S4 Biology Practice Paper (Set 2): Cell Cycle and Mitosis, Enzyme Kinetics, Cell Membrane and Osmosis, Nutrition and Digestion, Gas Exchange and Respiration, Plant Transport and Transpiration

S4 | Biology | Time: 75 minutes | Total: 100 marks | 24 questions

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Part 1 Cell Cycle and Mitosis

Study the data and show all working.

1. Source 1: the cell cycle of an animal cell lasts 20 hours, with 19 hours of interphase and 1 hour of mitosis. Find the percentage of the cycle spent in interphase and in mitosis (1 d.p. each), and state the main activities of interphase. [5]

2. Source 2: a culture starts with 12 cells that all undergo mitosis synchronously for 5 rounds. Find the multiplication factor per round, the total number of cells after 5 rounds and the net increase. [4]

3. Source 3: a human body cell has 46 chromosomes. State the chromosome number of each daughter cell after mitosis, and compare the DNA content of a G1 cell with that of a G2 cell (as a multiple). [4]

4. Source 4: among 500 root tip cells under a microscope, 30 are in mitosis. Find the mitotic index (percentage, 1 d.p.); if another slide has 800 cells in the same proportion, estimate how many are in mitosis. [4]

Part 2 Enzyme Kinetics

Study the experimental data and show all working.

5. Source 1: enzyme X breaks down 25 g of substrate in 10 minutes, with 10 g broken down in the first 2 minutes. Find the average rate in the first 2 minutes and over the whole experiment (g/min), the ratio between them, and explain why the rate falls. [5]

6. Source 2: enzyme Y shows activities of 12, 24, 24 and 6 units/min at 20, 30, 40 and 50 C. Find the Q10 between 20 C and 30 C, and explain the sharp fall at 50 C. [4]

7. Source 3: the same enzyme shows activities of 18, 72 and 45 units/min at pH 2, 7 and 9. State the optimum pH and the activity at pH 9 as a percentage of the maximum (1 d.p.). [4]

8. Source 4: an enzyme solution is heated to 80 C for 5 minutes and then cooled to 37 C; its activity is 0. Explain this result and contrast it with storage at 4 C. [4]

Part 3 Cell Membrane and Osmosis

Study the experimental data and show all working.

9. Source 1: three potato strips each start at 2.50 g. After immersion the strip in 0.0 M sucrose weighs 2.80 g and the strip in 0.4 M sucrose weighs 2.20 g. Find the percentage change in mass (1 d.p.) and estimate the concentration of the isotonic solution. [5]

10. Source 2: a cell has a solute potential of -0.6 MPa and a pressure potential of 0.2 MPa. Find its water potential and decide whether water enters the cell from a solution of water potential -0.2 MPa. [4]

11. Source 3: two cube models have sides of 2 cm and 4 cm. Find the surface area, volume and surface area to volume ratio (per cm) of each, and state which model diffuses more efficiently. [4]

12. Source 4: red blood cells burst in distilled water but keep their normal shape in 0.9% sodium chloride solution. Explain both results in terms of water potential and osmosis. [4]

Part 4 Nutrition and Digestion

Study the data and show all working.

13. Source 1: 100 g of a food contains 12 g protein, 60 g carbohydrate and 8 g fat. Using 17 kJ per gram for protein and carbohydrate and 37 kJ per gram for fat, find the total energy (kJ) and the percentage of energy supplied by fat (1 d.p.). [5]

14. Source 2: villi increase the absorbing surface of the small intestine about 8 times and the microvilli on them add a further 20 times. Find the total amplification and the actual absorbing surface if the inner wall itself has an area of 0.35 m2. [4]

15. Source 3: salivary amylase works best near pH 6.8, pepsin near pH 2 and trypsin near pH 8. The three enzymes are placed in tubes at pH 2, pH 7 and pH 8. Identify the most active enzyme in each tube and explain why pepsin is almost inactive at pH 7. [4]

16. Source 4: bile salts emulsify fat into small droplets, greatly increasing the surface area available to lipase. If poor bile secretion cuts the available fat surface area by 60%, estimate the fall in the rate of fat hydrolysis and explain why. [4]

Part 5 Gas Exchange and Respiration

Study the data and show all working.

17. Source 1: at rest the breathing rate is 18 breaths per minute with a tidal volume of 0.5 L; during exercise it is 30 breaths per minute with 0.9 L. Find the minute ventilation (L/min) in both cases and the percentage increase during exercise. [4]

18. Source 2: aerobic respiration yields 30 ATP per glucose molecule. A muscle cell uses 0.02 mol of glucose in 10 minutes. Find the amount of ATP produced in moles. [4]

19. Source 3: lactate fermentation yields only 2 ATP per glucose molecule while aerobic respiration yields 30. Find the ratio of ATP yield and explain why muscles still ferment lactate during vigorous exercise. [4]

20. Source 4: an adult has about 70 m2 of alveolar surface and about 1.8 m2 of body surface. Find how many times larger the alveolar surface is (1 d.p.) and explain its importance for gas exchange. [4]

Part 6 Plant Transport and Transpiration

Study the experimental data and show all working.

21. Source 1: the bubble of a potometer moves 12 mm in 4 minutes and the leaf area is 6 cm2. Find the transpiration rate in mm per minute and the rate per cm2 of leaf per minute. [4]

22. Source 2: a field of view of 0.5 mm2 on the lower epidermis contains 40 stomata. Find the stomatal density (per mm2) and estimate the total number on a lower epidermis of 1200 mm2. [4]

23. Source 3: about 95% of the water absorbed by a plant is lost by transpiration, the rest being used in photosynthesis and to maintain turgor. Find the percentage used otherwise and explain how the transpiration pull lifts water from root to leaf. [4]

24. Source 4: a ring of bark including the phloem is removed from a tree trunk; weeks later the bark above the cut swells while the region below withers. Explain the observation and state what the girdling experiment proves. [4]
