Index No.:_____ AM05/I.25s

L-Università ta' Malta

MATRICULATION AND SECONDARY EDUCATION CERTIFICATE EXAMINATIONS BOARD

ADVANCED MATRICULATION LEVEL
2025 SECOND SESSION

SUBJECT:	**Biology**
PAPER NUMBER:	I
DATE:	29th August 2025
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	11	12	12	17	8	13	13	14	**100**

© The MATSEC Examinations Board reserves all rights on the examination questions in all examination papers set by the said Board.

1. This question concerns the transition of chordates from marine to terrestrial environments.

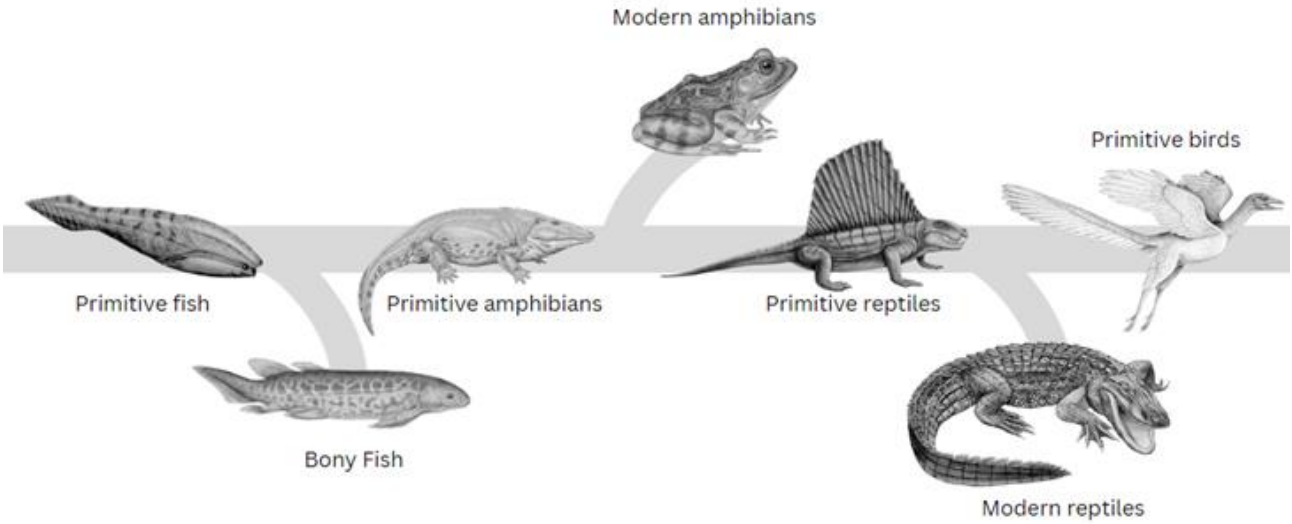


Figure 1: A simplified diagram showing the evolution of terrestrial chordates.

a. Using the evolutionary path of chordates as depicted in Figure 1, suggest **ONE** explanation for each of the following:

i. Primitive amphibians needed to change their gaseous exchange mechanism.

_____

_____

_____ (2)

ii. Primitive reptiles needed to change the type of egg they produce.

_____

_____

_____ (2)

iii. Primitive birds modified their limbs to survive.

_____

_____

_____ (2)

b. The type of fertilisation has also evolved among chordates, with some groups exhibiting external fertilisation and others exhibiting internal fertilisation. Using the vertebrate groups shown in Figure 1, identify two examples of chordates for each type of fertilisation.

External fertilisation: _____ _____

Internal fertilisation: _____ _____ (2)

c. All the organisms shown in Figure 1 exhibit the same type of body symmetry.

i. Name the type of symmetry shown.

_____ (1)

ii. Explain why this type of symmetry is advantageous for these organisms compared to other forms of symmetry.

_____

_____

_____ (2)

(Total: 11 marks)

2. For gaseous exchange to occur, a diffusion gradient must be maintained. Different organisms have developed various means of sustaining this gradient.

a. Indicate whether the following statements are **TRUE** or **FALSE.** Provide **ONE** justification for your answers.

i. If the lungs stop expanding and contracting, the diffusion gradient for gases would gradually be lost.

True or False: _____ Justification: _____

_____

_____ (2)

ii. The elasticity of the alveoli influences the diffusion gradient.

True or False: _____ Justification: _____

_____

_____ (2)

Question continues on the next page.

iii. The speed of the blood flow in the capillaries around the alveoli does **not** affect the diffusion gradient.

True or False: _____ Justification: _____

_____

_____ (2)

iv. If stagnant air remains in the alveoli due to incomplete ventilation, the diffusion gradient for gases will remain unaffected.

True or False: _____ Justification: _____

_____

_____ (2)

b. By referring to Fick's Law, explain how the following features influence the rate of gaseous diffusion between the alveoli and the neighbouring capillaries.

i. The alveolar walls become thicker due to disease.

_____

_____

_____ (2)

ii. The total surface area of the alveoli decreases due to smoking.

_____

_____

_____ (2)

(Total: 12 marks)

3. This question concerns nuclear division.

a. Explain the significance of nuclear division in the following cases:

i. A lizard regrows its tail after losing it to predators.

_____

_____

_____ (2)

ii. The formation of the second polar body in humans.

_____

_____

_____ (2)

b. Below are descriptions of events that occur during mitosis. Name the stages of mitosis that correspond to each description.

i. The chromosomes align at the centre of the cell, attached to spindle fibres.

