S3 Biology Practice Paper | magnification, cell size ratio, photosynthesis, inheritance, energy pyramid

Junior Secondary Science

S3 Biology practice paper with answers: microscope magnification, cell surface area to volume ratio, photosynthesis rate, inheritance probabilities and enzyme Q10.

Question 1 Microscope magnification and image size

A student uses a x10 eyepiece and a x40 objective to view a specimen 0.05 mm long.

#	Question	Answer and marking notes
1	(a) Find the total magnification.	Answer: 10 x 40 = 400 times.
2	(b) Find the length of the image seen, in mm.	Answer: 0.05 x 400 = 20.0 mm.
3	(c) A structure measures 30 mm in the field of view. Find its real length in mm and in micrometres.	Answer: 30 / 400 = 0.075 mm, that is 75 micrometres.
4	(d) With a x100 objective, how long is the image and how does the 1.8 mm field diameter change?	Answer: 1000 times, image 50 mm, field diameter 0.72 mm.

Question 2 Cell surface area to volume ratio

Three cube shaped cells have sides of 20, 10 and 40 micrometres.

#	Question	Answer and marking notes
5	(a) For the 20 micrometre cell, find the surface area and the volume.	Answer: 2400 and 8000.
6	(b) Find its surface area to volume ratio.	Answer: 2400 / 8000 = 0.30 per micrometre.
7	(c) Find the ratio for the 10 and 40 micrometre cells and compare.	Answer: 0.60 and 0.15, so the larger cell has the smaller ratio.
8	(d) Explain why cells cannot grow indefinitely and how a falling ratio affects diffusion.	Answer: volume grows as the cube but area only as the square, so less membrane serves each unit of volume and diffusion cannot meet the metabolic demand.

Question 3 Photosynthesis and bubble rate

A pondweed releases 30 bubbles in 5 minutes under bright light.

#	Question	Answer and marking notes
9	(a) Find the bubble rate per minute.	Answer: 30 / 5 = 6 per minute.
10	(b) With the lamp closer, 48 bubbles appear in 5 minutes. Find the new rate and the factor of increase.	Answer: 9.6 per minute, that is 1.6 times faster.

#	Question	Answer and marking notes
11	(c) Each bubble is 0.02 cm3. Find the gas volume released per hour at the first rate.	Answer: 0.12 cm3 per minute, 7.2 cm3 per hour.
12	(d) If light intensity is halved and all else is unchanged, predict the rate and name the limiting factor.	Answer: about 3 per minute, with light intensity as the limiting factor.

Question 4 Monohybrid cross and test cross

In peas, tall (T) is dominant to dwarf (t). Two heterozygous tall plants are crossed, giving 400 offspring.

#	Question	Answer and marking notes
13	(a) State the parent genotypes and the genotype ratio of the offspring.	Answer: Tt x Tt giving TT : Tt : tt of 1 : 2 : 1.
14	(b) How many tall and dwarf plants are expected?	Answer: 100 dwarf and 300 tall.
15	(c) If a tall plant (Tt) is test crossed with a dwarf plant, find the phenotype ratio.	Answer: Tt x tt gives tall to dwarf of 1 : 1.
16	(d) In a test cross giving 200 offspring, how many tall are expected and why may the actual number differ?	Answer: 100 expected, with sampling variation due to random fertilisation.

Question 5 Energy pyramid and transfer efficiency

Producers in an ecosystem fix 50000 kJ of energy with a transfer efficiency of 10 per cent.

#	Question	Answer and marking notes
17	(a) Find the energy available to primary, secondary and tertiary consumers.	Answer: 5000, 500 and 50 kJ.
18	(b) If efficiency were 15 per cent, what energy reaches the tertiary consumer?	Answer: 168.75 kJ.
19	(c) To supply 500 kJ to the tertiary consumer at 10 per cent efficiency, how much must producers fix?	Answer: 500 / 0.1 / 0.1 = 50000 kJ.
20	(d) Explain where the rest of the energy goes at each trophic level.	Answer: most is lost as heat from respiration, with the remainder in faeces, dead bodies and litter, so only about one tenth passes on.

Question 6 Enzyme activity and the Q10 temperature coefficient

An enzyme works at 12 units per minute at 20 C and 24 units per minute at 30 C.

#	Question	Answer and marking notes
21	(a) Find the temperature coefficient Q10 between 20 C and 30 C.	Answer: 24 / 12 = 2.0.

#	Question	Answer and marking notes
22	(b) Predict the rate at 40 C if Q10 held, but the measured value is only 30 units per minute. Find the shortfall and explain.	Answer: 48 expected, a shortfall of 18 because the enzyme is denatured above its optimum.
23	(c) At 50 C the rate falls to 3 units per minute. Find this as a percentage of the 30 C rate.	Answer: 3 / 24 = 12.5 per cent.
24	(d) Deduce the optimum temperature of this human enzyme and describe the effect of further heating.	Answer: about 37 C, the human body temperature; beyond it the enzyme denatures and the rate falls sharply to zero.