S3 Biology Practice Paper 1 with Answers

Biology · S3 · Data-response

S3 biology practice paper on magnification, enzyme activity, photosynthesis, breathing volumes, transpiration and food energy, with full answers and mark scheme.

1. Microscope magnification and cell size (16 marks)

A student uses a microscope with a 10× eyepiece to observe onion epidermis cells, first with a 10× objective and then with a 40× objective. The field diameter at low power is 1.4 mm. At high power a cell measures 20 mm long in the drawing.

#	Question	Answer and marking notes
1	Find the total magnification at high power and how many times greater it is than at low power.	Answer: total magnification = eyepiece × objective = 10 × 40 = 400×; low power is 10 × 10 = 100×, so high power is 4 times greater.
2	Find the actual length of the cell, in mm and in µm.	Answer: actual length = drawing length ÷ magnification = 20 ÷ 400 = 0.05 mm = 50 µm.
3	Find the field diameter at high power, in mm and in µm.	Answer: field diameter is inversely proportional to magnification, so 1.4 × (10 ÷ 40) = 0.35 mm = 350 µm.
4	If a cell is 50 µm long, how many cells fit across the field diameter? Explain why the low-power objective should be used first to focus.	Answer: 350 ÷ 50 = 7 cells; the low-power field is wider and easier to search, and it avoids the high-power objective hitting or crushing the slide.

2. Enzyme activity and temperature (16 marks)

Equal pieces of potato are placed in hydrogen peroxide solution at different temperatures and the oxygen produced in 30 s is measured. At 30 °C, 3.0 cm³ is collected; at 20 °C the rate is 3.0 cm³/min; at 60 °C only 2.0 cm³ is collected in 30 s. The rate at the optimum 37 °C is 8.0 cm³/min.

#	Question	Answer and marking notes
5	Calculate the rate at 30 °C in cm³/min and in cm³/s.	Answer: 3.0 cm³ ÷ (30 ÷ 60) min = 6.0 cm³/min; 3.0 ÷ 30 = 0.1 cm³/s.
6	What percentage of the optimum rate is reached at 60 °C?	Answer: rate at 60 °C = 2.0 ÷ 0.5 = 4.0 cm³/min; 4.0 ÷ 8.0 × 100% = 50%.
7	By what percentage does the rate increase from 20 °C to 30 °C?	Answer: (6.0 – 3.0) ÷ 3.0 × 100% = 100%.
8	Explain why the reaction almost stops above 70 °C.	Answer: high temperature changes the shape of the active site, so the enzyme is denatured and can no longer bind the substrate; the fall is large and irreversible.

3. Photosynthesis and bubble counting (18 marks)

Pondweed is placed in a measuring cylinder of sodium hydrogencarbonate solution and lit by a lamp. At a lamp distance of 20 cm, 12 bubbles are counted in 30 s. When the lamp is moved to 40 cm, only 4 bubbles are counted in 30 s.

#	Question	Answer and marking notes
9	Calculate the number of bubbles per minute at 20 cm.	Answer: 12 ÷ (30 ÷ 60) = 24 bubbles/min.
10	When the lamp distance rises from 20 cm to 40 cm, what fraction of the original light intensity remains? Predict the bubbles per minute.	Answer: intensity is inversely proportional to distance squared, $(20 \div 40)^2 = 0.25$, i.e. one quarter; predicted rate = 24 × 0.25 = 6 bubbles/min.
11	The measured count at 40 cm is 4 bubbles in 30 s. Calculate how many percent higher the measured rate is than the prediction, and give one possible explanation.	Answer: measured 8 bubbles/min against a predicted 6, i.e. (8 – 6) ÷ 6 × 100% = 33.3% higher; the lamp may have warmed the water, speeding up the reactions.
12	Explain why leaves are decolourised in hot alcohol before the starch test, and state the role of a control.	Answer: chlorophyll masks the iodine colour change, so hot alcohol dissolves it out and the blue-black colour is easier to see; a control leaf kept in the dark shows the starch comes from photosynthesis. A water bath is used because alcohol is flammable.

4. Breathing and lung ventilation (16 marks)

At rest a person breathes 16 times per minute with a tidal volume of 0.50 dm^3; after exercise the rate is 30 times per minute with a tidal volume of 0.80 dm^3. Inhaled air contains 21% oxygen and exhaled air contains 16% oxygen.

#	Question	Answer and marking notes
13	Calculate the ventilation rate at rest in dm^3/min.	Answer: 16 × 0.50 = 8.0 dm^3/min.
14	Calculate the ventilation rate after exercise and its ratio to the resting value.	Answer: 30 × 0.80 = 24.0 dm^3/min; ratio 24.0 ÷ 8.0 = 3 times.
15	Each breath extracts 5% by volume of the oxygen in the inhaled air. Find the oxygen taken in per minute at rest in cm^3.	Answer: 8.0 × 0.05 = 0.40 dm^3 = 400 cm^3/min.
16	Explain the physiological need for the higher ventilation during exercise, and why lactic acid builds up in muscles after strenuous exercise.	Answer: muscles need more oxygen for aerobic respiration to make ATP and must remove more carbon dioxide; when oxygen supply is short, muscles respire anaerobically, forming lactic acid that builds up and causes fatigue.

5. Transpiration and leaf area (17 marks)

A shoot is set up in a potometer; it loses 4.5 g of water in 3 hours and its total leaf area is 0.030 m². In another measurement it loses 3.6 g in 2 hours by day and 0.6 g in 4 hours at night.

#	Question	Answer and marking notes
17	Calculate the average transpiration rate in g/h.	Answer: 4.5 ÷ 3 = 1.5 g/h.
18	Calculate the transpiration rate per square metre of leaf area in g/m²/h.	Answer: 1.5 ÷ 0.030 = 50 g/m²/h.
19	Find the ratio of daytime to night-time transpiration rate and explain the difference.	Answer: day 1.80 g/h and night 0.15 g/h, a ratio of 12; most stomata close at night, so transpiration falls sharply.
20	Explain how wind and humidity affect the rate of transpiration, and describe the pathway of water from root to leaf.	Answer: wind removes the humid layer and steepens the water potential gradient, speeding transpiration; high humidity reduces the gradient and slows it. Water enters root hairs, passes through the cortex into xylem vessels and is pulled up by the transpiration stream to the leaves, where it evaporates through stomata.

6. Energy in food and digestion (17 marks)

A 50 g food sample contains 30 g carbohydrate, 12 g protein and 8 g fat. Energy values: carbohydrate 17 kJ/g, protein 17 kJ/g, fat 38 kJ/g.

#	Question	Answer and marking notes
21	Calculate the total energy in the 50 g sample in kJ.	Answer: carbohydrate 510 + protein 204 + fat 304 = 1018 kJ.
22	Calculate the energy content per 100 g in kJ/100 g.	Answer: 1018 ÷ 50 × 100 = 2036 kJ/100 g.
23	Find the percentage of the total energy supplied by fat and by carbohydrate (one decimal place).	Answer: fat 304 ÷ 1018 × 100% = 29.9%; carbohydrate 510 ÷ 1018 × 100% = 50.1%.
24	Explain why fat supplies more energy per gram than carbohydrate, and describe the roles of bile and pancreatic lipase in fat digestion.	Answer: fat has more hydrogen per gram, so more energy is released on oxidation. Bile emulsifies fat into small droplets, increasing surface area; pancreatic lipase hydrolyses fat into fatty acids and glycerol, which are absorbed by the villi.