Stage: _____ (1)

ii. The nuclear membrane breaks down, chromosomes condense and the spindle fibres begin to form.

Stage: _____ (1)

iii. The sister chromatids are separated and move toward opposite poles of the cell.

Stage: _____ (1)

iv. The chromosomes reach opposite poles and the nuclear membrane reforms around each set of chromosomes.

Stage: _____ (1)

c. Explain how meiosis increases genetic variation.

_____

_____

_____ (2)

d. A farmer wants to produce identical plants. Explain why the farmer would use processes that rely on mitosis rather than meiosis to achieve his aim.

_____

_____

_____ (2)

(Total: 12 marks)

Please turn the page.

4. This question is about respiration.

a. Explain the difference in energy efficiency between aerobic and anaerobic respiration in humans.

_____

_____

_____

_____

_____ (4)

b. Explain the difference in energy efficiency between the final products obtained in anaerobic respiration taking place in yeast and anaerobic respiration taking place in human muscles.

_____

_____

_____ (2)

c. List and quantify the total input and output of reactants and products during glycolysis.

_____

_____

_____

_____ (3)

d. Explain the role of oxygen in cellular respiration.

_____

_____

_____ (2)

e. Figure 2 shows a graph of oxygen uptake during a six-minute exercise and immediately after exercise during a recovery period.

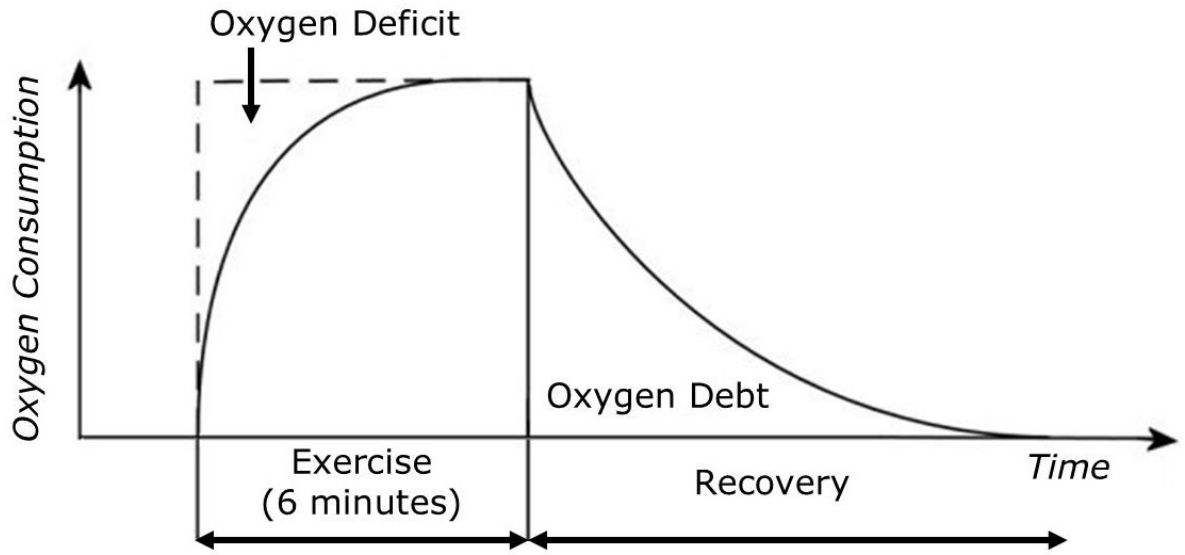


Figure 2: Oxygen uptake during exercise and recovery
(Adapted from https://www.aatbio.com/resources)

i. Distinguish between oxygen deficit and oxygen debt.

_____

_____

_____ (2)

ii. Identify **TWO** physiological mechanisms that maintain the supply of energy in the first 6 minutes.

_____

_____

_____ (2)

iii. Identify **TWO** physiological processes that contribute to the repayment of oxygen debt.

_____

_____

_____ (2)

(Total: 17 marks)

Please turn the page.

5. This question concerns muscular contractions.

The figure below shows a simplified diagram of a sarcomere at rest.

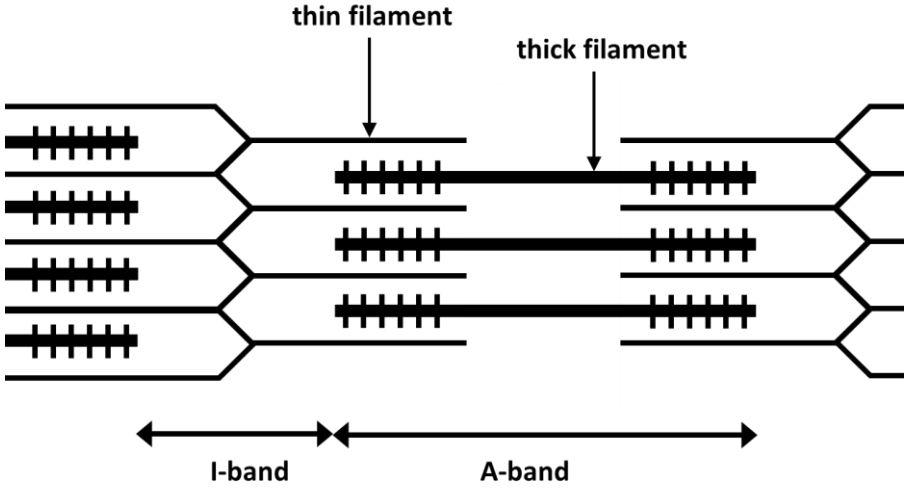


Figure 3: A schematic representation of a sarcomere.

a. On Figure 3 label the H-zone and the Z-line. (1)

b. Name the proteins that make up the thin and thick filaments.

