Index No.:_____ AM05/I.26m

L-Università ta' Malta

MATRICULATION AND SECONDARY EDUCATION CERTIFICATE EXAMINATIONS BOARD

ADVANCED MATRICULATION LEVEL
2026 FIRST SESSION

SUBJECT:	**Biology**
PAPER NUMBER:	I
DATE:	5th May 2026
TIME:	9:00 a.m. to 12:05 p.m.

Directions to Candidates

- Write your index number in the space at the top left-hand corner of this page.
- Answer **ALL** questions. Write all your answers in the spaces provided in this booklet.
- The mark allocation is indicated at the end of each question. Marks allocated to parts of questions are also indicated.
- You are reminded of the necessity for good English and orderly presentation in your answers.
- In calculations you are advised to show all the steps in your working, giving your answer at **each** stage.
- The use of electronic calculators is permitted.

For examiners' use only:

Question	1	2	3	4	5	6	7	8	**Total**
Score									
Maximum	12	14	10	14	15	13	13	9	**100**

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1. The question is about carbohydrates.

   a. Complete the table below by giving the name of a monosaccharide that matches each property. Some properties may be represented by the same monosaccharide.

	Property	**Example of a monosaccharide**
i.	This monosaccharide is a component of DNA.	
ii.	This monosaccharide is involved in the synthesis of adenosine triphosphate (ATP).	
iii.	This monosaccharide is used as the primary substrate in glycolysis during respiration.	
iv.	When joined to glucose by a glycosidic bond formed during a condensation reaction, lactose is produced.	
v.	This monosaccharide contains five carbon atoms.	
vi.	This monosaccharide is used in the synthesis of the cofactor nicotinamide adenine dinucleotide (NAD).	

(3)

   b. Two forms of glucose include α-glucose and β-glucose.

      i. Explain the difference between α-glucose and β-glucose.

_____

_____

_____

_____ (2)

In plants α-glucose forms starch, while β-glucose forms cellulose.

      ii. Explain why cellulose is more suitable for structural support in plants than starch, even though both are composed of glucose monomers.

_____

_____

_____

_____ (2)

iii. Suggest why humans can digest starch but are unable to digest cellulose.

_____

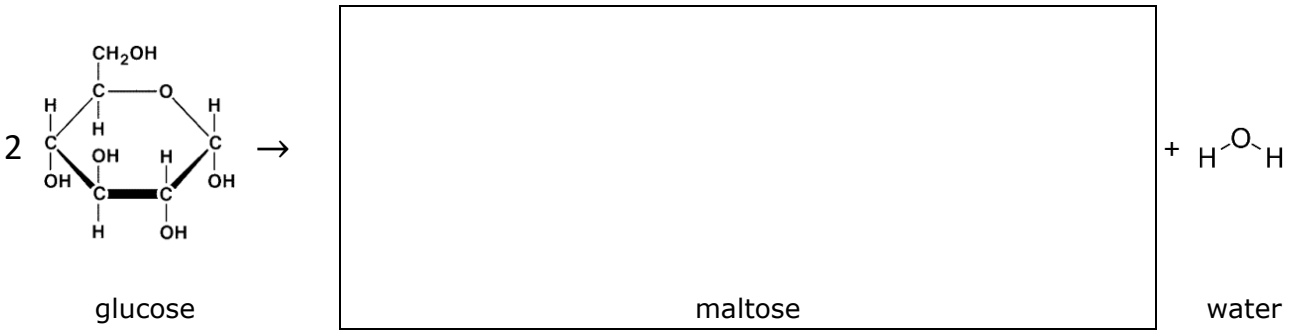
_____

_____

_____ (2)

c. Maltose and sucrose are both disaccharides.

i. Maltose is a disaccharide composed of two glucose molecules. In the space provided, complete the reaction by showing the structure of maltose.



(1)

ii. A student adds sucrase to sucrose and tests the products using Benedict's test. Predict the result and explain your answer.

_____

_____

_____

_____ (2)

(Total: 12 marks)

2. Briefly explain the following statements related to cells.

a. The nuclear envelope has pores allowing selective movement of molecules across membrane.

_____

_____

_____

_____ (2)

Question continues on the next page.

b. The structure of centrioles is closely linked to the formation of flagella.

_____

_____

_____

_____ (2)

c. The Golgi apparatus is well developed in secretory cells.

_____

_____

_____

_____ (2)

d. Macrophages contain a high number of lysosomes.

_____

_____

_____

_____ (2)

e. The size of the nucleolus varies depending on the cell's metabolic activity.

_____

_____

_____

_____ (2)

f. The presence or absence of ribosomes on the endoplasmic reticulum determines its function.

_____

_____

_____

_____ (2)

g. Prokaryotic cells lack membrane-bound organelles.

_____

_____

_____

_____ (2)

(Total: 14 marks)

