Index No.:_____ AM 05/I.21m

L-Università ta' Malta

MATRICULATION AND SECONDARY EDUCATION CERTIFICATE EXAMINATIONS BOARD

ADVANCED MATRICULATION LEVEL
2021 FIRST SESSION

SUBJECT:	**Biology**
PAPER NUMBER:	I
DATE:	4th June 2021
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	9	**Total**
Score										
Maximum	8	17	8	12	13	10	10	8	14	**100**

1. This question is about biochemistry.

   There are four levels of protein structures: primary, secondary, tertiary, and quaternary.

   a. Identify and explain the type of bonding that determines the secondary structure of a protein.

   _____

   _____

   _____

   _____ (2)

   b. List and define **THREE** types of bonding/interactions that are involved in determining the tertiary structure of a protein.

   _____

   _____

   _____

   _____

   _____

   _____

   _____

   _____

   _____ (6)

   (Total: 8 marks)

2. This question is about DNA replication.

   In 1957, Meselson and Stahl conducted an experiment to explain the model by which DNA replicates. The researchers took cultures of *Escherichia coli* containing only ^{15}N in their DNA and transferred this culture to a medium containing ^{14}N. Meselson and Stahl allowed the bacteria to divide and then collected some of the bacteria after each division and centrifuged the DNA. The outcome can be seen in Figure 1 (next page).

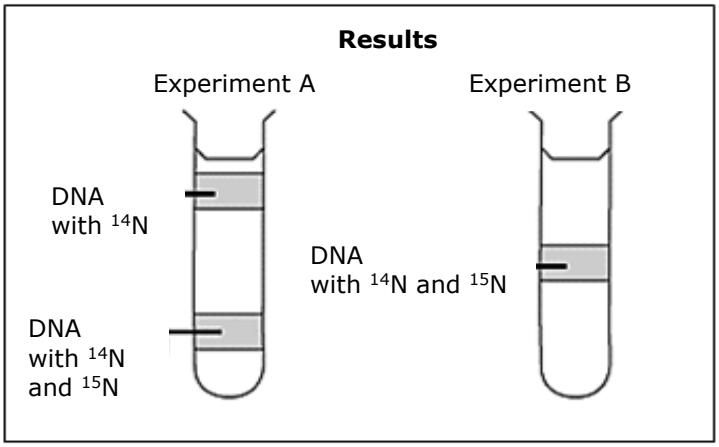


Figure 1: The centrifuged tubes after cell division.
(Adapted from: https://stanford.library.sydney.edu.au)

a. Which experiment (A or B in Figure 1) represents the results from the first generation? Explain your answer.

_____

_____

_____

_____ (3)

b. Which experiment (A or B in Figure 1) represents the results from the second generation? Explain your answer.

_____

_____

_____

_____ (3)

c. Describe what will happen to the DNA in subsequent generations.

_____

_____

_____

_____ (2)

Questions continue on next page

d. What is this type of DNA replication model called? Briefly explain the model.

_____

_____

_____

_____

_____

_____ (3)

e. **THREE** of the enzymes listed below have a role in DNA replication. Fill in Table 1 by identifying these enzymes and briefly explain the role that the respective enzyme plays in DNA replication.

Rubisco	RNA polymerase	Primase
DNA Polymerase I	Proteases	Helicase

Table 1: Enzymes and their role in DNA replication.

Enzyme	**Role in DNA replication**

(6)

(Total: 17 marks)

3. This question concerns the human nervous system.
   a. The nervous system can be divided into the central nervous system (CNS) and the peripheral nervous system (PNS). The CNS is made up of the brain and the spinal cord. Give the main function of the following structures within the brain:

      i. pons;

      _____(1)

      ii. thalamus;

      _____(1)

      iii. cerebellum;

      _____(1)

      iv. cerebral hemispheres.

