiration — releases energy (ATP) for plant processes [1]
- Converted to starch — for storage (insoluble, no osmotic effect) [1]
- Converted to cellulose — for cell walls [1]
- Used to make amino acids (with nitrates) → proteins / converted to lipids for seed storage / sucrose for transport [1] — any four valid uses

### Limiting Factors of Photosynthesis (4.4.1.2)

#### Q4 (1 mark)

Name the THREE main limiting factors of photosynthesis.

- Light intensity,  $\text{CO}_2$  concentration, temperature [1] — all three required

#### Q5 (4 marks)

A student increases the light intensity on a pondweed but the rate of photosynthesis does not increase.

- Another factor is now limiting the rate of photosynthesis — not light [1]
- This is likely  $\text{CO}_2$  concentration or temperature [1]
- Student could increase  $\text{CO}_2$  concentration (e.g. add  $\text{NaHCO}_3$  to water) [1]
- Or increase temperature (up to the enzyme optimum) to increase rate of photosynthesis reactions [1]

#### Q6 (3 marks) [★ HT]

★ A lamp is moved from 10 cm to 20 cm from a pondweed. Calculate the change in light intensity.

- Light intensity  $\propto 1/d^2$  so at 20 cm the intensity is 1/4 of the intensity at 10 cm (25%) [1]
- Light intensity has decreased — less energy available per unit area per second [1]
- Fewer photons absorbed by chlorophyll → rate of photosynthesis decreases [1]

### Aerobic and Anaerobic Respiration (4.4.2)

#### Q7 (2 marks)

Write the word equation for aerobic respiration and state where in the cell this occurs.

- Glucose + oxygen → carbon dioxide + water (+ energy/ATP) [1]
- Occurs in the mitochondria [1]

#### Q8 (2 marks)

Write the word equation for anaerobic respiration (a) in human muscle cells and (b) in yeast.

- (a) Glucose → lactic acid (+ small amount of energy) [1]
- (b) Glucose → ethanol + carbon dioxide (+ small amount of energy) [1]

#### Q9 (4 marks)

A sprinter finishes a 100 m race and continues to breathe heavily for several minutes.

- During the sprint, muscles could not receive  $O_2$  fast enough → anaerobic respiration occurred [1]
- Lactic acid accumulated in muscles [1]
- After the race, extra oxygen is needed to break down the lactic acid (convert to glucose in the liver) — this is the oxygen debt [1]
- Heavy breathing repays the oxygen debt by supplying the extra  $O_2$  needed [1]

**Q10 (3 marks) [★ HT]**

★ Compare aerobic and anaerobic respiration in terms of energy released, product...

- Aerobic: large amount of energy (38 ATP per glucose); anaerobic: very little energy (2 ATP per glucose) [1]
- Aerobic:  $CO_2$  + water produced; anaerobic: lactic acid (animals) OR ethanol +  $CO_2$  (yeast) produced [1]
- Aerobic: occurs in mitochondria; anaerobic: occurs in cytoplasm [1]