3. This question is about heterotrophic nutrition in mammals.

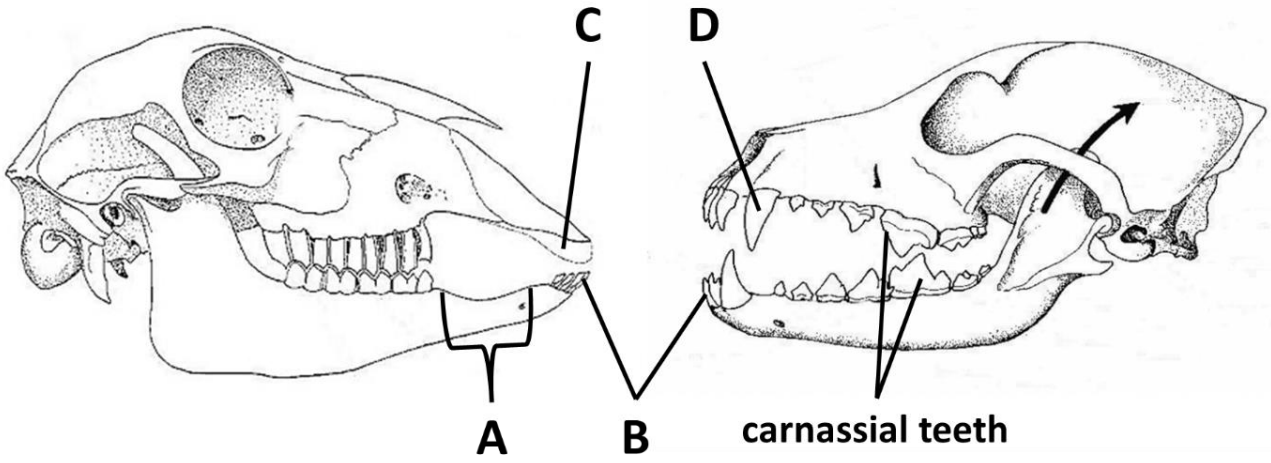


Figure 1: Skulls of a typical herbivore (left) and a typical carnivore (right).
(Adapted from http://www.biology-resources.com)

a. Label the structures A-D.

A	
C	

B	
D	

(2)

b. Describe how the shape of the teeth in carnivores are adapted to their diets.

_____

_____

_____ (1)

Question continues on the next page.

c. Explain how the teeth and multi-chambered stomach of ruminants work together to maximise nutrient extraction.

_____

_____

_____

_____

_____ (3)

d. Rabbits are hind-gut fermenters. Explain this behaviour and suggest why it is important.

_____

_____

_____

_____ (2)

e. Predict the effects on digestion if the secretion of CCK in humans is inhibited. Justify your answer.

_____

_____

_____

_____ (2)

(Total: 10 marks)

4. This question is about the support and locomotion in animals.

a. Discuss how different skeletal types are selectively advantageous in terrestrial environments.

i. Hydrostatic skeleton:

_____

_____

_____

_____ (2)

ii. Exoskeleton:

_____

_____

_____

_____ (2)

iii. Endoskeleton:

_____

_____

_____

_____ (2)

b. The skeleton in insects prevents continuous growth. Evaluate **TWO** risks associated to this growth strategy.

_____

_____

_____

_____

_____ (3)

c. Explain the roles of troponin and tropomyosin in resting muscle.

_____

_____

_____

_____ (2)

Question continues on the next page.

d. Using the sliding filament theory, explain how ATP contributes both to muscle contraction and relaxation.

_____

_____

_____

_____

_____ (3)

(Total: 14 marks)

5. This question is about hormonal control.

Both insulin and cortisol regulate blood glucose levels. Insulin is a peptide hormone, whereas cortisol is a steroid hormone. These hormones are transported in the bloodstream to their target tissues, where they either instigate a secondary messenger mechanism or diffuse through the plasma membrane and bind to intracellular receptors.

a. Distinguish between peptide hormones and steroid hormones in terms of:

i. structure;

_____

_____ (1)

ii. solubility.

_____

_____ (1)

b. Which of the two hormones require a protein carrier for transportation in the blood? Provide **ONE** justification for your answer.

_____

_____

_____ (1.5)

c. Define the term 'secondary messenger mechanism'.

_____

_____ (1)

d. Which of the two mentioned hormones activates a secondary messenger mechanism? Give **ONE** reason for your choice.

_____

_____

_____ (1.5)

The graph below shows blood glucose, insulin and cortisol levels in a healthy individual throughout the day, including meals marked as breakfast (B), lunch (L), dinner (D) and a snack (S).

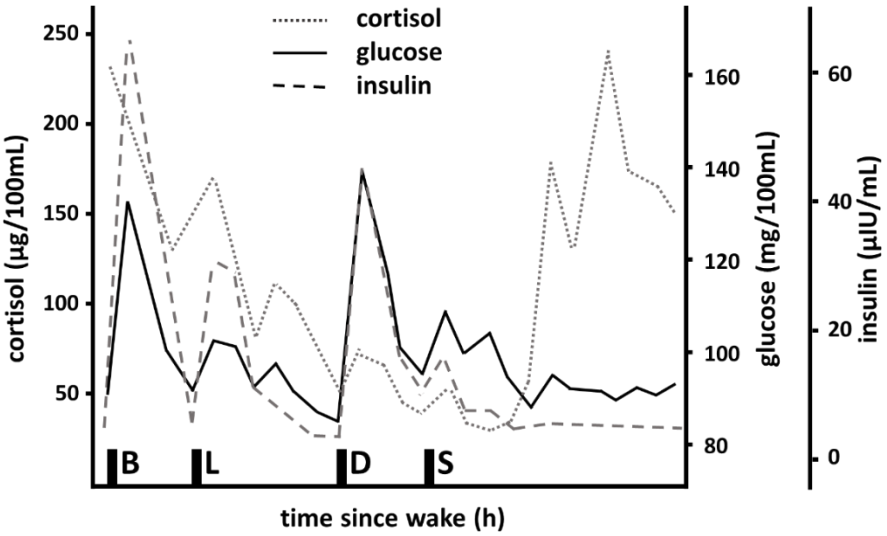


Figure 2: A graph showing blood glucose, insulin and cortisol levels in a healthy human
(Adapted from: https://www.researchgate.net)

e. Using the information provided on the graph (Figure 2), answer the following questions.

i. Using evidence from the graph, state the relationship between insulin levels and blood glucose levels after a meal.