Thin filaments: _____ Thick filaments: _____ (1)

c. By referring to the Figure 3, indicate what would happen to the length of both A-band and I-band under each of the following conditions. Justify your answer.

i. Influx of calcium ions into the sarcomere.

	Length: increases / decreases / remains the same
A-band size	
I-band size	

Reason: _____

_____ (2)

ii. No nerve impulses trigger end-plate potentials in the muscle.

	Length: increases / decreases / remains the same
A-band size	
I-band size	

Reason: _____

_____ (2)

iii. The muscle is stretched.

	Length: increases / decreases / remains the same
A-band size	
I-band size	

Reason: _____

_____ (2)

(Total: 8 marks)

6. This question is about stimulus reception in animals.

a. Explain **TWO** features of cone cells that enable them to provide high visual acuity when compared to rods.

_____

_____

_____

_____ (3)

b. Explain **TWO** features that allow rods to be more sensitive to light than to cones.

_____

_____

_____

_____ (3)

Question continues on the next page.

c. Figure 4 shows a dark adaptation curve related to nocturnal vision in humans.

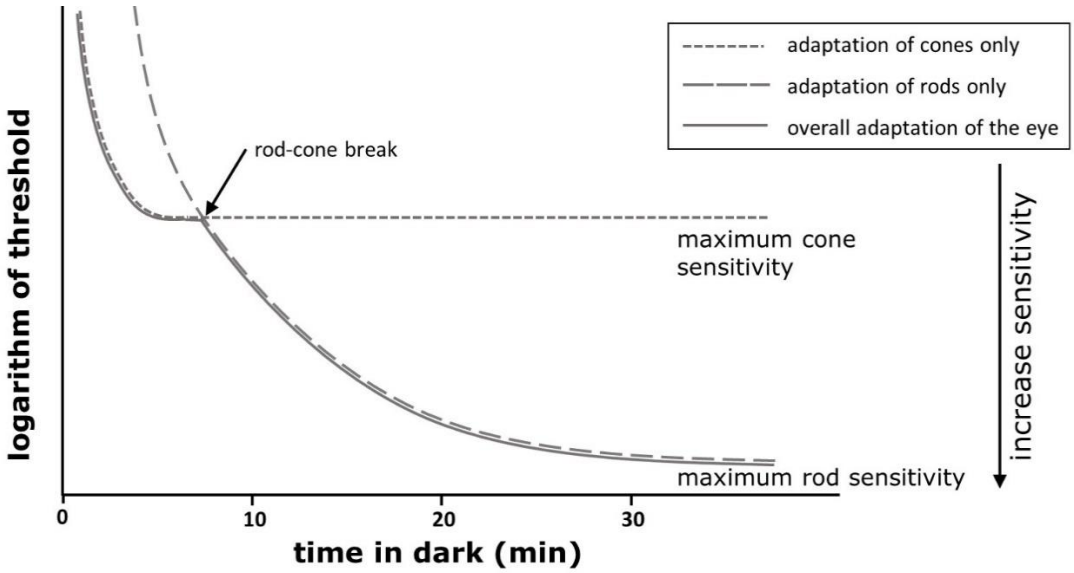


Figure 4: Dark adaptation curve
(Source: https://www.semanticscholar.org)

i. Describe how the dark adaptation curves differ between rod cells and cone cells.

_____

_____

_____ (2)

ii. Explain the effect of prolonged exposure to bright light on the process of dark adaptation.

_____

_____

_____ (2)

Humans and nocturnal animals such as owls have different adaptations for vision. Owls have very large eyes with a high density of rod cells, whereas humans have more cone cells.

iii. Explain how having more rod cells benefits the owl's vision.

_____

_____

_____ (2)

iv. Suggest **ONE** disadvantage for an owl of having fewer cone cells than humans.

_____

_____ (1)

(Total: 13 marks)

7. This question is about evolution.

a. Before the Industrial Revolution, most moths of the species *Biston betularia* were pale-coloured and camouflaged well on lichen-covered trees. As pollution killed lichens and darkened tree bark, a darker form of the moth became more common. When pollution levels later dropped, the pale form increased in frequency again. Figure 5 shows the frequency map the two forms of moth in England during the Industrial Revolution.

