

Biology AQA Topic 4 Bioenergetics Mark Scheme

Q1.

(a) Word equation for photosynthesis:

- Point 1 – 1 mark: carbon dioxide + water
- Point 2 – 1 mark: → glucose + oxygen

(b) One factor that affects the rate of photosynthesis:

- Point 1 – 1 mark: light intensity / temperature / carbon dioxide concentration / amount of chlorophyll

Total: 3 marks

Q2.

(a) Gas released during photosynthesis:

- Point 1 – 1 mark: Oxygen

(b) Measuring rate of photosynthesis:

- Point 1 – 1 mark: Count bubbles of gas
- Point 2 – 1 mark: Measure volume of gas released using a syringe or gas collection tube

Total: 3 marks

Q3.

(a) How greenhouses improve photosynthesis:

- Point 1 – 1 mark: Trap heat to maintain temperature
- Point 2 – 1 mark: Light can be controlled to increase rate of photosynthesis

(b) Condition controlled in a greenhouse:

- Point 1 – 1 mark: Carbon dioxide / temperature / light / humidity

Total: 3 marks

Q4.

(a) Uses of glucose in plants:

- Point 1 – 1 mark: Used for respiration
- Point 2 – 1 mark: Used to make cellulose / amino acids / fats / stored as starch

(b) Stored form of glucose:

- Point 1 – 1 mark: Starch

Total: 3 marks

Q5.

(a) Limiting factor of photosynthesis:

- Point 1 – 1 mark: Light / temperature / carbon dioxide / chlorophyll

(b) Effect of temperature:

- Point 1 – 1 mark: Increases rate to a point
- Point 2 – 1 mark: Too high temperature damages enzymes and decreases rate

Total: 3 marks

Q6.

(a) Why lamp is moved further away:

- Point 1 – 1 mark: To reduce light intensity
- Point 2 – 1 mark: To investigate effect of distance/light intensity on photosynthesis

(b) Effect of moving lamp further:

- Point 1 – 1 mark: Photosynthesis rate decreases

Total: 3 marks

Q7.

(a) Use of energy in the body:

- Point 1 – 1 mark: Muscle contraction / keeping warm / active transport / making molecules

(b) Process that releases energy:

- Point 1 – 1 mark: Respiration

Total: 2 marks

Q8.

(a) Word equation for aerobic respiration:

- Point 1 – 1 mark: glucose + oxygen
- Point 2 – 1 mark: → carbon dioxide + water (+ energy)

(b) Where respiration happens:

- Point 1 – 1 mark: Mitochondria

Total: 3 marks

Q9.

(a) Anaerobic respiration in muscles:

- Point 1 – 1 mark: glucose → lactic acid

(b) Why it's less efficient:

- Point 1 – 1 mark: Less energy released
- Point 2 – 1 mark: Glucose not fully broken down

Total: 3 marks

Q10.

(a) Change during exercise:

- Point 1 – 1 mark: Heart rate increases / breathing rate increases / sweating

(b) Why this helps:

- Point 1 – 1 mark: More oxygen to muscles
- Point 2 – 1 mark: Removes carbon dioxide / allows more respiration

Total: 3 marks

Q11.

(a) Gas used:

- Point 1 – 1 mark: Oxygen

(b) Gas produced:

- Point 1 – 1 mark: Carbon dioxide

Total: 2 marks

Q12.

(a) Respiration type:

- Point 1 – 1 mark: Exothermic

(b) Why:

- Point 1 – 1 mark: Transfers energy to the surroundings
- Point 2 – 1 mark: Releases heat

Total: 3 marks

Q13.

(a) Effect of lactic acid:

- Point 1 – 1 mark: Causes muscle fatigue or cramps

(b) Oxygen debt:

- Point 1 – 1 mark: Extra oxygen needed
- Point 2 – 1 mark: To break down lactic acid

Total: 3 marks

Q14.

(a) Removing lactic acid:

- Point 1 – 1 mark: Reacts with oxygen
- Point 2 – 1 mark: Broken down in the liver

(b) Organ involved:

- Point 1 – 1 mark: Liver

Total: 3 marks

Q15.