_____

_____ (1)

ii. Explain how insulin lowers blood glucose levels after a meal.

_____

_____

_____

_____

_____ (3)

Question continues on the next page.

iii. Which meal most likely contained the greatest amount of carbohydrates? Use evidence from the graph to support your answer.

_____

_____ (1)

iv. Explain why cortisol levels increase when the person is asleep.

_____

_____

_____

_____ (2)

v. If the graph represented a person with impaired insulin secretion, predict how the blood glucose pattern after meals would differ.

_____

_____

_____

_____ (2)

(Total: 15 marks)

6. This question is about circulation in humans.

During physical exercise, the distribution and volume of blood flow change to meet the body's increased metabolic demands. This is largely achieved by an increase in cardiac output.

Table 1: Blood flow (mL per minute) in selected organs at rest and during two types of exercise.
(Adapted from: https://www.skillstat.com)

Organ	**Blood flow (mL per minute)**		
	At rest	**Exercise A**	**Exercise B**
Brain	650	650	650
Heart muscle	200	600	400
Muscles	1000	8000	6000
Kidneys	950	380	475
Skin	400	1200	800
Other organs	3100	930	1550

a. Name the **TWO** factors that determine cardiac output.

_____ (1)

b. Identify **ONE** organ from Table 1 that shows vasodilation and **ONE** organ that shows vasoconstriction during exercise.

Vasodilation: _____ Vasoconstriction: _____ (1)

c. Which exercise is the most strenuous? Justify your answer using evidence from the table.

_____

_____

_____ (2)

d. Explain the following observations:

i. The blood flow to the brain remains constant.

_____

_____

_____ (2)

ii. The blood flow to the kidneys decreases during both exercises.

_____

_____

_____ (2)

iii. The blood flow to the skin increases during both exercises.

_____

_____

_____ (2)

e. Explain the role of the atrioventricular node during heartbeat.

_____

_____

_____

_____ (2)

f. When faced with sudden danger, a person's cardiac output increases. Name the hormone responsible for this response.

_____(1)

(Total: 13 marks)

Please turn the page.

7. This question is about the control of gene expression in prokaryotes.

   a. Distinguish between 'constitutive enzymes' and 'inducible enzymes'.

_____

_____

_____ (2)

   b. The *lac* operon is an example of an inducible enzyme system in prokaryotes.

      i. Describe the function of the operator region in the *lac* operon.

_____

_____

_____

_____ (2)

      ii. Explain how lactose induces transcription of the *lac* operon structural genes.

_____

_____

_____

_____

_____ (3)

      iii. Discuss why the *lac* operon is considered an efficient system for conserving energy in prokaryotic cells.

_____

_____

_____

_____ (2)

      iv. A mutation deletes the promoter sequence of the *lac* operon. Predict the effect of this mutation on *lac* operon function and explain your reasoning.

_____

_____

_____

_____ (2)

c. **Mutation 1** changes a codon in a gene without changing the amino acid produced. **Mutation 2** results in a different amino acid sequence from the point of mutation onwards. Compare and explain why these mutations have different effects on the protein produced.

_____

_____

_____

_____ (2)

(Total: 13 marks)

8. This question is about gene technology.

a. A laboratory is producing insulin using genetically modified bacteria. Describe the roles of **THREE** enzymes used in forming a recombinant plasmid containing the human insulin gene.

_____

_____

_____

_____

_____

_____

_____ (5)

b. After the recombinant plasmid is introduced into bacterial cells, not all cells are successfully transformed. Briefly explain **TWO** methods that can be used to select bacterial cells that have taken up the insulin gene.

Method 1: _____

_____

_____

_____

Method 2: _____

_____

_____

_____ (4)

(Total: 9 marks)

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MATRICULATION AND SECONDARY EDUCATION CERTIFICATE EXAMINATIONS BOARD

ADVANCED MATRICULATION LEVEL
2026 FIRST SESSION

SUBJECT:	**Biology**
PAPER NUMBER:	II
DATE:	6th May 2026
TIME:	9:00 a.m. to 12:05 p.m.

Directions to Candidates

- Answer the question in Section A, any **TWO** questions from Section B and **ONE** question from Section C. Write all your answers in the separate booklet provided.
- If more than two questions from Section B are attempted, only the first two answers shall be taken into consideration.
- If more than one question from Section C is attempted, only the first answer shall be taken into consideration.
- The mark allocation is indicated at the end of each question. Marks allocated to parts of questions are also indicated.
- You are reminded of the necessity for good English and orderly presentation in your answers.
- In calculations you are advised to show all the steps in your working, giving your answer at each stage.
- The use of electronic calculators is permitted.

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SECTION A

1. Read the following extract carefully, and using the information provided and your knowledge of biology, answer the questions that follow. The numerals in the left-hand margin are the line numbers.

Evolution through isolation

Isolating mechanisms play a central role in speciation. These mechanisms limit the exchange of genes between populations, allowing divergence over time. Some isolating mechanisms arise because populations live in different environments or habitats, while others result from biological differences that prevent reproduction.

Many lower animals and protists reproduce both sexually and asexually. When sexual reproduction occurs in these organisms, isolating mechanisms function in essentially the same way as they do in species that reproduce only sexually. Reproductive isolating mechanisms are commonly divided into prezygotic and postzygotic types. Prezygotic mechanisms act before fertilisation, preventing mating or the fusion of gametes. Postzygotic mechanisms act after fertilisation and often result in offspring with reduced survival or fertility. Because prezygotic barriers prevent wasted reproductive effort, natural selection tends to favour genes that promote premating isolation.