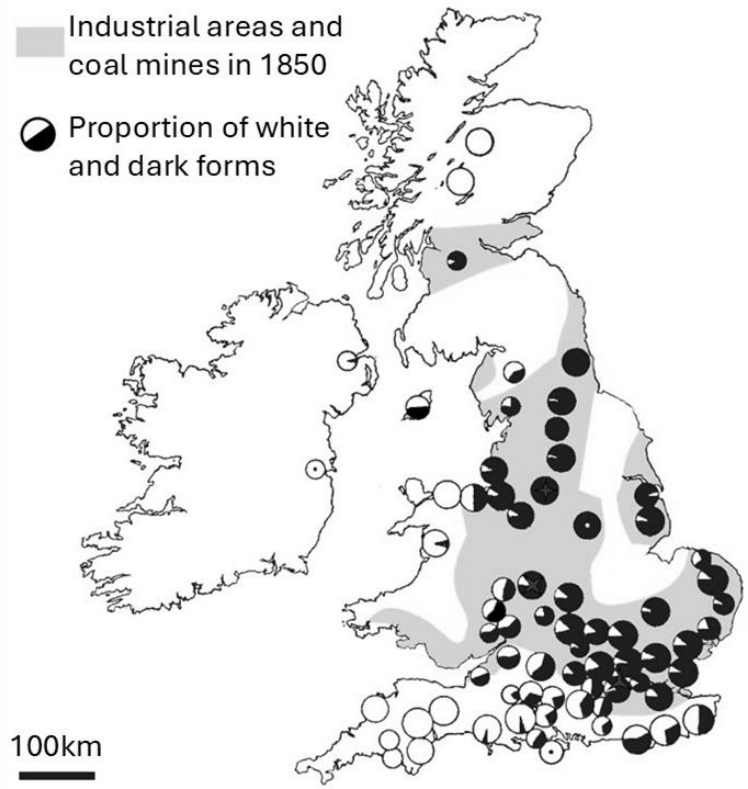


Figure 5: The distribution of white and dark forms of *Biston betularia* in England.
(Adapted from https://pedagogie.ac-reunion.fr)

i. Define polymorphism in the context of *Biston betularia*.

_____ (1)

ii. Name the type of polymorphism illustrated by *Biston betularia*.

_____ (1)

Question continues on the next page.

iii. Name the process that gives rise to alleles that code for different colours.

_____ (1)

iv. Explain how natural selection acted on *Biston betularia* during the Industrial Revolution.

_____

_____

_____ (2)

v. Explain **ONE** piece of evidence from Figure 5 that supports the theory of natural selection.

_____

_____

_____ (2)

b. Consider the following scenarios and explain whether directional, disruptive or stabilising selection is being depicted.

i. A lake has fish with light or dark colours. Light fish hide between rocks, while dark fish hide in mud. Both colour morphs persist because predators struggle to see camouflaged fish.

Type of selection: _____ Justification: _____

_____

_____ (2)

ii. A bird population has various beak sizes. As the environment changes and larger seeds become more common, birds with bigger beaks eat better and survive more easily, while those with smaller beaks struggle to eat the larger seeds.

Type of selection: _____ Justification: _____

_____

_____ (2)

iii. In a species of birds, individuals with very small or very large wings are less efficient at migrating long distances, while birds with moderate wing sizes migrate more successfully. Over time, birds with intermediate wing sizes become more common.

Type of selection: _____ Justification: _____

_____

_____ (2)

(Total: 13 marks)

8. This question is about environmental biology.

a. Explain why 'pioneer' species are often small and fast-growing.

_____

_____

_____ (2)

b. Suggest how an invasive species can alter an ecological succession.

_____

_____

_____ (2)

c. Succession may reach a point where the ecosystem's structure and function remain relatively stable for long periods. What is the community at this stage of succession called?

_____ (1)

d. Describe how resource partitioning allows similar species to coexist and suggest **ONE** consequence if a key shared resource suddenly becomes scarce.

_____

_____

_____

_____ (2)

Question continues on the next page.

e. In North America, grey wolves have a fundamental niche that includes a wide range of habitats such as forests, grasslands and mountains. They may inhabit anywhere they can find sufficient prey such as deer, elk and smaller mammals. However, their realised niche is much narrower.

i. Explain the difference between a species' fundamental niche and its realised niche.

_____

_____

_____

_____ (2)

ii. Explain **TWO** human activities that may be influencing the realised niche of the grey wolves in North America.

Human activity 1: _____

_____

Human activity 2: _____

_____ (3)

iii. Explain **ONE** possible consequence for the wider ecosystem if grey wolves are removed from an area.

_____

_____

_____ (2)

(Total: 14 marks)

Blank Page

Blank Page

L-Università ta' Malta

MATRICULATION AND SECONDARY EDUCATION CERTIFICATE
EXAMINATIONS BOARD

ADVANCED MATRICULATION LEVEL
2025 SECOND SESSION

SUBJECT:	**Biology**
PAPER NUMBER:	II
DATE:	1st September 2025
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.

© The MATSEC Examinations Board reserves all rights on the examination questions in all examination papers set by the said Board.

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.

Why do elephants have big ears?

Elephants are known for their intelligence, complex social behaviour, memory and size, including their giant ears. The ears of African elephants, *Loxodonta africana*, can grow to about 17% of their body length, which means they are the animal with the largest ears, although they do not actually have the largest ears relative to their body size. That award goes to the mouse-like rodent, *Euchoreutes naso*, which lives in desert and semi-desert habitats.

Animals as big as elephants generate a lot of body heat, especially in the hot savannahs, forests and grasslands where they live. But unlike humans, elephants do not really sweat. Instead they have massive ears filled with large blood vessels that help these giant animals' thermoregulation. When the elephant gets really warm, it can force blood into its ears, and then flaps them. Its ears have thin skin that is only a few millimetres thick and the blood vessels that pass through them are large, enabling elephants to move about 20% of their blood supply through their ears at any one time.

Because the blood flowing through them is warmer than the air, heat dissipates into the surroundings. Cooler blood then circulates back into the body, helping to reduce the animal's overall temperature. Blood vessels in the elephants' ears can undergo vasoconstriction or vasodilation to regulate the elephants' temperature.

Woolly mammoths, which are relatives of modern elephants, first evolved in Africa. As they began moving into colder climates, their ears gradually became smaller. Studies on mummified woolly mammoths in the northern hemisphere show that these now extinct animals had very small ears compared to savannah African elephants, and more importantly they had fur.