(a) What is metabolism:

- Point 1 – 1 mark: All chemical reactions in the body
- Point 2 – 1 mark: Controlled by enzymes

(b) Example of metabolic reaction:

- Point 1 – 1 mark: Respiration / breakdown of proteins / synthesis of proteins or lipids or carbohydrates

Total: 3 marks

Q16.

(a) One difference:

- Point 1 – 1 mark: Aerobic uses oxygen, anaerobic does not / anaerobic produces lactic acid

(b) Which causes oxygen debt:

- Point 1 – 1 mark: Anaerobic respiration

Total: 2 marks

Q17.

(a) Why breathe heavily:

- Point 1 – 1 mark: More oxygen taken in
- Point 2 – 1 mark: To remove lactic acid / repay oxygen debt

(b) Substance to break down:

- Point 1 – 1 mark: Lactic acid

Total: 3 marks

Q18. (a) Explanation of endothermic reaction:

- Takes in energy from the surroundings (1)
- Usually in the form of light or heat (1)

(b) Leaf adaptations:

- Broad surface area to absorb more light (1)
- Thin so gases diffuse easily (1)
- Contains chloroplasts with chlorophyll to absorb light (1)

[5 marks]

Q19. (a) One variable to keep constant:

- Light intensity / temperature / type or amount of pondweed (1)

(b) Explanation:

- More carbon dioxide means more raw material for photosynthesis (1)
- Increases the rate of production of glucose (1)

(c) Measuring photosynthesis:

- Count number of bubbles released in a set time (1)
- Use a gas syringe to measure volume of gas (1)
- Keep conditions constant between repeats (1)

[6 marks]

Q20. (a) Glucose conversion products:

- Starch (1)
- Cellulose / lipids / amino acids / proteins (1)

(b) Explanation:

- Starch is insoluble (1)
- So it doesn't affect osmosis or water balance in the cell (1)

[4 marks]

Q21. (a) Balanced symbol equation:

- $C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O$ (1)
- (Correct balancing) (1)

(b) Uses of energy:

- Muscle contraction (1)
- Maintaining body temperature / active transport / cell division (1)

[4 marks]

Q22. (a) Word equation:

- Glucose \rightarrow ethanol + carbon dioxide (1)

(b) Advantage:

- Doesn't require oxygen (1)
- Allows rapid production of ethanol / occurs in sealed conditions (1)

(c) Preference for aerobic respiration:

- Releases more energy per glucose molecule (1)
- Prevents lactic acid build-up and fatigue (1)

[5 marks]

Q23. (a) Explanation:

- Muscles need more energy (1)

- Increased respiration requires more oxygen and glucose (1)
- More waste products (CO₂) need to be removed (1)

(b) Anaerobic respiration:

- Glucose is broken down to lactic acid (1)
- Without oxygen / produces less energy (1)

[5 marks]

Q24. (a) High temperature effect:

- Enzymes denature (1)
- So rate of photosynthesis falls / stops (1)

(b) Importance of enzymes:

- Control chemical reactions / act as biological catalysts (1)
- Speed up reactions involved in photosynthesis (1)

[4 marks]

Q25. (a) Environmental conditions:

- Light intensity (1)
- Temperature (1)
- Carbon dioxide concentration (1)

(b) Explanation:

- Optimal conditions increase rate of photosynthesis (1)
- More glucose is produced (1)
- Which increases growth and crop yield (1)

[6 marks]

Q26. (a) Substance:

- Lactic acid (1)

(b) Removal:

- Transported to liver via blood (1)
- Converted back into glucose (1)

[3 marks]

Q27. (a) Metabolic reactions:

- Protein synthesis / breakdown of excess proteins in liver (1)
- Formation of lipids from fatty acids and glycerol / respiration (1)

(b) Link to respiration:

- Respiration provides energy (1)
- Needed for metabolic processes (1)

[4 marks]

Q28. (a) Pattern:

- As light intensity increases, rate of photosynthesis increases (1)
- Then levels off / plateaus (1)

(b) Reason for plateau:

- Another factor becomes limiting (e.g. CO₂ or temperature) (1)
- Photosynthesis rate can't increase further (1)

[4 marks]

Q29. (a) Independent variable:

- Type of fertiliser used (1)