Mate recognition and mating behaviour are important forms of reproductive isolation. Many species rely on specialised signals to identify suitable mates. For example, the electric fish *Eigenmannia virescens* produces distinctive electrical signals during courtship, while the silk moth *Bombyx mori* releases pheromones that attract members of its own species. These signalling systems help ensure that mating occurs between compatible individuals.

Another form of isolation is ecological isolation, in which populations occupy different habitats within the same geographic region. Although this type of barrier is common, it may be incomplete where habitats overlap. In these transitional zones, individuals from different populations may occasionally interbreed and postzygotic mechanisms may then reduce the success of the resulting offspring.

An example involves frogs of the genus *Pseudophryne* found near Melbourne, Australia. Closely related species can interbreed in areas where their habitats meet and produce hybrid offspring. However, these hybrids generally have reduced fitness. The parent populations possess specialised traits, such as distinctive skin colouration, movement patterns, and mating calls that are well adapted to their environments. Hybrids may lack these adaptations and therefore survive or reproduce less successfully.

A different postzygotic outcome is seen when horses and donkeys interbreed. Although mating can occur, the hybrid offspring (mules) are typically sterile, preventing the continued exchange of genes between the parent species.

While evolutionary change ultimately depends on genetic variation, isolating mechanisms help guide the process by restricting gene flow between populations. In doing so, they maintain species boundaries and help preserve the biological diversity observed in nature.

Adapted from: Isolating mechanisms in evolution
https://www.ebsco.com/research-starters/history/isolating-mechanisms-evolution

a. Explain the meaning of 'speciation' (line 1). (2)

b. Explain the meaning of 'gene flow between populations' (line 33). (1)

c. Explain the role of isolating mechanisms in speciation. (2)

d. Distinguish between prezygotic and postzygotic isolating mechanisms (lines 8–10). (2)

e. Suggest **ONE** reason why prezygotic barriers are often favoured by natural selection. (1)

f. Using **TWO** examples from the text, explain how mating signals help prevent interbreeding between species. (3)

g. Explain the typical outcome for offspring produced through postzygotic isolation. Use **TWO** examples from the text to support your answer. (3)

h. Suggest why reduced hybrid fitness (line 25) can help maintain species boundaries. (2)

i. The text suggests that different frog species have different mating calls (line 26). Propose a hypothesis explaining how differences in mating calls may have evolved. (2)

j. Explain how genetic drift can contribute to speciation in isolated populations. (2)

k. A scientist stated that 'reproductive isolating mechanisms are both a cause and a consequence of speciation'. Discuss this statement. (2)

l. Suggest how climate change and habitat alteration might affect existing isolating mechanisms between closely related species. (3)

(Total: 25 marks)

SECTION B

Answer any TWO questions from this section; your answers should take the form of essays. Each question carries twenty-five marks.

1. Describe the process of oxidative phosphorylation in mitochondria and how mitochondrial structure supports this process.

2. Discuss the roles of antidiuretic hormone and aldosterone in maintaining water and electrolyte balance and analyse the consequences of deficiency or excess of these hormones.

3. Discuss how the sympathetic and parasympathetic divisions of the autonomic nervous system regulate the body through feedback mechanisms.

4. The plant kingdom displays a diverse range of life cycle patterns. Discuss this statement with reference to mosses, ferns and flowering plants as examples.

(Total: 50 marks)

Please turn the page.

SECTION C
Answer ONE question from this section.

1. Use your knowledge of biology to explain the following statements:

   a. Body symmetry is typically linked with motility mechanisms in Animalia. (5)

   b. Triploblastic organisation was a key evolutionary step that enabled complex life to colonise land. (5)

   c. Divergent evolution is exemplified by the pentadactyl tetrapod limb. (5)

   d. The cleidoic egg enabled vertebrates to colonise terrestrial habitats. (5)

   e. Cnidocytes in cnidarians facilitate feeding. (5)

(Total: 25 marks)

OR

2. Use your knowledge of biology to explain the following statements related to human biology:

   a. Germ-line cells undergo reduction division as part of their function. (5)

   b. Sperm cells lack many organelles found in egg cells. (5)

   c. Cellular divisions transform the zygote into a blastula. (5)

   d. Parturition is a three-stage process. (5)

   e. Lactation is a hormonally regulated process of milk production. (5)

(Total: 25 marks)

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L-Università ta' Malta

MATRICULATION AND SECONDARY EDUCATION CERTIFICATE EXAMINATIONS BOARD

ADVANCED MATRICULATION LEVEL
2026 FIRST SESSION

SUBJECT:	**Biology**
PAPER NUMBER:	III
DATE:	6th May 2026
TIME:	4:00 p.m. to 5:35 p.m.

Directions to Candidates

- Write your index number in the space at the top left-hand corner of this page.
- Answer **ALL** questions. Write all your answers in the spaces provided in this booklet.
- The mark allocation is indicated at the end of each question. Marks allocated to parts of questions are also indicated.
- You are reminded of the necessity for good English and orderly presentation in your answers.
- In calculations you are advised to show all the steps in your working, giving your answer at each stage.
- The use of electronic calculators is permitted.

For examiners' use only:

Question	1	2	3	**Total**
Score				
Maximum	17	13	20	**50**

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1. Genetic inheritance in corn snakes.

Corn snakes (*Pantherophis guttatus*) are non-venomous snakes that are popular as pets. Their wide variety of colour morphs makes them useful for studying the genetics of pigmentation.

In corn snakes, body colour is determined by two genes that interact to produce skin pigment. The genes are located on separate chromosomes and each gene has two alleles: C/c and R/r.

