

Name: _____

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A-Level Biology — Practice Exam

Instructions: A calculator is permitted. Show the working for all calculations.

Time Limit: 60 minutes

Multiple Choice (10 questions)

- [1 point] 1. An enzyme-catalysed reaction was investigated with and without an inhibitor. With the inhibitor present, the maximum rate of reaction was unchanged, but a higher substrate concentration was needed to reach half of the maximum rate. Which type of inhibitor was used, and why?
- A. Competitive, because increasing the substrate concentration overcomes the effect of the inhibitor
 - B. Competitive, because the inhibitor binds to a site away from the active site
 - C. Non-competitive, because the inhibitor changes the shape of the active site
 - D. Non-competitive, because the maximum rate was unchanged
- [1 point] 2. Two adjacent plant cells, A and B, have water potentials of -400 kPa and -250 kPa respectively. In which direction is the net movement of water by osmosis, and why?
- A. There is no net movement, because the cells are in the same tissue
 - B. From A to B, because A has the more negative water potential
 - C. From A to B, because 400 is a larger number than 250
 - D. From B to A, because B has the higher (less negative) water potential
- [1 point] 3. The oxygen dissociation curve of the haemoglobin of a mammal that lives at high altitude lies to the left of the curve for human haemoglobin. Which statement is correct?
- A. It has a higher affinity for oxygen, so it is more saturated at the low partial pressures of oxygen found at altitude
 - B. It has a lower affinity for oxygen, so it unloads oxygen more readily to respiring tissues
 - C. Each molecule carries more oxygen because it has more than four haem groups
 - D. The shift is caused by the lower carbon dioxide concentration in the air at altitude

- [1 point]** 4. In the gills of a bony fish, blood flows through the gill lamellae in the opposite direction to the water flowing over them. Why does this counter-current arrangement make gas exchange more efficient?
- A. It allows oxygen to be moved into the blood by active transport
 - B. It increases the surface area of the lamellae
 - C. It makes the water flow faster, which reduces the diffusion distance
 - D. A diffusion gradient for oxygen is maintained along the whole length of the lamella
- [1 point]** 5. A mature mRNA molecule is 1200 nucleotides long and contains a single stop codon at its end, with no untranslated regions. The maximum number of amino acids in the polypeptide translated from it is
- A. 399
 - B. 400
 - C. 600
 - D. 1200
- [1 point]** 6. A student samples the invertebrates in a pond and finds four species with 2, 4, 6 and 8 individuals respectively. Using the index of diversity $d = \frac{N(N-1)}{\sum n(n-1)}$, where N is the total number of organisms and n is the number of each species, the value of d is
- A. 0.26
 - B. 0.70
 - C. 3.80
 - D. 4.00
- [1 point]** 7. A culture of algae is photosynthesising steadily in bright light when the supply of carbon dioxide is suddenly cut off. In the first few seconds, how do the concentrations of glycerate 3-phosphate (GP) and ribulose biphosphate (RuBP) change?
- A. GP rises and RuBP falls
 - B. GP falls and RuBP rises
 - C. Both GP and RuBP fall
 - D. Both GP and RuBP rise
- [1 point]** 8. In a grassland, the producers have a gross primary production of 32,000 kJ per square metre per year and lose 24,000 kJ per square metre per year in respiration. The net production of the primary consumers is 640 kJ per square metre per year. The percentage efficiency of energy transfer from producers to primary consumers is
- A. 2.0%
 - B. 2.7%
 - C. 8.0%
 - D. 20%

[1 point] 9. In a large, randomly mating population, 4% of individuals show a phenotype caused by a homozygous recessive genotype. Assuming the Hardy–Weinberg principle applies, the percentage of the population that are heterozygous carriers is

- A. 16%
- B. 32%
- C. 40%
- D. 64%

[1 point] 10. In each cycle of the polymerase chain reaction (PCR), the mixture is first heated to about 95°C. The purpose of this step is to

- A. break the phosphodiester bonds in the sugar–phosphate backbone
- B. activate the heat-stable DNA polymerase
- C. allow the primers to anneal to the template strands
- D. break the hydrogen bonds between complementary bases so that the two DNA strands separate

Short Answer (2 questions)

[10 points] 11. Required practical. A student used a quantitative Benedict's test to find the concentration of reducing sugar in a fruit juice. She made a series of glucose solutions of known concentration from a 1.0% stock solution, added an excess of Benedict's reagent to 2 cm³ of each, heated them in a water bath at 80°C for 5 minutes, filtered off the precipitate and measured the absorbance of each filtrate in a colorimeter fitted with a red filter. On her calibration curve, absorbance fell in a straight line from 1.20 for 0% glucose to 0.20 for 1.0% glucose.

[2 points] (a) Describe how the student could make 0.50%, 0.25% and 0.125% glucose solutions from the 1.0% stock solution.

[2 points] (b) Explain why the absorbance of the filtrate decreases as the glucose concentration increases.

[3 points] (c) The student diluted the fruit juice by a factor of 10 before testing it. The filtrate from the diluted juice had an absorbance of 0.60. Calculate the concentration of reducing sugar in the undiluted juice.

[1 point] (d) Explain why the juice had to be diluted before testing.

[2 points] (e) The juice also contains sucrose, which does not react with Benedict's reagent. Describe how the student could show that sucrose is present.

[10 points] 12. A sprinter's leg muscles are stimulated by impulses in motor neurones. This question is about the nerve impulse, muscle contraction, and how the muscles are supplied with ATP and glucose during and after a sprint.

[3 points] (a) Explain how the resting potential of about -70 mV is maintained across the membrane of the axon.

[3 points] (b) Describe the roles of calcium ions and ATP in the contraction of a myofibril.

- [2 points]** (c) During the sprint the muscle cells respire anaerobically. Explain why lactate is produced and why this allows ATP production to continue.

- [2 points]** (d) After the race the sprinter's blood glucose concentration falls below normal. Explain how glucagon returns it to normal.

Calculations (1 question)

- [10 points]** 13. In a species of plant, flower colour is controlled by a gene with two alleles: R (red) is dominant to r (white). Plant height is controlled by a gene on a different chromosome: T (tall) is dominant to t (dwarf). A pure-breeding red, tall plant was crossed with a pure-breeding white, dwarf plant to produce the F1 generation. The F1 plants were then allowed to self-fertilise to produce the F2 generation.

- [1 point]** (a) Give the genotype and the phenotype of the F1 plants.

[2 points] (b) State the expected ratio of phenotypes in the F2 generation and explain how independent assortment produces this ratio.

[3 points] (c) Of 320 F2 plants, 172 were red tall, 66 red dwarf, 62 white tall and 20 white dwarf. Use the chi-square test, $\chi^2 = \sum \frac{(O-E)^2}{E}$, to calculate the value of chi-square for these results.

[2 points] (d) The critical value of chi-square at $p = 0.05$ with 3 degrees of freedom is 7.81. What conclusion should be drawn from the test? Explain your answer.

[2 points]

- (e) Two populations of this plant become separated by a mountain range. Explain how, over many generations, they could become two different species.