While elephants likely have their big ears to keep themselves cool, their ears also have other uses. Some studies suggest that elephants use their ears to funnel sound waves, which can help them hear lower-frequency sounds. Their large ears also help these highly social animals communicate with each other. For example, elephants about to charge will bring their ears forward and start moving them rapidly to appear larger.

(Adapted from: https://www.livescience.com/animals/elephants/why-do-elephants-have-big-ears)

a. Why are large ears more common in animals living in hot environments (line 2 and line 5)? (1)

b. Describe **TWO** other structural features, apart from size, that increase the efficiency of the elephants' ears in thermoregulation. (2)

c. Describe **ONE** behavioural mechanism related to the ear that increases the rate of cooling in elephants. (1)

d. Suggest **ONE** disadvantage of large ears for an animal like the African elephant. (1)

e. Explain the role of vasodilation and vasoconstriction in dissipating heat from surfaces such as an elephant's ear (lines 15 – 16). (3)

f. Suggest **TWO** reasons why it is more efficient for large mammals, such as elephants, to lose heat through their ears rather than by sweating. (2)

g. Unlike elephants, humans have sweat glands distributed across their skin. Explain the mechanism by which sweat glands help cool the human body. (2)

h. Compare the thermoregulatory adaptations for elephants that live in warm climates with those of woolly mammoths that lived in colder climates. (2)

i. Explain how the adaptations mentioned in part (h) indicate evolutionary processes. (2)

j. Suggest **TWO** disadvantages of having large ears in icy regions like those inhabited by woolly mammoths. (2)

k. Reptiles living in harsh, hot environments have evolved behavioural mechanisms to cope with heat. Describe **ONE** such behavioural adaptation. (2)

l. In addition to heat, savannahs are also characterised by long periods of drought. Some animals enter a state of dormancy to survive such conditions. What is this process called? (1)

m. In savannahs and deserts, some small mammals have evolved long loops of Henle to conserve water in dry conditions. Explain this adaptation. (3)

n. Explain how rising temperatures might impact the future evolution of elephant ear size. (1)

(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. Compare the structural differences between monosaccharides, disaccharides and polysaccharides, and explain how these differences relate to their biological functions.

2. Describe the mechanism of DNA replication and discuss its role in maintaining genetic stability.

3. Proteins within chloroplasts enable the formation of carbohydrates. Discuss.

4. Compare and contrast spermatogenesis and oogenesis.

(Total: 50 marks)

SECTION C
Answer ONE question from this section.

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

   a. Ecosystem diversity influences species diversity. (5)

   b. Viruses rely on their own genetic material and the host's cell function for replication. (5)

   c. The engulfment of a prokaryotic cell led to the evolution of eukaryotic cells. (5)

   d. Fungi were formerly classified as plants, but are no longer so. (5)

   e. Besides being heterotrophic, all animals share other common characteristics. (5)

(Total: 25 marks)

OR

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

   a. Microtubules are important for intracellular transport and cellular movement. (5)

   b. All double-membrane-bound organelles have at least one membrane that is significantly more porous. (5)

   c. Biomolecules on and within cell surface membranes allow for different modes of transmembrane transport. (5)

   d. Active transport moves substances against their concentration and electrochemical gradients. (5)

   e. Receptor-mediated endocytosis relies on the binding of specific molecules to form vesicles. (5)

(Total: 25 marks)

Index No.:_____ AM05/III.25s

L-Università ta' Malta

MATRICULATION AND SECONDARY EDUCATION CERTIFICATE EXAMINATIONS BOARD

ADVANCED MATRICULATION LEVEL
2025 SECOND SESSION

SUBJECT:	**Biology**
PAPER NUMBER:	III
DATE:	2nd September 2025
TIME:	9:00 a.m. to 10:35 a.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	19	14	**50**

© The MATSEC Examinations Board reserves all rights on the examination questions in all examination papers set by the said Board.

1. This question is about viruses, classification of animals and life-cycles of plants.

   a. Below is an image of a virus as seen under an electron microscope.

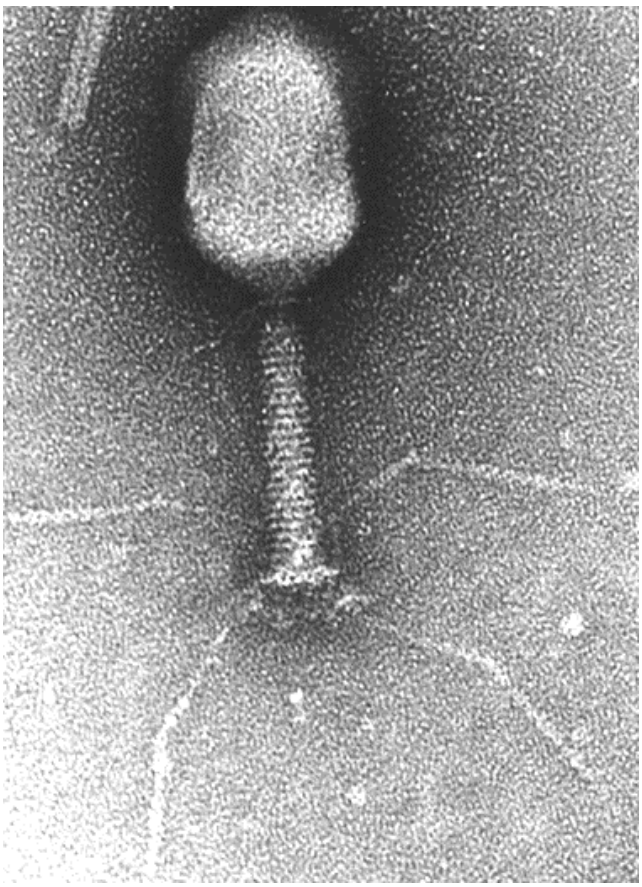


Figure 1: An electron micrograph of a virus.
(Source: https://www.researchgate.net/)

   i. Explain why an electron microscope is needed to observe viruses like the one shown in Figure 1.