The pathway for pigment production is as follows:

- The dominant allele C allows the production of a pigment precursor.
- The dominant allele R converts the precursor into red pigment, producing the typical red colouration.
- If one of the genes is coded by a homozygous recessive form, the snake is albino and lacks its typical red colouration.

a. A snake breeder crosses two snakes that are both heterozygous at both genes.

i. Name the relationship between the two genes in producing the observed phenotype.

_____ (1)

ii. The two genes controlling pigment are located on separate chromosomes. Explain the consequence of this for the inheritance of these genes.

_____

_____ (1)

iii. State the genotype and phenotype of the parent corn snakes.

Phenotype: _____ Genotype: _____ (1)

iv. Use the grid below to produce a Punnett square showing **all** possible genotypes of the F1 generation.

(3)

v. Deduce the phenotypes of the F1 generation and their ratios.

_____

_____ (2)

b. A snake breeder investigated whether the colouration of juvenile corn snakes affects their growth over a 6-week period. The body length of 24 snakes was measured at the start of the experiment. The snakes were then allowed to roam freely in a large garden and were measured again after 6 weeks. The growth of each snake was calculated and recorded in Table 1.

Table 1: Growth in length of corn snakes over 6 weeks.

Red snakes	
Snake number	**Growth (cm)**
1	2.8
2	3.1
3	3.0
4	3.2
5	3.2
6	2.9
7	3.3
8	3.0
9	3.1
10	3.3
11	3.2
12	2.8

Albino snakes	
Snake number	**Growth (cm)**
13	3.1
14	2.6
15	3.0
16	2.8
17	3.0
18	2.7
19	2.6
20	2.8
21	2.9
22	2.7
23	2.8
24	2.9

i. State the null hypothesis for this investigation.

_____

_____ (1)

ii. Suggest **ONE** biological explanation that could account for any difference in growth between the red and albino snakes.

_____

_____

_____ (2)

iii. An independent t-test was used to analyse this data. How many degrees of freedom should be used in this analysis?

_____ (1)

Question continues on the next page.

iv. The calculated t-value for this analysis is 3.64 and the critical value at $p = 0.05$ is 2.074. State whether the result is statistically significant and justify your answer.

_____

_____ (1)

v. Based on the t-test results, should the null hypothesis be accepted or rejected?

_____ (1)

vi. Identify **TWO** limitations of this investigation and suggest **ONE** improvement for each limitation.

Limitation 1: _____

Improvement: _____

Limitation 2: _____

Improvement: _____ (3)

(Total: 17 marks)

2. This question is about biological investigations related to human blood.

a. The following is a photomicrograph of a blood smear from a person having sickle cell anaemia.

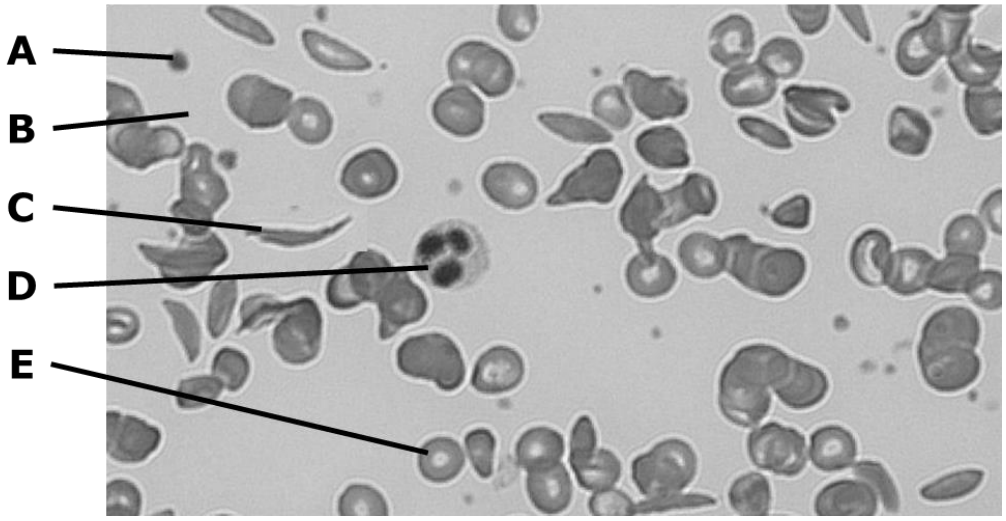

Figure 1: A photomicrograph of blood.
(Source: https://commons.wikimedia.org/)

i. From the photomicrograph (Figure 1), identify the following features using the letters provided:

Feature	**Letter/s**
Erythrocyte	
Leukocyte	

Feature	**Letter/s**
Plasma	
Platelet	

(2)

ii. Using **ONE** feature shown in Figure 1, explain how it may be concluded that red blood cells are specialised for transport rather than cellular division.

_____

_____ (1)

iii. During analyses it was noted that blood with a large proportion of sickle-shaped red blood cells came from a person with reduced oxygen content in the blood.

What conclusion can be drawn from this observation about how the shape of red blood cells influences their ability to transport oxygen?

_____

_____ (1)

b. A student investigated the effect of sodium chloride (NaCl) concentration on red blood cells. A series of NaCl solutions of different concentrations was prepared. The same volume of a red blood cell suspension was then added to each NaCl solution and the mixtures were gently mixed. After a fixed time, the amount of haemoglobin released into each solution was measured using a spectrophotometer. The percentage haemolysis was then calculated.