(b) Control variable:

- Amount of water / light / plant species / soil type (1)

(c) Measuring rate:

- Measure oxygen production / count bubbles (1)
- Over a fixed time period (1)

[4 marks]

Q30. Comparison:

- Photosynthesis in chloroplasts; respiration in mitochondria (1)

- Photosynthesis uses CO₂ and water; respiration uses glucose and oxygen (1)
- Photosynthesis produces glucose and oxygen; respiration produces CO₂ and water (1)
- Photosynthesis is endothermic (1)
- Respiration is exothermic (1)
- Both involve enzyme-controlled reactions (1)

[6 marks]

Q31. Photosynthesis occurs in chloroplasts of plant cells.

(a) Describe the role of chlorophyll in photosynthesis.

- Absorbs light energy (1)
- Light energy is used to carry out photosynthesis (1)

(b) Explain how the structure of chloroplasts helps them carry out photosynthesis efficiently.

- Chloroplasts contain chlorophyll pigments to absorb light (1)
- Thylakoid membranes provide large surface area for light absorption and light-dependent reactions (1)
- Stroma contains enzymes for the light-independent reactions (1)

[Total: 5 marks]

Q32. Light intensity, temperature, and carbon dioxide concentration affect photosynthesis.

(a) Explain how light intensity affects the rate of photosynthesis.

- Light provides energy for photosynthesis (1)
- Higher light intensity increases the rate up to a certain point (1)

(b) Describe how plants adapt to low light conditions to increase photosynthesis.

- Larger or broader leaves to capture more light (1)
- More chlorophyll to absorb light efficiently (1)

(c) Suggest one reason why photosynthesis cannot happen without light.

- Light is needed to provide energy for the reaction (1)

[Total: 5 marks]

Q33. Investigating photosynthesis: A student uses pondweed to measure oxygen production at different temperatures.

(a) Explain why oxygen production can be used as a measure of the rate of photosynthesis.

- Oxygen is a product of photosynthesis (1)
- More oxygen produced means a faster rate of photosynthesis (1)

(b) Predict how the rate of photosynthesis changes as temperature rises from 10°C to 30°C. Explain your answer.

- Rate increases as temperature increases (1)
- Because enzymes work faster up to an optimum temperature (1)
- After optimum, enzymes denature and rate decreases (1)

[Total: 5 marks]

Q34. The glucose made by photosynthesis is used by plants in different ways.

(a) Write the chemical formula for glucose.

- $C_6H_{12}O_6$ (1)

(b) Explain how glucose is used to produce cellulose and starch in plants.

- Glucose molecules join together to form cellulose, which strengthens cell walls (1)
- Glucose molecules join together to form starch, which is stored energy (1)

- Both involve polymerisation reactions (1)

[Total: 4 marks]

Q35. Aerobic respiration releases energy from glucose.

(a) Write the balanced symbol equation for aerobic respiration.

- $C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O$ (2)

(b) Explain why aerobic respiration releases more energy than anaerobic respiration.

- Aerobic respiration fully breaks down glucose (1)
- Produces more ATP molecules per glucose molecule (1)
- Anaerobic respiration incompletely breaks down glucose, producing less energy (1)

[Total: 5 marks]

Q36. Anaerobic respiration in muscles produces lactic acid.

(a) Explain why lactic acid builds up during vigorous exercise.

- Oxygen supply is insufficient for aerobic respiration (1)
- Muscles respire anaerobically producing lactic acid (1)

(b) Describe how the body removes lactic acid after exercise.

- Lactic acid transported to the liver (1)
- Converted back into glucose or broken down (1)

(c) Suggest why anaerobic respiration is less efficient than aerobic respiration.

- Produces less energy per glucose molecule (1)

[Total: 5 marks]

Q37. ATP is the energy currency of cells.

(a) Describe the role of ATP in cellular processes.

- Provides energy for cellular activities (1)
- Releases energy when phosphate bonds are broken (1)

(b) Explain how ATP is produced during respiration.

- During respiration, glucose is broken down (1)
- Energy released is used to convert ADP + Pi into ATP (1)
- Mainly produced in mitochondria (1)

[Total: 5 marks]

Q38. During photosynthesis, energy is transferred through the ecosystem.