_____

_____ (1)

   ii. Name the type of virus shown in Figure 1.

_____ (1)

   iii. On Figure 1, label **TWO** structural features of the virus. (1)

   iv. On Figure 1, indicate where viral genetic material is found. (1)

   v. Name the type/s of genetic material that may be found in viruses such as the one shown in Figure 1.

_____ (1)

b. Below are images of four different arthropods (Figures 2 to 5).

Figure 2: Arthropod A
(Source: https://www.ecoguardpestmanagement.com)

Figure 3: Arthropod B
(Source: https://www.rte.ie/)

Figure 4: Arthropod C
(Source: https://www.beaconpest.ca/)

Figure 5: Arthropod D
(Source: https://vichighmarine.ca)

i. Using visible external features, construct a simple dichotomous key that could be used to distinguish between the arthropods shown in Figures 2 to 5.

_____

_____

_____

_____

_____

_____ (4)

Question continues on the next page.

ii. Identify the major taxonomic group within the phylum Arthropoda to which each of the animals shown in Figures 2 to 5 belongs.

Arthropod A: _____ Arthropod B: _____

Arthropod C: _____ Arthropod D: _____ (2)

iii. Describe **TWO** limitations of using dichotomous keys when identifying living organisms during fieldwork.

_____

_____

_____

_____ (2)

c. A student was given different plant tissues and analysed whether the cells were haploid or diploid.

i. The cells collected from the leaf-like structures were haploid, but the cells from the seta were diploid. Identify the type of plant the student was examining and justify your answer.

_____

_____

_____

_____ (2)

ii. The cells collected from the leaves were diploid, while the cells obtained from the microsporangia were haploid. Identify the type of plant the student was examining and justify your answer.

_____

_____

_____

_____ (2)

(Total: 17 marks)

2. A group of students was doing an ecological fieldwork in a field.

a. Initially they wanted to compare the population density of two beetle species (species A and species B) using random sampling with quadrats, by using ten 1 m^2 quadrats. They recorded the number of beetles per quadrat in Table 1.

Table 1: The number of beetles of species A and species B found in each quadrant analysed.

Quadrat number	**Species A**	**Species B**
1	5	2
2	7	3
3	4	2
4	6	4
5	5	3
6	6	2
7	6	2
8	5	3
9	7	4
10	5	3
mean density beetles / m^2	5.6	2.8

i. Define random sampling in ecological fieldwork.

_____

_____ (1)

ii. Describe how the students could ensure that their quadrats were randomly placed in the field studied.

_____

_____

_____ (2)

iii. The students wish to test whether the mean density differs significantly between the two species. Name the statistical test they should use.

_____ (1)

Question continues on the next page.

iv. List **THREE** properties of the dataset that make the test chosen in part (iii) appropriate.

_____

_____ (3)

v. To check for significant difference, the students use a table of critical values associated with the test mentioned in part (iii). How many degrees of freedom should they consider in their analysis?

_____ (1)

vi. Another method that can be used to measure the population size of the two species of beetle is the capture–release–recapture technique. Briefly explain how this method can be applied during this study.

_____

_____

_____

_____ (3)

vii. Which statistical index is used in the capture–release–recapture technique to estimate the population size?

_____ (1)

b. Afterwards, they investigated how the number of daisy plants changes along a 20 metre transect from the edge of the field towards its centre, into the open field. They recorded the number of daisies in 1 m^2 quadrats placed every 5 metres along the line transect.

Table 2: The number of daisies found in each quadrant analysed at various distances from the field's edge.

Distance from edge of field (m)	**Number of daisies (per m^2)**
0	1
5	2
10	6
15	8
20	8

i. Explain whether the sampling carried out during this second investigation is based on random or non-random sampling.

_____

_____ (2)

ii. Suggest how the students could modify the method to use a belt transect instead.

_____

_____ (1)

iii. Mention **TWO** advantages of using a belt transect over the method used here.

_____

_____ (2)

iv. Describe the pattern shown in Table 2.

_____

_____ (1)

v. Provide **ONE** reason that could lead to the pattern noted in Table 2.

_____

_____ (1)

(Total: 19 marks)

3. Wildlife biologists are investigating a litter of two wolf pups to determine which of two male wolves fathered the litter. Because the wolves are difficult to sample, the biologists collected a small fur sample and used PCR to amplify a short sequence of DNA. To compare the DNA profiles, they used the restriction enzyme EcoRI, which cuts the DNA at a specific base sequences.

Table 3: The band sizes detected on a gel for a five wolf specimens.

Wolf	**Band positions after EcoRI digest (mm from the well)**
Mother	5, 15, 40, 50
Pup 1	5, 50, 55
Pup 2	5, 50
Male A	15, 40, 55
Male B	5, 50, 55

a. Explain the role of PCR in helping the biologists in this case.

_____

_____

_____ (2)

Question continues on the next page.

b. Describe the role of a restriction enzyme, such as EcoRI, in creating a DNA profile.