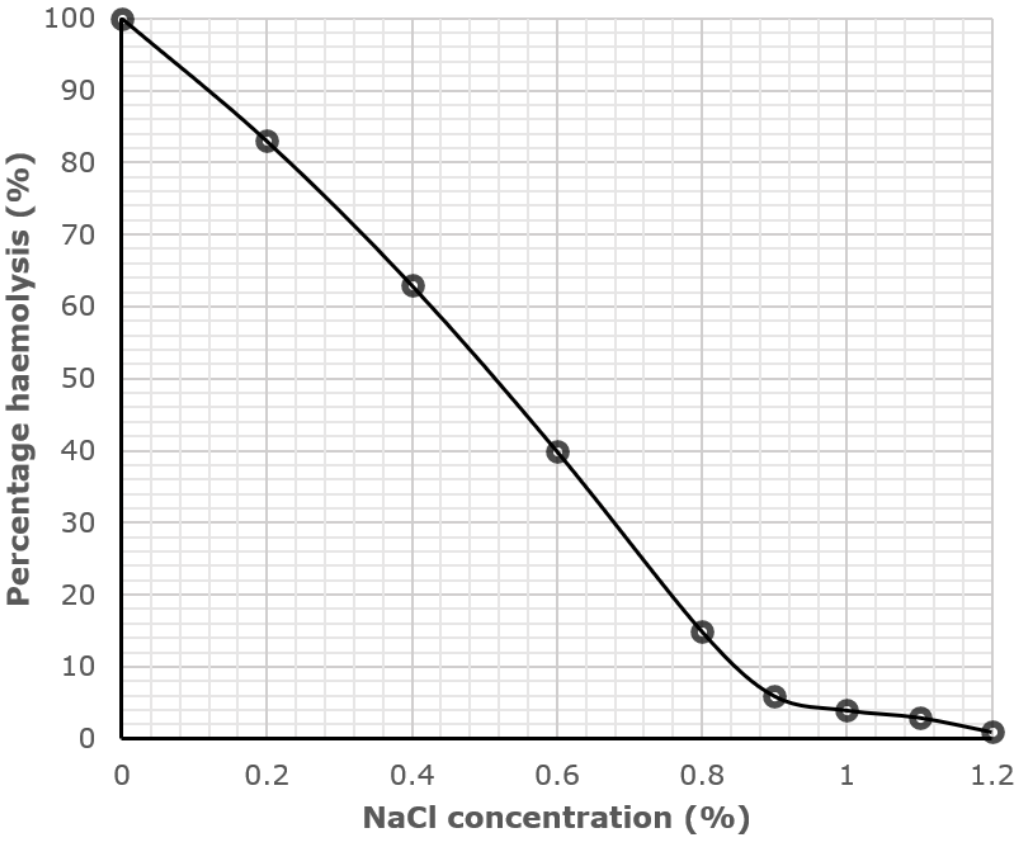

Figure 2: The effect of NaCl concentration on haemolysis of red blood cells

Question continues on the next page.

i. Describe the relationship between NaCl concentration and percentage haemolysis shown by the graph.

_____

_____ (1)

ii. Explain the results obtained at 0% NaCl.

_____

_____

_____ (2)

iii. Explain why very little haemolysis occurs at NaCl concentrations above 0.9%.

_____

_____ (1)

iv. Suggest **TWO** reasons why the red blood cell suspension was gently mixed with each NaCl solution.

_____

_____ (2)

v. While data books indicate that no haemolysis should occur in a 1% NaCl solution, yet in this experiment some red blood cells were observed to break down. Suggest **ONE** reason for this result.

_____

_____ (1)

vi. State **ONE** variable, other than time and volume, that should be kept constant during this experiment. Justify your answer.

_____

_____ (2)

(Total: 13 marks)

3. *Nucella lapillus* is a marine gastropod. Distinct forms, differing in shell length, size and banding patterns, occur along the same stretch of coastline. A biologist collected two forms found along the shoreline in the British Isles.

a. **Form A** has a small shell with a wide opening. This form is found high on the shore where wave exposure can be intense but crab numbers are low.
Form B has large shells with thicker lips at the opening. This form occurs lower on the shore where crab density is high.

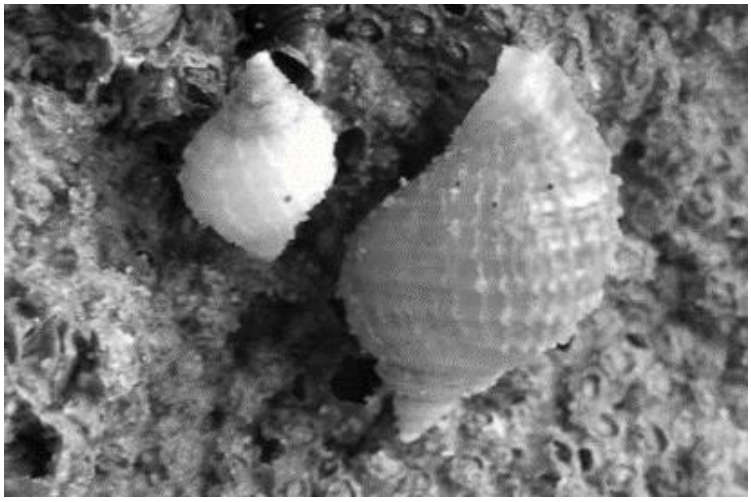

Figure 3: An image showing *Nucella lapillus*: Form A (left) and From B (right)
(Source: https://www.glaucus.org.uk)

i. Suggest how the biologist could determine whether the two forms are genuinely different forms rather than the same form at different life stages.

_____

_____

_____ (1)

ii. Name **TWO** variables the biologist recorded at each sampling site to investigate the cause of differences in shell morphology.

_____

_____ (1)

iii. Suggest what would the biologist do to ensure that the sample of snails collected is representative of the population present.

_____ (1)

iv. Suggest a setup that the scientist can use to confirm that Form A and Form B occur at different parts of the shore.

