S6 Biology Practice Paper

S6 | Biology | Time: 60 minutes | Total: 100 marks | 24 questions

---

Part A Genetics and Molecular Biology (18 marks)

Answer all questions. Show your working and units.

1. A double-stranded DNA molecule of a species has 1200 base pairs, and guanine (G) makes up 40% of all bases. Calculate the number of G, C, A and T bases, and state the base-pairing rule you used.

2. The coding region of a gene contains 900 base pairs. If the whole region is translated, what is the maximum number of amino acids coded for? How many peptide bonds are formed? Explain why one is deducted.

3. Two genes assort independently and the parents are AaBb x AaBb. If 1600 offspring are produced, state the expected ratio of the four phenotypes and the number of each.

4. The observed numbers in such an experiment rarely match the expected numbers exactly. Give one reason, and name the statistical test used to judge whether the difference is significant, together with its null hypothesis.

Part B Genetic Engineering and Biotechnology (17 marks)

Answer all questions. Show your working; give percentages to one decimal place.

5. The polymerase chain reaction (PCR) starts from a single DNA molecule. Calculate the number of DNA molecules after 20 cycles, and find the minimum number of cycles needed to exceed 1,000,000 molecules.

6. A plasmid vector is 4000 bp long and a 1200 bp target gene is inserted to form a recombinant plasmid. Find the total length of the recombinant plasmid and the percentage of the recombinant plasmid contributed by the insert.

7. A 100 microlitre sample of a 10^-3 dilution of a bacterial culture is spread on an agar plate and 120 colonies grow. Calculate the concentration of the original culture in CFU per mL and show the calculation.

8. A gel electrophoresis standard curve shows that a 1000 bp fragment migrates 2.0 cm and a 100 bp fragment migrates 6.0 cm. Estimate the position of a 300 bp fragment and explain why smaller fragments travel further.

Part C Ecosystems and Energy Flow (17 marks)

Answer all questions; give energy in kJ as whole numbers.

9. The producers of an ecosystem fix 50000 kJ of energy in a year and the energy transfer efficiency between trophic levels is 10%. Calculate the energy available to the primary, secondary and tertiary consumers, and explain where the rest of the energy goes.

10. A population grows from 200 to 260 individuals in one year with no immigration or emigration. Calculate its intrinsic growth rate r and its doubling time, and state which growth model this represents.

11. A mark-recapture study marks 40 animals and releases them. A second sample of 50 animals contains 16 marked individuals. Estimate the population size and state two assumptions of the method.

12. A pioneer community contains only 3 plant species while the climax community that develops contains 12. Calculate the increase in species number (absolute and percentage) and give two environmental changes that occur during succession.

Part D Human Physiology and Transport (16 marks)

Answer all questions. State the formula and the units.

13. At rest a person has a heart rate of 72 beats per minute and a stroke volume of 70 mL. Calculate the cardiac output in mL/min and in L/min, and state the formula used.

14. During exercise the same person reaches a heart rate of 140 beats per minute and a stroke volume of 110 mL. Calculate the cardiac output during exercise and how many times the resting value this is.

15. A person has a glomerular filtration rate of 125 mL/min. Calculate the volume of filtrate produced per day in litres, and the daily urine volume if 99% of the filtrate is reabsorbed by the tubules.

16. A person has a tidal volume of 500 mL, a breathing rate of 12 breaths per minute and an anatomical dead space of about 150 mL. Calculate the minute ventilation and the alveolar ventilation, and explain why the difference matters.

Part E Plant Physiology and Photosynthesis (16 marks)

Answer all questions. Show your working and units.

17. A leaf fixes a net 18 micromol of CO2 per square metre per second under a light intensity of 600 micromol per square metre per second. Calculate its quantum yield and suggest one reason why the value is low.

18. A plant loses 45 g of water by transpiration in 5 hours and its total leaf area is 0.03 square metres. Calculate the transpiration rate in g/h and in g per square metre per hour, and state two environmental factors that affect it.

19. At light intensities of 200, 400 and 800 micromol per square metre per second the net photosynthetic rates are 8, 15 and 16 micromol of CO2 per square metre per second. Describe how the rate changes with light intensity and explain the limiting factor at the higher intensities.

20. If a ring of bark is removed from a tree trunk (ringing), sugars accumulate in the leaves above the ring and the roots below eventually die. Explain this observation and name the transport tissue involved.

Part F Health, Disease and Immunity (16 marks)

Answer all questions. Show your working; give percentages to one decimal place.

21. An infectious disease has a basic reproduction number R0 = 5. Calculate the herd immunity threshold and explain what it means.

22. A vaccine has been given to 85% of a population and is 90% effective. Calculate the proportion actually protected and decide whether this is enough for herd immunity against a disease with R0 = 5.

23. A patient carries 10^9 bacteria and the natural frequency of a resistance mutation is 10^-6. Calculate the number of resistant bacteria present before treatment and explain why the full course of antibiotics must be completed.

24. Explain how a vaccine produces immunological memory, and compare active immunity with passive immunity produced by injecting antibodies.