_____

_____

_____ (2)

c. Outline how gel electrophoresis separates the DNA fragments produced by restriction enzymes.

_____

_____

_____

_____ (3)

d. Assuming that only one male fathered the litter, use the banding pattern (Table 3), to compare the DNA fragments and determine which male wolf is more likely to be the father of the pups. Justify your answer.

_____

_____

_____

_____ (3)

e. Explain **ONE** reason why the biologists might repeat this analysis using an additional restriction enzyme.

_____

_____

_____ (2)

f. Mention **TWO** advantages of using DNA profiling in wildlife conservation programmes.

_____

_____

_____ (2)

(Total: 14 marks)

Index No.:_____ AM05/IV.25s

L-Università ta' Malta

MATRICULATION AND SECONDARY EDUCATION CERTIFICATE EXAMINATIONS BOARD

ADVANCED MATRICULATION LEVEL
2025 SECOND SESSION

SUBJECT:	**Biology**
PAPER NUMBER:	IV – *Practical*
DATE:	28th August 2025
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**

© The MATSEC Examinations Board reserves all rights on the examination questions in all examination papers set by the said Board.

1. Figure 1 shows a labelled cross-section of a celery stalk (*Apium graveolens*).

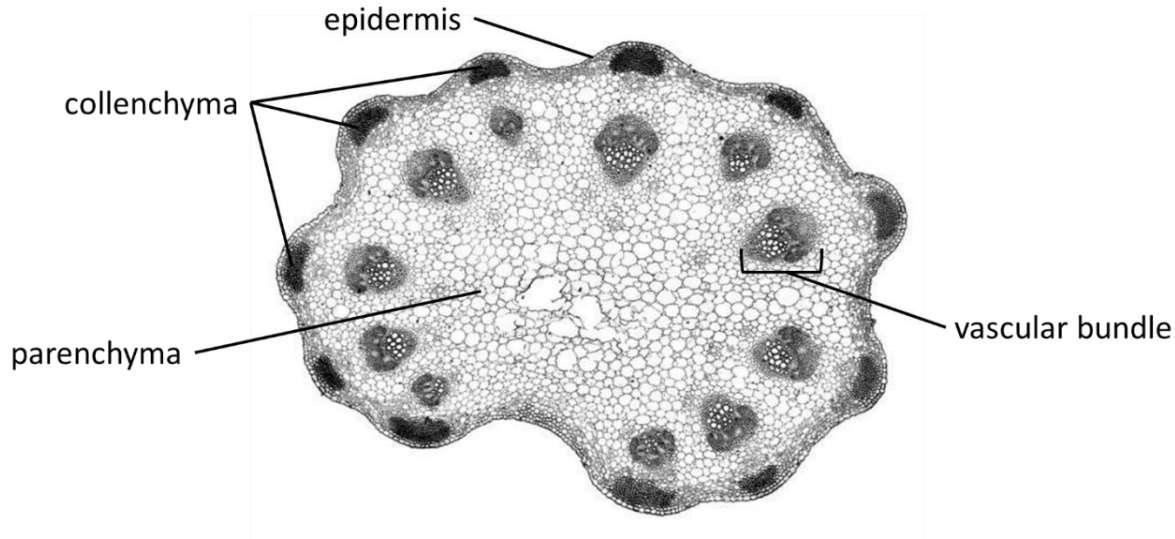


Figure 1: A labelled cross-section of celery stalk.
(Adapted from: https://www.istockphoto.com/)

Given the different cell types shown in Figure 1, when a celery stalk is bisected longitudinally as shown in Figure 2 and exposed to different salt concentrations, its cut ends bend. You are required to design and implement an experimental procedure to investigate how the dissected celery stalks respond to different sodium chloride concentrations.

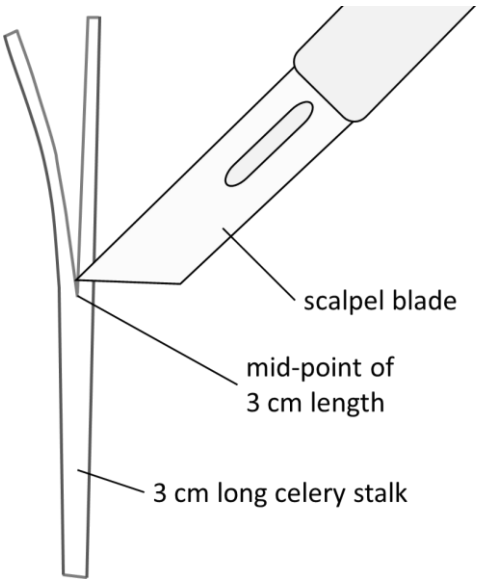


Figure 2: Method of longitudinally bisecting a celery stalk using a scalpel blade.

You are provided with the following materials:
- celery stalks (*Apium graveolens*);
- 0.8 M sodium chloride solution (labelled as NaCl solution);
- distilled water;
- petri dishes;
- other laboratory apparatus as required.

a. Before starting the investigation, you are required to prepare the following solutions. Complete the table below to show how the different solutions should be prepared. In each case, the total volume of each solution should be 40 mL. Then prepare the solutions as indicated and transfer them into the respective petri dishes.

Concentration of solution (M)	**Volume of 0.8 M sodium chloride solution (mL)**	**Volume of distilled water (mL)**	**Total volume (mL)**
0.8	40	0	40
0.6			40
0.4			40
0.2			40
0.0			40

(2)

b. Suggest a suitable null hypothesis for this investigation.