_____

_____

_____

_____ (2)

Question continues on the next page.

v. Design a suitable table of results to record the number of Form A and Form B snails found at different distances along the shore. In your table, include the variables used to relate snail form to environmental conditions.

(3)

vi. Suggest **ONE** reason to justify why small shell snails (Form A) are not usually found in areas with high crab densities.

_____ (1)

vii. Suggest **ONE** reason to justify why large shell snails (Form B) are not usually found in areas with high wave exposure.

_____ (1)

viii. Although the two forms live on the same coastline, interbreeding between the two forms might eventually become rare. Suggest **ONE** pre-zygotic isolating mechanism that could reduce breeding between the two forms. Justify your answer.

_____

_____

_____

_____ (2)

b. Further investigation showed that different forms of *Nucella lapillus* also differed in the length of their digestive tract. This is possibly related to the different feeding conditions experienced by the two forms on the rocky shore.

As part of this investigation, the biologist analysed photomicrographs of epithelial cells from the intestines of these snails. Draw a labelled biological diagram showing **TWO** different cell types present in Figure 4.

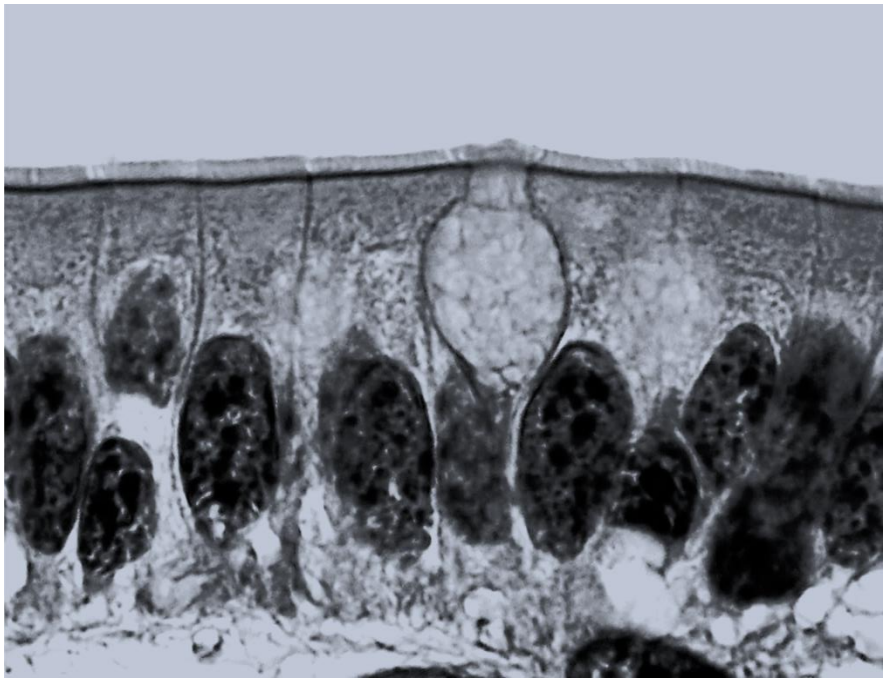

Figure 4: Photomicrograph showing epithelial cells
*(Source: https://*commons.wikimedia.org/*)*

(5)

Question continues on the next page.

c. In a separate experiment, the biologist estimated the population size of Form A using the Lincoln Index (mark–release–recapture method).

The population size (N) can be estimated using the following formula: $N = \frac{(n_1 \text{ x } n_2)}{m_2}$

N = estimated population size
n_1 = number of individuals captured, marked and released initially
n_2 = total number of individuals captured in the second sample
m_2 = number of marked individuals recaptured in the second sample

At the start of the investigation, 120 snails were captured, marked, and released. Two weeks later, a second sample of 150 snails was captured. Of these, 12 were marked.

i. Provide **ONE** assumption related to the use of the Lincoln Index method to estimate population size.

_____

_____ (1)

ii. Calculate the population size of the Form A snails using the Lincoln Index and the data provided. Include your working.

_____

_____

_____

_____ (2)

(Total: 20 marks)

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L-Università ta' Malta

MATRICULATION AND SECONDARY EDUCATION CERTIFICATE EXAMINATIONS BOARD

ADVANCED MATRICULATION LEVEL
2026 FIRST SESSION

SUBJECT:	**Biology**
PAPER NUMBER:	IV – *Practical*
DATE:	4th June 2026
TIME:	1 hour 35 minutes

Directions to Candidates

- Write your index number in the space at the top left-hand corner of this page.
- Answer **ALL** parts of the question. Write all your answers in this booklet. Drawings of biological material and graphical representations of data are to be made on the appropriate pages within this booklet.
- The marks allotted to parts of question are indicated.
- You are reminded of the necessity for good English and orderly presentation in your answers.
- In calculations you are advised to show all the steps in your working, giving your answer at each stage.
- The use of electronic calculators is permitted.

For examiners' use only:

Question	**Total**
Score	
Maximum	**40**

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1. The enzyme catalase is present in high concentrations in potato tuber cells. This enzyme breaks down the substrate hydrogen peroxide into oxygen and water. The oxygen produced forms froth and the amount of froth produced can be used as an estimate of the rate of enzyme activity.

   You are required to design and carry out an experiment to investigate how pH affects the activity of the enzyme catalase.

   You are provided with the following materials:
   - potato chips;
   - hydrogen peroxide solution (labelled as **substrate**);
   - buffer solutions of pH 4, pH 6, pH 8 and pH 10;
   - syringes for measuring volumes;
   - distilled water;
   - test tubes;
   - small cups for transferring volumes if required;
   - other laboratory apparatus as required.

a. Explain why buffer solutions were provided rather than other solutions when investigating the effect of pH on catalase activity.