(a) Explain the importance of photosynthesis to life on Earth.

- Produces glucose which is food/energy source for plants (1)
- Produces oxygen necessary for aerobic respiration (1)

(b) Describe what happens to the energy stored in glucose when it is eaten by animals.

- Animals respire to release energy from glucose (1)
- Energy is used for growth, movement, and other cellular activities (1)
- Some energy is lost as heat (1)

[Total: 5 marks]

Q39. A student measures the rate of photosynthesis at different carbon dioxide concentrations.

(a) What is the limiting factor when increasing carbon dioxide concentration no longer increases photosynthesis?

- Light intensity or temperature (1)

(b) Explain why photosynthesis stops increasing beyond a certain carbon dioxide concentration.

- Another factor (like light or temperature) becomes limiting (1)
- Enzymes may be saturated or working at maximum rate (1)
- Carbon dioxide is no longer the rate-limiting factor (1)

[Total: 4 marks]

Q40. Plants store glucose as starch.

(a) Explain why starch is a better storage molecule than glucose.

- Starch is insoluble and doesn't affect water potential (1)
- Starch is compact and stores lots of energy in small volume (1)

(b) Suggest how the storage of starch helps plants survive in winter.

- Provides energy when photosynthesis is not possible (1)
- Can be broken down into glucose for respiration during cold months (1)

[Total: 4 marks]

Q41. Photosynthesis can be represented by the equation:



(a) Name the reactants and products in this equation.

- Reactants: carbon dioxide and water (1)
- Products: glucose and oxygen (1)

(b) Explain the role of water in photosynthesis.

- Water is split in light-dependent reactions (1)
- Provides electrons and protons for the light reactions (1)

(c) Describe what happens to the oxygen produced during photosynthesis.

- Released into the air (1)

[Total: 5 marks]

Q42. Temperature can affect enzyme activity in photosynthesis.

(a) Describe what happens to the rate of photosynthesis if temperature exceeds the optimum.

- Enzymes denature (1)
- Rate of photosynthesis decreases (1)

(b) Explain why enzymes are important in photosynthesis.

- Enzymes catalyse the chemical reactions (1)
- They lower activation energy to speed up reactions (1)

[Total: 4 marks]

Q43. Plants need minerals for healthy growth.

(a) Name two minerals plants need and explain how each is used.

- Nitrate: used for protein synthesis / growth (1 + 1)
- Magnesium: used to make chlorophyll (1 + 1)

[Total: 4 marks]

Q44. (6 MARK QUESTION)

Describe the process of photosynthesis and explain the factors that affect its rate. In your answer, include:

- The main stages of photosynthesis
- The role of chlorophyll
- How light intensity, carbon dioxide concentration, and temperature affect photosynthesis

Mark points to include:

- Photosynthesis uses light energy to convert CO₂ and water into glucose and oxygen (1)
- Light-dependent reaction occurs in thylakoids; light-independent in stroma (1)
- Chlorophyll absorbs light energy (1)
- Light intensity increases rate up to a point (1)
- CO₂ concentration affects the rate, more CO₂ increases rate (1)
- Temperature affects enzyme activity; too low or too high reduces rate (1)

[Total: 6 marks]

Q45. Energy transfer in cells is essential for life.

(a) Explain how glucose produced in photosynthesis is converted into energy for cellular activities.

- Glucose is broken down by respiration (1)
- Respiration releases energy stored in glucose (1)
- Energy is transferred to ATP which powers cellular processes (1)

(b) Describe the difference between aerobic and anaerobic respiration in terms of oxygen use and energy yield.

- Aerobic respiration uses oxygen; anaerobic does not (1)
- Aerobic produces more energy per glucose molecule than anaerobic (1)
- Anaerobic produces lactic acid or ethanol as by-products (1)

[Total: 6 marks]

If you want me to format it in a spreadsheet or specific document style, just say!

You said:

if there are any alternative possible answers add them aswell

ChatGPT said:

Sure! I've expanded the mark scheme with common alternative or equivalent answers for each mark point where applicable. This keeps it flexible for marking a range of student responses while maintaining clarity.

Q31. Photosynthesis occurs in chloroplasts of plant cells.