      _____(1)

   b. The peripheral nervous system (PNS) can be divided into the somatic and the autonomic nervous system. The autonomic nervous system is then subdivided into the sympathetic and parasympathetic nervous systems.

      i. Give **TWO** similarities between the sympathetic and parasympathetic nervous systems.

      _____

      _____

      _____(2)

      ii. Give **TWO** differences between the sympathetic and parasympathetic nervous systems.

      _____

      _____

      _____(2)

(Total: 8 marks)

Questions continue on next page

4. This question concerns biotechnology.

a. Plasmids can be used as vectors to insert foreign DNA into bacteria.

i. Define plasmid.

_____(1)

ii. Define vector.

_____(1)

b. Different enzymes are used in the production of recombinant DNA.

i. Which enzyme is used in order to cut open the plasmid?

_____ (1)

ii. Cut plasmids and foreign DNA can join in the presence of the enzyme ligase. What features make them able to join?

_____

_____ (1)

iii. In the boxes provided below, draw **THREE** different structures that could form when the cut plasmids are incubated with the foreign DNA in the presence of the enzyme ligase.

(3)

c. Tetracycline and Ampicillin are two different antibiotics. Figure 2a shows a plasmid that contains two genes for antibiotic resistance. Figure 2b shows the same plasmid after being modified by inserting a gene from another organism.

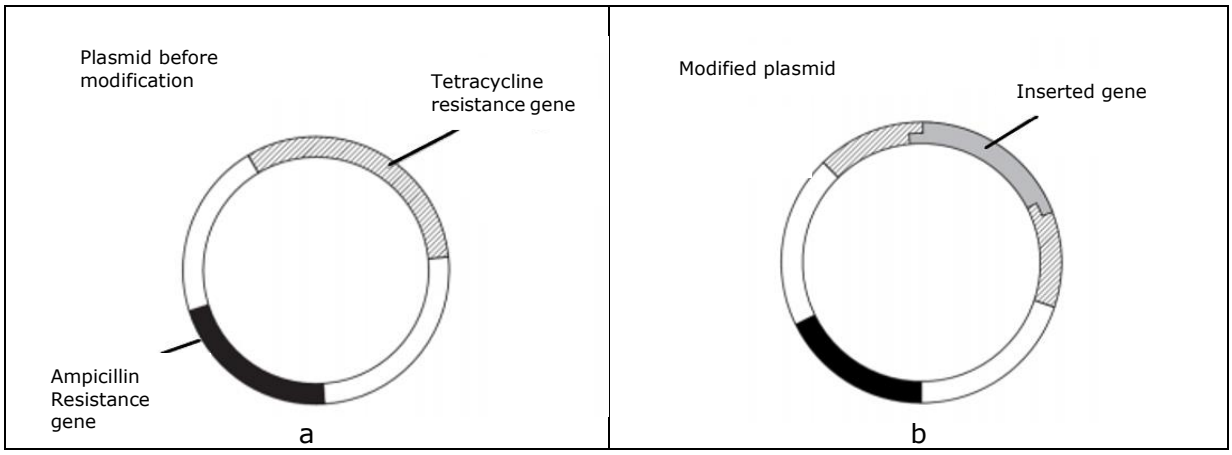


Figure 2a: Plasmid containing a gene for tetracycline resistance and a gene for ampicillin resistance.
Figure 2b: Same plasmid after being modified by inserting a gene from another organism.
(Adapted from https://chemstuff.files.wordpress.com)

Bacteria took up the modified plasmids. Explain why these bacteria were:

i. Resistant to ampicillin.

_____

_____ (2)

ii. Not resistant to tetracycline.

_____

_____ (2)

d. Mention **ONE** way of introducing the vectors into the host cell.

_____(1)

(Total: 12 marks)

Questions continue on next page

5. This question is about transport in animals.

Blood is said to be a good transporting medium whereby its constituents allow both energy and matter to be transported throughout the organism's pulmonary and systemic circuits.

a. Which component of blood allows for the transportation of nutrients and waste products? Give a reason for your answer.

