# S6 Biology Practice Paper (Set 1): Mendelian Inheritance and Chi-square Test, Population Growth and Carrying Capacity, Photosynthesis Rate and Limiting Factors, Enzyme Kinetics, Gas Exchange and Respiratory Quotient, Water Potential and Osmosis

S6 Biology | Time: 75 minutes | Total: 100 marks | 24 questions

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## Section A: Mendelian Inheritance and Chi-square Test (16 marks)

**Show working and genetic ratios; state the test conclusion at alpha = 0.05.**

**1. Two heterozygous tall pea plants (Tt x Tt) are crossed. Find the percentage of tall offspring.**

**2. Two double heterozygotes (AaBb x AaBb, genes assorting independently) produce 480 offspring. Find the expected number of double recessives (aabb).**

**3. The cross actually gave 470, 140, 145 and 45 plants (total 800) against the 9:3:3:1 expectation. Find the expected numbers and chi-square.**

**4. With 3 degrees of freedom the critical value at alpha = 0.05 is 7.815. Draw a conclusion, then give the expected number of tall plants among 200 test-cross (Tt x tt) offspring and the probability that two randomly chosen are both tall.**

## Section B: Population Growth and Carrying Capacity (18 marks)

**Use N = N0*exp(rt) for exponential growth and dN/dt = rN(1 - N/K) for logistic growth.**

**5. A population starts at 200 individuals with intrinsic growth rate r = 0.35 per year. Find the population after 6 years (nearest whole number).**

**6. Find the doubling time in years (3 significant figures) and state how it relates to r.**

**7. The carrying capacity is K = 5,000. At N = 1,000, find the unused fraction of environmental space and the population size giving maximum logistic growth.**

**8. Using the logistic equation, find dN/dt (individuals per year) when N = 1,000.**

## Section C: Photosynthesis Rate and Limiting Factors (16 marks)

**Oxygen volumes are in cm3 and rates in cm3 per hour.**

**9. A leaf releases 4.5 cm3 of oxygen net in 30 minutes at 20 kLux. Find the net photosynthetic rate (cm3 per hour).**

**10. In darkness the same leaf takes up 1.5 cm3 of oxygen in 30 minutes. Find the respiration rate and the gross photosynthetic rate at 20 kLux.**

**11. Net oxygen release (kLux : cm3 per hour): 0 : -3.0, 5 : 0.0, 10 : 4.5, 20 : 9.0, 30 : 12.0, 35 : 12.0. Find the compensation point and saturation point and explain the plateau.**

**12. If the 20 kLux result came from 10 cm2 of leaf, find the net rate per cm2 and the net release expected from 25 cm2 at the same light intensity.**

## Section D: Enzyme Kinetics (18 marks)

**Use v = Vmax*[S] / (Km + [S]); rate in micromol per minute, [S] in mM.**

**13. An enzyme has Vmax = 120 micromol per minute and Km = 5 mM. Find the rate at [S] = 5 mM.**

**14. Find the rate at [S] = 20 mM and explain the biological meaning of Km.**

**15. Find the substrate concentration needed for v = 100 micromol per minute.**

**16. With a competitive inhibitor Km rises to 15 mM while Vmax is unchanged. Find the rate at [S] = 15 mM and state how competitive inhibition can be relieved.**

## Section E: Gas Exchange and Respiratory Quotient (16 marks)

**RQ = volume of CO2 released / volume of O2 used; carbohydrate RQ = 1.0, fat RQ is about 0.7.**

**17. An organism uses 500 cm3 of oxygen and releases 500 cm3 of carbon dioxide. Find the RQ and identify the respiratory substrate.**

**18. If an animal respires fat (RQ = 0.7) and uses 600 cm3 of oxygen, find the volume of carbon dioxide released.**

**19. A tissue oxidises both substrates: 200 cm3 of O2 on carbohydrate and 400 cm3 on fat. Find the overall RQ.**

**20. Carbohydrate yields 16 kJ per g and fat 38 kJ per g. Find the total energy from 5 g carbohydrate plus 2 g fat, and the mean energy per gram.**

## Section F: Water Potential and Osmosis (16 marks)

**Solute potential is -CRT with R = 8.31 kPa dm3 per mol per K and T = 300 K.**

**21. Find the solute potential (kPa) of a 0.2 mol dm-3 sucrose solution.**

**22. Find the solute potential of a 0.05 mol dm-3 sucrose solution and compare the water potentials of the two solutions.**

**23. A cell with solute potential -600 kPa (pressure potential zero) is placed in the 0.2 mol dm-3 solution. State the net water movement and explain.**

**24. Find the sucrose concentration (mol dm-3, 3 significant figures) that gives no net water movement for that cell.**

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