_____

_____ (1)

c. Using the materials provided, devise and describe an experimental procedure to investigate the effect of different sodium chloride concentrations on the bending of celery stalks.

It is recommended that for each test you:
- cut the celery stalks in 3 cm lengths;
- bisect 1.5 cm of the stalk length as indicated in Figure 2;
- stop the experiment after a maximum of 15 minutes;
- measure the distance between the cut ends of the stalk segments.

_____

_____

_____

_____

_____

_____

DO NOT WRITE ABOVE THIS LINE

(10)

d. List and justify **TWO** precautions that should be taken during the experiment.

Precaution 1: _____

_____

_____

_____ (2)

Precaution 2: _____

_____

_____

_____ (2)

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

Question continues on the next page.

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

(6)

f. On the graph paper provided on the following page, draw a graph to show the effect of different sodium chloride concentrations on the movement of the cut ends of the celery stalks. (6)

g. Describe the results obtained.

_____

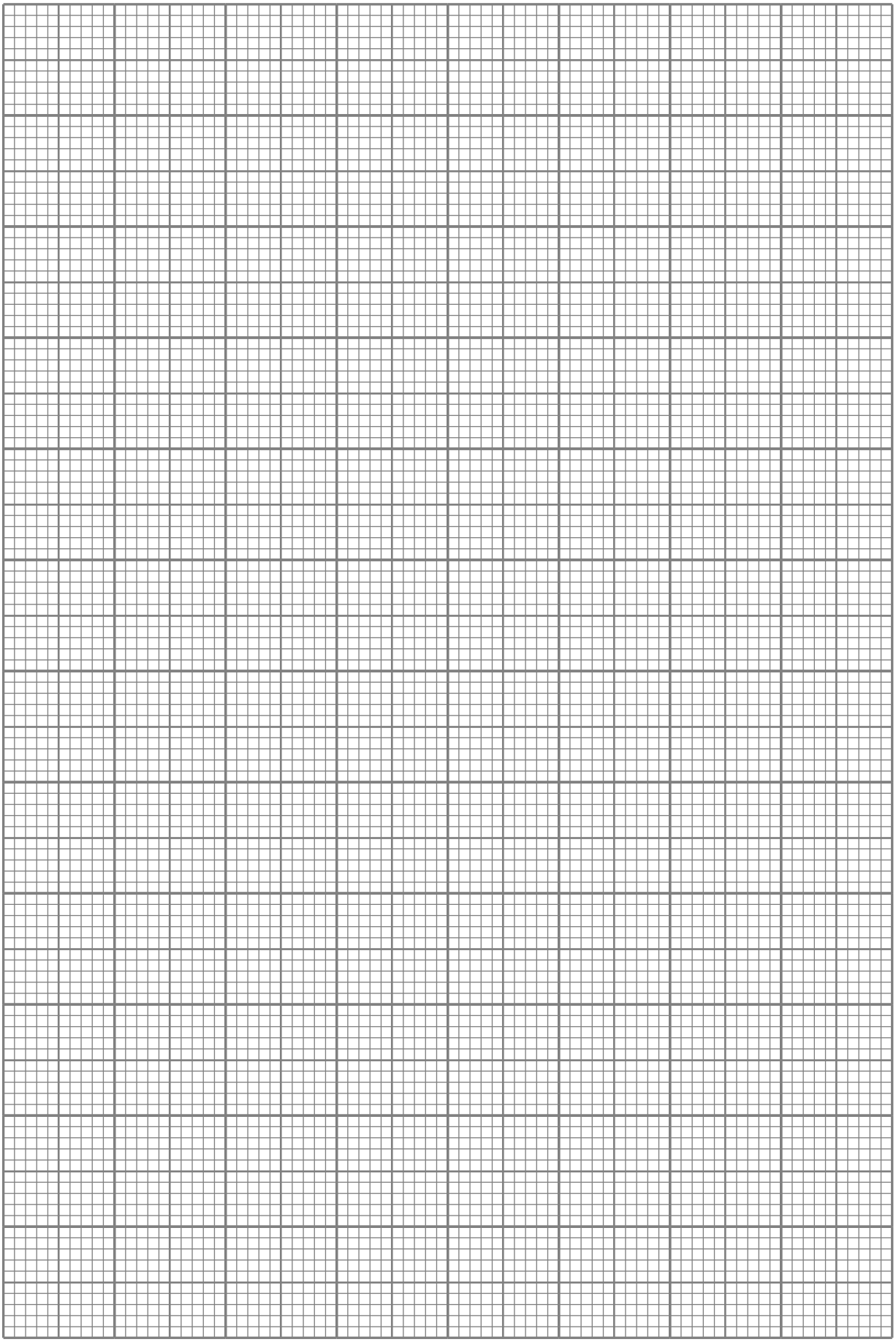
_____

_____

_____

_____

_____ (2)



Question continues on the next page.

h. Suggest an explanation for the observed responses of the cut ends of the celery stalks in different solutions tested.

_____

_____

_____

_____

_____

_____

_____

_____

_____ (4)

i. List **TWO** sources of error that may have occurred during your investigation.

Source of error 1: _____

_____

Source of error 2: _____

_____ (2)

j. A student repeated the experiment using stalk lengths that had not been cut longitudinally. Explain the differences that the student might observe compared to your results.

_____

_____

_____

_____

_____ (3)

(Total: 40 marks)