_____

_____(2)

b. Erythrocytes are also a vital component of blood that are modified for effective transportation of oxygen. Explain why mature erythrocytes should be devoid of:

i. mitochondria:_____

_____(1)

ii. rough endoplasmic reticulum: _____

_____(1)

c. Briefly explain how erythropoietin helps in augmenting the transportation of oxygen.

_____

_____(2)

d. Pressure also serves an important role in the transportation of energy and matter. Explain why:

i. pressure in the pulmonary artery is much lower than that exhibited by the aorta;

_____

_____

_____(2)

ii. pressure in capillaries decreases from the arterial end to the venous end.

_____

_____

_____(2)

iii. most veins need to be in close proximity to skeletal muscles.

_____

_____

_____(2)

e. How can blood vessels regulate high blood pressure?

_____(1)

(Total: 13 marks)

6. This question is about the immune system.

Antibodies, also known as immunoglobulins (Ig), are glycoprotein molecules that are produced by plasma cells in order to trigger an immune response. Their intramolecular bonding allows for these molecules to carry out their function.

a. What type of protein structure is exemplified by immunoglobulins?

_____(1)

b. Under which type of immunity would the production of antibodies be classified under?

_____(1)

It is important to monitor antibody levels during pregnancy. The graph (Figure 3) demonstrates the onset of immunoglobulin production post a specific antigen exposure of a pregnant person.

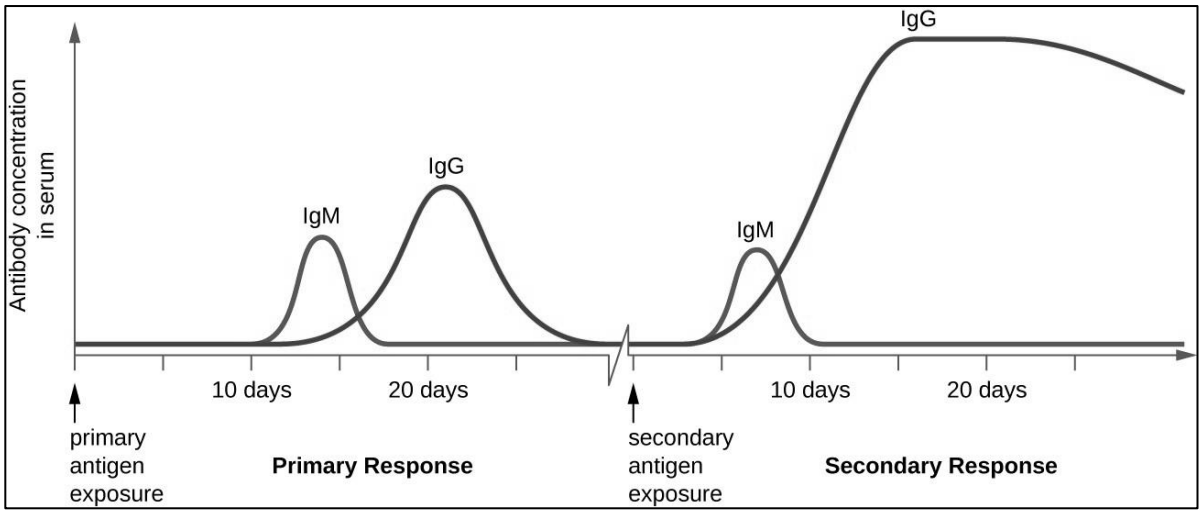


Figure 3: IgM and IgG concentration in the blood
(*Adapted from: https://courses.lumenlearning.com*)

Question continues on next page

c. Do both IgM and IgG serve the same function? Support your answer with evidence from the graph.

_____

_____

_____

_____(2)

d. What would happen to the duration of the response should the antigen in question changes its chemical structure and a third exposure is exhibited? Give a reason for your answer.

_____

_____

_____

_____(2)

e. Direct blood IgG transferred from the mother to foetus during gestation may be lethal. Briefly explain why this is so.

