

IGCSE Biology 0610 Paper 4 (Extended) Mock Paper (10 questions, 80 marks)

IGCSE (Year 10-11) Biology | 時限：75 分鐘 | 總分：80 分 | 共 10 題

Section A (40 marks) — Questions 1 to 5

Answer all questions. Show your working; the marks for each question are shown in brackets.

1. A micrograph shows a cell 45 mm long. The magnification of the micrograph is $\times 500$.

(a) Convert the image length to μm and calculate the actual length of the cell in μm .

(b) State one function of the nucleus and one function of the cell membrane.

(c) Explain why a plant cell does not burst when placed in distilled water.

答案：(a) $45\text{ mm} = 45,000\text{ }\mu\text{m}$; actual length = $45,000 / 500 = 90\text{ }\mu\text{m}$. [3 marks]

(b) Nucleus: stores genetic material (DNA) and controls the activities of the cell. Cell membrane: controls the movement of substances into and out of the cell (partially permeable). [2 marks]

(c) A plant cell has a cellulose cell wall that withstands the pressure (turgor) produced as water enters, which limits swelling, so the cell does not burst as an animal cell would. [3 marks]

2. Three identical potato strips, each of initial mass 2.40 g, are left for 30 minutes in distilled water and in 1.0 mol/dm³ sucrose solution. The strip in distilled water has a final mass of 2.88 g and the strip in 1.0 mol/dm³ sucrose solution has a final mass of 2.16 g.

(a) Calculate the percentage change in mass for each strip.

(b) A fourth strip shows almost no change in mass in 0.5 mol/dm³ sucrose solution. Explain why.

(c) Describe the state of the cells of the strip in 1.0 mol/dm³ sucrose solution.

答案：(a) Distilled water: $(2.88 - 2.40) / 2.40 \times 100\% = +20.0\%$; 1.0 mol/dm³: $(2.16 - 2.40) / 2.40 \times 100\% = -10.0\%$. [4 marks]

(b) The water potential of 0.5 mol/dm³ sucrose solution equals that of the cell sap, so there is no net movement of water and the mass stays the same. [2 marks]

(c) Water leaves the cells by osmosis, the cells lose turgor and become flaccid, and the cell membrane pulls away from the cell wall (plasmolysis). [2 marks]

3. A student investigates the effect of temperature on amylase activity by timing how long it takes to break down all the starch: 80 s at 20 °C, 20 s at 40 °C and 40 s at 60 °C.

(a) Calculate how many times faster the reaction is at 40 °C than at 20 °C.

(b) Explain why the reaction is slower at 60 °C than at 40 °C.

(c) State two factors other than temperature that affect enzyme activity.

答案：(a) Rate is inversely proportional to the time taken: $80 / 20 = 4.0$ times faster. [3 marks]

(b) 60 °C is above the optimum temperature, so the enzyme is denatured: the shape of the active site changes, the substrate can no longer bind and no enzyme – substrate complexes form, so the rate falls. [3 marks]

(c) pH and substrate concentration (also accept enzyme concentration or inhibitors). [2 marks]

4. A pondweed is placed in sodium hydrogencarbonate solution and illuminated by a lamp at different distances. In 2 minutes, 24 bubbles are counted at 0.5 m and 6 bubbles at 1.0 m.

- (a) Calculate the bubble production rate per minute at each distance.
- (b) Light intensity is inversely proportional to the square of the distance. Use this to explain the difference.
- (c) Predict the effect on the bubble rate at 0.5 m if the sodium hydrogencarbonate concentration is reduced, and describe how you would test your prediction.

答案 : (a) 0.5 m: $24 / 2 = 12$ bubbles per minute; 1.0 m: $6 / 2 = 3.0$ bubbles per minute. [3 marks]

(b) Doubling the distance reduces light intensity to $1 / 2^2 = 1/4$, and the rate falls from 12 to 3.0, a factor of 4, which matches the change in light intensity. [3 marks]

(c) The bubble rate will decrease because carbon dioxide becomes the limiting factor. Control variables: keep the lamp distance, water temperature and pondweed the same and change only the sodium hydrogencarbonate concentration (e.g. 1%, 0.5%, 0.1%), repeat three times and compare mean bubble counts. [2 marks]

5. At rest an athlete has a heart rate of 70 beats per minute and a stroke volume of 70 cm³. During vigorous exercise the heart rate is 120 beats per minute and the stroke volume is 100 cm³.

- (a) Calculate the cardiac output at rest and during exercise in dm³ per minute.
- (b) Calculate how many times greater the cardiac output is during exercise.
- (c) Explain how the heart rate is increased during exercise and why this benefits the muscles.

答案 : (a) At rest: $70 \times 70 = 4,900$ cm³ per minute = 4.9 dm³ per minute; during exercise: $120 \times 100 = 12,000$ cm³ per minute = 12.0 dm³ per minute. [4 marks]

(b) $12.0 / 4.9 = 2.45$ times greater. [2 marks]

(c) During exercise more adrenaline is secreted and carried in the blood to the heart, where it acts on the sinoatrial node (pacemaker), increasing heart rate and the force of contraction; breathing also becomes faster and deeper, delivering more oxygen and glucose to the muscles and removing carbon dioxide faster, so the muscles can carry out more aerobic respiration. [2 marks]

Section B (40 marks) — Questions 6 to 10

Answer all questions. Show your working; the marks for each question are shown in brackets.