_____

_____ (1)

b. The buffer solutions contain a small amount of soap at a concentration that has no effect on the potato cells. Suggest **ONE** practical reason for the inclusion of soap during this experiment.

_____

_____ (1)

c. For this experiment, it is advisable to use a 1 cm length of potato chip in each test tube. This piece is then cut into smaller pieces. Suggest and explain why the potato chip is cut into smaller pieces.

_____

_____

_____

_____ (2)

d. State and explain **THREE** variables that must be kept constant during this experiment to ensure comparable results.

Variable 1: _____

_____

_____

_____ (2)

Variable 2: _____

_____

_____

_____ (2)

Variable 3: _____

_____

_____

_____ (2)

e. Using the materials provided, devise and describe an experimental procedure to investigate the effect of pH on catalase activity. Include an appropriate control for pH 8 only.

It is recommended that for each test you:

- use 3 mL of buffer solution;
- use 3 mL of hydrogen peroxide solution;
- use a 1 cm length of potato chip;
- cut the 1 cm potato chip into smaller pieces on the tile provided;
- remove any potato skin, if present.

It is advisable to stop the experiment after a maximum of 10 minutes (or earlier as required).

_____

_____

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_____

Question continues on the next page.

(10)

Carry out the investigation that you devised in part (e) and record your results in part (f).

f. Record your results in the space below. *Marks will be awarded for the structure and the organisation of the results obtained.*

(6)

g. Draw an appropriate graph to represent your results. A graph paper is provided on the following page.

(6)

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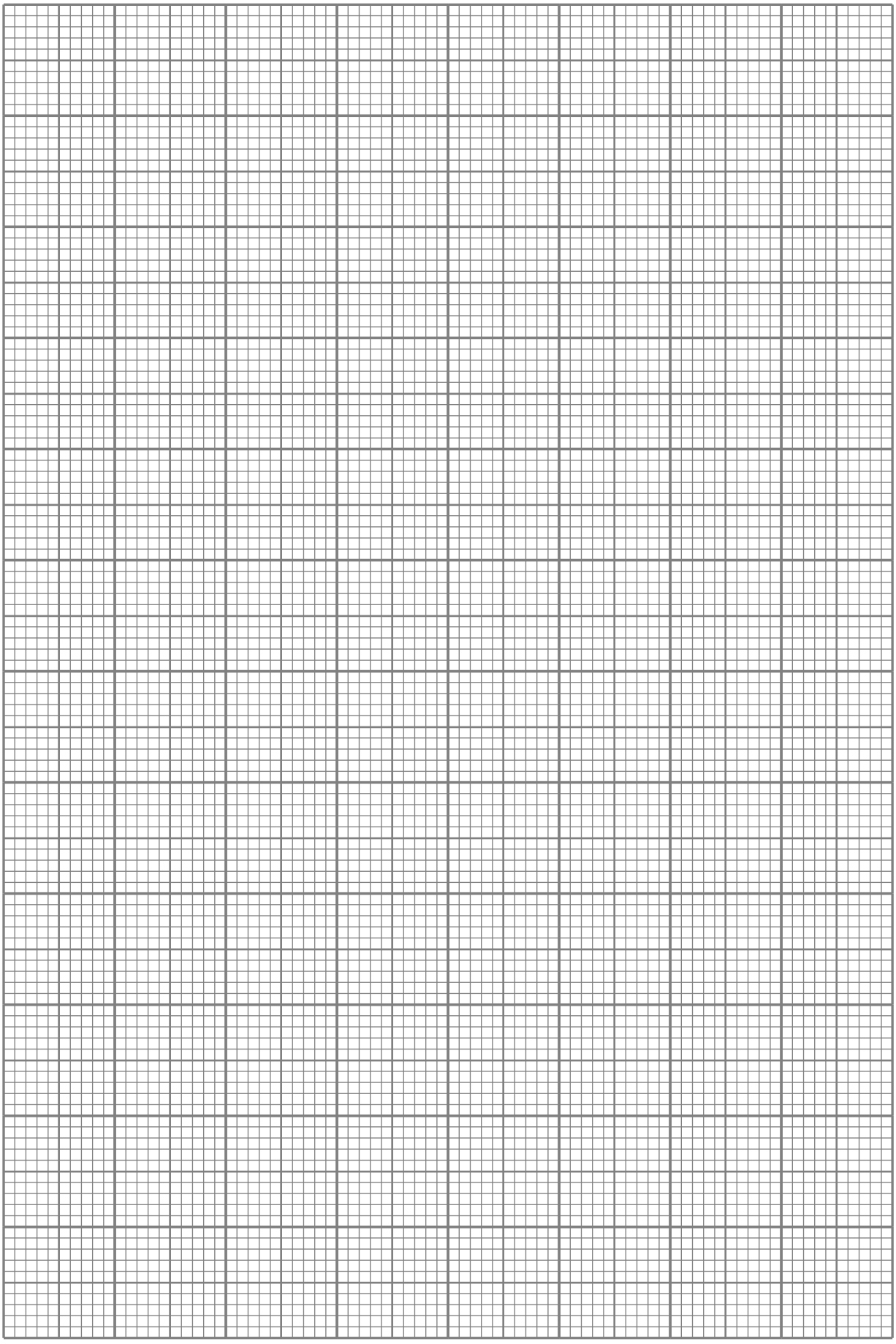

h. Describe your results.

_____

_____

_____

_____

_____

_____ (3)

i. Use your knowledge of enzymes to interpret your results.

_____

_____

_____

_____

_____

_____

_____ (4)

j. State **ONE** source of error that may have occurred during your investigation.

_____

_____ (1)

(Total: 40 marks)

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