S5 Biology Practice Paper (Set 2): Membrane Transport and Water Potential, Enzyme Kinetics, Photosynthesis and Respiration, Cell Cycle and Mitosis, Ecosystem Energy Flow and Population Estimation, Kidney and Osmoregulation (100 marks)

Biology · S5

S5 biology practice paper: 24 parts, 100 marks, 75 minutes on membrane transport, water potential, enzymes, photosynthesis, mitosis, energy flow and the kidney.

Question 1 - Membrane Transport and Water Potential (16 marks)

Plant cell A has a solute potential of -600 kPa and a pressure potential of +200 kPa. The surrounding solution B has a solute potential of -500 kPa and a pressure potential of 0 kPa. The temperature is 25 C.

#	Question
1	Calculate the water potential of cell A.
2	Compare the water potentials of A and B, state the net direction of water movement and explain your answer.
3	If the cell volume falls from 1.00 x 10^-13 m3 to 0.85 x 10^-13 m3 in 300 seconds, calculate the average rate of volume change.
4	The cell eventually becomes plasmolysed. Explain how it recovers and becomes turgid again when placed in pure water.

Question 2 - Enzymes and Metabolic Rate (16 marks)

Enzyme X catalyses a reaction. The initial rate is 2.4 micromol per minute at 30 C and 6.0 micromol per minute at 50 C. After 5 minutes at 60 C the rate has fallen to 0.40 micromol per minute.

#	Question
5	Calculate the temperature coefficient Q10 between 30 C and 50 C.
6	Explain why the rate falls sharply at 60 C.
7	If a competitive inhibitor is added, explain how Vmax and Km change.
8	At 60 C the activity decays with first-order kinetics, k = 0.35 per minute. Calculate the percentage of activity remaining after 5 minutes.

Question 3 - Photosynthesis and Respiration (18 marks)

A leaf in bright light shows a net uptake of 45 mg of carbon dioxide per hour. In darkness it releases 12 mg of carbon dioxide per hour through respiration. Molar masses: carbon dioxide 44 g/mol, glucose 180 g/mol.

#	Question
9	Calculate the true rate of photosynthesis in the light in mg of CO2 per hour.
10	State the net rate of photosynthesis in the light and explain how it differs from the true rate.

#	Question
11	Using the true rate, calculate the mass of glucose produced per hour.
12	A tissue uses 8.0 cm3 of oxygen and releases 6.8 cm3 of carbon dioxide per minute. Calculate the respiratory quotient and suggest the substrate used.

Question 4 - Cell Cycle and Mitosis (16 marks)

There are 20 synchronised dividing cells in an onion root tip meristem. The cell cycle lasts 20 hours: G1 8 hours, S 6 hours, G2 4 hours, M 2 hours.

#	Question
13	If all the cells complete four mitotic divisions, calculate the final number of cells.
14	Calculate the percentage of the cell cycle occupied by S phase.
15	A random sample of 500 cells is examined under the microscope. Estimate how many are in M phase.
16	Explain how mitosis keeps the chromosome number of the daughter cells the same as that of the parent cell.

Question 5 - Energy Flow and Population Estimation (18 marks)

Energy in a grassland per square metre per year: producers 45 000 kJ, primary consumers 4 500 kJ, secondary consumers 450 kJ, tertiary consumers 45 kJ.

#	Question
17	Calculate the efficiency of energy transfer from producers to primary consumers.
18	State the energy available to tertiary consumers and calculate it as a percentage of the energy in producers.
19	If tertiary consumers need 900 kJ per square metre per year, calculate the producer energy required at the transfer efficiency found above.
20	A researcher captures and marks 40 snails, releases them, then recaptures 50 snails of which 8 are marked. Estimate the population size using the Lincoln index.

Question 6 - Kidney and Osmoregulation (16 marks)

A person has a glomerular filtration rate of 125 cm3 per minute, a plasma glucose concentration of 1.0 mg per cm3, a urine output of 1.0 cm3 per minute and no glucose in the urine.

#	Question
21	Calculate the mass of glucose filtered into the Bowman capsules each minute.
22	Calculate the percentage of filtered glucose that is reabsorbed.
23	Calculate the percentage of filtered water that is reabsorbed.
24	Explain how antidiuretic hormone (ADH) makes the urine more concentrated.