6. In pea plants the allele for tall stems, A, is dominant to the allele for dwarf stems, a. Two heterozygous tall plants (Aa) are crossed and produce 400 seeds.

- (a) Use a Punnett square to find the ratio of tall to dwarf offspring and calculate the number of tall and dwarf plants expected from 400 seeds.
- (b) One of the Aa plants is crossed with a dwarf plant. State the phenotypic ratio of the offspring.
- (c) Calculate the probability that two offspring of the heterozygous cross are both dwarf.

答案 : (a) Punnett square: AA, Aa, Aa, aa, ratio 3:1. Tall = $400 \times 3/4 = 300$ plants; dwarf = $400 \times 1/4 = 100$ plants. [4 marks]

(b) Aa $\times$ aa gives Aa : aa = 1:1, i.e. 50% tall and 50% dwarf. [2 marks]

(c) The probability that one offspring is dwarf is 1/4, so two dwarf offspring = $(1/4)^2 = 1/16 = 6.25\%$. [2 marks]

7. A student uses $0.5\text{ m} \times 0.5\text{ m}$ quadrats to sample a 500 m^2 grassland at random and counts 8 plants of one species in one quadrat.

(a) Calculate the area of the quadrat and the density of the plants in plants per m^2 .

(b) Estimate the total number of these plants in the grassland.

(c) The food chain is grass $\rightarrow$ insect $\rightarrow$ frog $\rightarrow$ snake. If the grass fixes 20,000 kJ and 10% of the energy is transferred at each level, calculate the energy available to the snake and explain why food chains rarely have more than five levels.

答案 : (a) Area = $0.5 \times 0.5 = 0.25\text{ m}^2$; density = $8 / 0.25 = 32$ plants per m^2 . [3 marks]

(b) Total $\approx 32 \times 500 = 16000$ plants. [2 marks]

(c) Insects 2000 kJ, frogs 200 kJ, snakes 20 kJ. At each level much energy is lost through respiration (as heat), in excretory products and in parts that are not eaten, leaving only about 10% for the next level; too little energy remains to support further levels, so food chains are short. [3 marks]

8. A leafy shoot is attached to a potometer and the air bubble moves 60 mm in 5 minutes.

(a) Calculate the rate of bubble movement in mm per minute and in mm per hour.

(b) Explain how a fan placed beside the shoot would affect the rate.

(c) State what is transported in the xylem and in the phloem.

答案 : (a) Rate = $60 / 5 = 12$ mm per minute; per hour = $12 \times 60 = 720$ mm. [4 marks]

(b) The bubble moves faster. The fan removes water vapour from the leaf surface, increasing the concentration gradient of water vapour between the inside and outside of the leaf, so transpiration is faster, the xylem takes up water more quickly and the bubble moves faster. [2 marks]

(c) Xylem: water and mineral salts (upwards from the root). Phloem: sucrose and other organic nutrients (in either direction). [2 marks]

9. During vigorous exercise an athlete's body temperature rises from 37.0°C to 37.8°C and the sweating rate reaches 1.2 dm^3 per hour. The latent heat of vaporisation of sweat is about 2,430 kJ/kg.

(a) Calculate the heat lost per hour by the evaporation of sweat.

(b) State two responses of the skin to a rise in body temperature.

(c) Explain why both water and salts must be replaced after vigorous exercise.

答案 : (a) Mass of sweat = 1.2 kg ; heat lost = $1.2 \times 2,430 = 2916$ kJ per hour. [3 marks]

(b) Vasodilation of the skin arterioles so that more blood flows near the skin surface to lose heat; increased secretion of sweat which evaporates and cools the body (also: hair erector muscles relax). [3 marks]

(c) Sweating loses both water and salts; dehydration reduces sweat production, thickens the blood and increases the strain on the heart, reducing the ability to regulate temperature; loss of sodium affects nerve impulses and muscle contraction, so a drink containing electrolytes is needed. [2 marks]

10. A species of bacteria divides every 20 minutes, starting from 100 bacteria.

(a) Calculate the number of bacteria after 100 minutes.

(b) Calculate the number after a further 60 minutes.

(c) Explain why antibiotics are ineffective against viruses, and how the overuse of antibiotics leads to an increase in resistant bacteria.

答案：(a) $100 / 20 = 5$ divisions, so the number $= 100 \times 2^5 = 3200$. [3 marks]

(b) A further $60 / 20 = 3$ divisions, so the number $= 3200 \times 2^3 = 25600$. [2 marks]

(c) Viruses have no cellular structure and cannot carry out metabolism on their own; they must replicate inside living cells, whereas antibiotics target bacterial cell walls or protein synthesis, so they have no effect on viruses. With overuse, bacteria carrying resistance genes survive and reproduce, so the proportion of resistant bacteria in the population rises (natural selection) and resistant strains emerge. [3 marks]