(a) Describe the role of chlorophyll in photosynthesis.

- Absorbs light energy (or sunlight) (1)
- Light energy is used to drive photosynthesis (or convert carbon dioxide and water into glucose) (1)

(b) Explain how the structure of chloroplasts helps them carry out photosynthesis efficiently.

- Contains chlorophyll pigments to absorb light (or capture sunlight) (1)
- Thylakoid membranes provide a large surface area for light absorption and light-dependent reactions (1)
- Stroma contains enzymes for light-independent reactions (Calvin cycle) (1)

[Total: 5 marks]

Q32. Light intensity, temperature, and carbon dioxide concentration affect photosynthesis.

(a) Explain how light intensity affects the rate of photosynthesis.

- Light provides energy needed for photosynthesis (1)
- As light intensity increases, the rate of photosynthesis increases up to a maximum (or plateau) (1)

(b) Describe how plants adapt to low light conditions to increase photosynthesis.

- Larger or broader leaves to capture more light (or increased leaf surface area) (1)
- More chlorophyll to absorb available light efficiently (1)

(c) Suggest one reason why photosynthesis cannot happen without light.

- Light provides energy to power the reaction (or without light, no energy to make glucose) (1)

[Total: 5 marks]

Q33. Investigating photosynthesis: A student uses pondweed to measure oxygen production at different temperatures.

(a) Explain why oxygen production can be used as a measure of the rate of photosynthesis.

- Oxygen is produced as a product of photosynthesis (1)
- More oxygen means photosynthesis is happening faster (or rate is higher) (1)

(b) Predict how the rate of photosynthesis changes as temperature rises from 10°C to 30°C. Explain your answer.

- Rate increases as temperature increases (1)
- Because enzymes involved in photosynthesis work faster up to the optimum temperature (1)

- Above optimum temperature, enzymes denature and rate decreases (1)

[Total: 5 marks]

Q34. The glucose made by photosynthesis is used by plants in different ways.

(a) Write the chemical formula for glucose.

- $C_6H_{12}O_6$ (accept molecular formula of glucose) (1)

(b) Explain how glucose is used to produce cellulose and starch in plants.

- Glucose molecules join (or polymerise) to form cellulose (1)
- Cellulose strengthens plant cell walls (1)
- Glucose molecules join to form starch for energy storage (1)

[Total: 4 marks]

Q35. Aerobic respiration releases energy from glucose.

(a) Write the balanced symbol equation for aerobic respiration.

- $C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O$ (accept correct multiples, balanced equation) (2)

(b) Explain why aerobic respiration releases more energy than anaerobic respiration.

- Aerobic respiration completely breaks down glucose (or anaerobic only partially breaks it down) (1)
- Aerobic produces more ATP (or energy) per glucose molecule than anaerobic (1)
- Anaerobic produces by-products like lactic acid or ethanol which store some energy (1)

[Total: 5 marks]

Q36. Anaerobic respiration in muscles produces lactic acid.

(a) Explain why lactic acid builds up during vigorous exercise.

- Oxygen supply to muscles is insufficient for aerobic respiration (1)
- Muscles switch to anaerobic respiration, producing lactic acid (1)

(b) Describe how the body removes lactic acid after exercise.

- Lactic acid is transported in the blood to the liver (1)
- Lactic acid is converted back to glucose or broken down in the liver (1)

(c) Suggest why anaerobic respiration is less efficient than aerobic respiration.

- Produces less energy (ATP) per glucose molecule (1)

[Total: 5 marks]

Q37. ATP is the energy currency of cells.

(a) Describe the role of ATP in cellular processes.

- Provides energy for cellular processes (or powers cell activities) (1)
- Releases energy when high-energy phosphate bonds are broken (1)

(b) Explain how ATP is produced during respiration.

- Glucose is broken down during respiration (1)
- Energy released is used to add phosphate to ADP forming ATP (1)
- Mainly produced in mitochondria (accept "site of aerobic respiration") (1)

[Total: 5 marks]

Q38. During photosynthesis, energy is transferred through the ecosystem.

(a) Explain the importance of photosynthesis to life on Earth.

- Produces glucose which is an energy source for plants and other organisms (1)
- Produces oxygen required for aerobic respiration by animals (or all aerobic organisms) (1)

(b) Describe what happens to the energy stored in glucose when it is eaten by animals.

- Animals respire, breaking down glucose to release energy (1)
- Energy is used for movement, growth, repair, and other cellular activities (1)
- Some energy is lost as heat (1)

[Total: 5 marks]

Q39. A student measures the rate of photosynthesis at different carbon dioxide concentrations.

(a) What is the limiting factor when increasing carbon dioxide concentration no longer increases photosynthesis?

- Light intensity (or temperature) (1)

(b) Explain why photosynthesis stops increasing beyond a certain carbon dioxide concentration.

- Another factor (light or temperature) becomes limiting (1)
- Enzymes involved in photosynthesis may be saturated (1)
- Carbon dioxide concentration is no longer limiting (1)

[Total: 4 marks]

Q40. Plants store glucose as starch.

(a) Explain why starch is a better storage molecule than glucose.

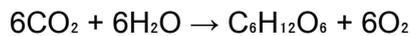
- Starch is insoluble, so does not affect water potential (1)
- Starch is compact and can store a lot of energy in a small space (1)

(b) Suggest how the storage of starch helps plants survive in winter.

- Starch can be broken down to glucose when photosynthesis is not possible (1)
- Provides energy for respiration during cold or dormant periods (1)

[Total: 4 marks]

Q41. Photosynthesis can be represented by the equation:



(a) Name the reactants and products in this equation.

- Reactants: carbon dioxide and water (or CO_2 and H_2O) (1)
- Products: glucose and oxygen (or $\text{C}_6\text{H}_{12}\text{O}_6$ and O_2) (1)

(b) Explain the role of water in photosynthesis.

- Water is split during the light-dependent reaction (1)
- Provides electrons and protons for producing glucose (or involved in photolysis) (1)

(c) Describe what happens to the oxygen produced during photosynthesis.

- Oxygen is released into the air (or used by plants or animals for respiration) (1)

[Total: 5 marks]

Q42. Temperature can affect enzyme activity in photosynthesis.

(a) Describe what happens to the rate of photosynthesis if temperature exceeds the optimum.

- Enzymes denature (or lose shape/function) (1)

- Rate of photosynthesis decreases sharply (or stops) (1)

(b) Explain why enzymes are important in photosynthesis.

- Enzymes catalyse chemical reactions in photosynthesis (1)
- Lower activation energy so reactions occur faster (1)

[Total: 4 marks]

Q43. Plants need minerals for healthy growth.

(a) Name two minerals plants need and explain how each is used.

- Nitrate: used for making amino acids and proteins / growth (1+1)
- Magnesium: used for chlorophyll production (1+1)

[Total: 4 marks]

Q44. (6 MARK QUESTION)

Describe the process of photosynthesis and explain the factors that affect its rate. In your answer, include:

- Photosynthesis converts carbon dioxide and water into glucose and oxygen using light energy (1)
- Light-dependent stage in thylakoid membranes produces ATP and oxygen (1)
- Light-independent stage (Calvin cycle) in stroma synthesizes glucose (1)
- Chlorophyll absorbs light energy (1)
- Light intensity limits the rate; higher light increases rate up to a maximum (1)
- Carbon dioxide concentration limits the rate; increased CO₂ increases rate until another factor limits it (1)
- Temperature affects enzyme activity; low temperature slows rate, high temperature can denature enzymes (if included, max 6 marks total) (1)

[Total: 6 marks]

Q45. Energy transfer in cells is essential for life.

(a) Explain how glucose produced in photosynthesis is converted into energy for cellular activities.

- Glucose is broken down by respiration (1)
- Respiration releases energy stored in glucose (1)
- Energy is transferred to ATP molecules which power cellular processes (1)

(b) Describe the difference between aerobic and anaerobic respiration in terms of oxygen use and energy yield.

- Aerobic respiration requires oxygen; anaerobic does not (1)
- Aerobic respiration produces more ATP (energy) per glucose than anaerobic (1)
- Anaerobic respiration produces lactic acid (in animals) or ethanol and CO₂ (in yeast) as by-products (1)

[Total: 6 marks]