_____

_____

_____

_____(2)

f. List **TWO** methods how infants (aged 0-2 months) may attain antibodies.

_____

_____(2)

(Total: 10 marks)

7. This question is about reabsorption of biomolecules.

a. Blood filtration is one of the multiple homeostatic functions of the kidney. Table 2 below shows the relative concentration of plasma proteins, glucose and urea in different areas of the kidney's nephron.

Table 2: The relative concentration of plasma proteins, glucose and urea in different areas of the nephron

		Concentration in mg/100 ml					
		Blood in glomerulus	Glomerular Filtrate	Filtrate in descending limb	Filtrate in ascending limb	Urine with ADH	Urine without ADH
Biomolecule	Plasma proteins	750	0	0	0	0	0
	Glucose	515	100	100	100	100	100
	Urea	45	45	135	300	2400	240

i. Explain why there are no plasma proteins found within the glomerular filtrate.

_____

_____

_____(2)

ii. Explain why a concentration of 100 mg/ml glucose can still be found within the glomerular filtrate.

_____

_____

_____(2)

iii. How does the concentration of urea change from the filtrate within the descending limb to the ascending limb? Explain your answer.

_____

_____

_____(2)

iv. Explain how the concentration of urea is influenced by the presence of ADH.

_____

_____

_____(2)

Question continues on next page

b. From the information given in Table 2, determine whether the readings were attained from a healthy person or not. Provide a reason for your answer.

_____

_____

_____(2)

(Total: 10 marks)

8. This question is about environmental biology.

The graphs depicted in Table 3 show different types of interspecific interactions. Identify and explain **each** interaction in Table 3.

Table 3: Different types of interspecific interactions.

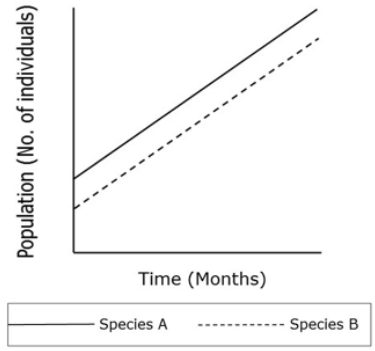
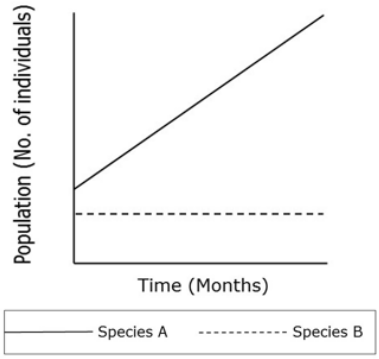
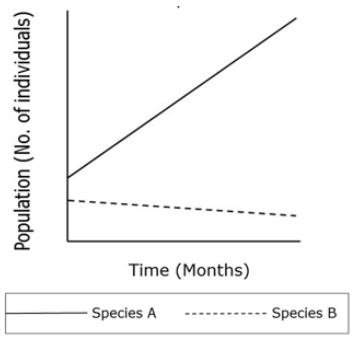
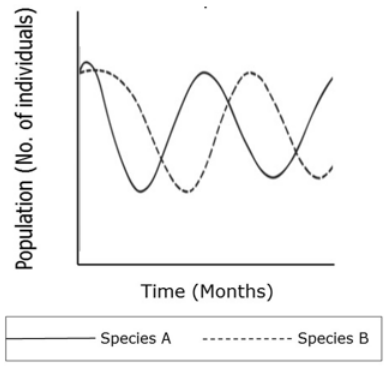
a.		Interaction: _____ Explanation: _____ _____ _____ _____ _____ (2)
b.		Interaction: _____ Explanation: _____ _____ _____ _____ _____ (2)

Table 3: Different types of interspecific interactions (Continued)

c.		Interaction: _____ Explanation: _____ _____ _____ _____ _____ (2)
d.		Interaction: _____ Explanation: _____ _____ _____ _____ _____ (2)

(Total: 8 marks)

9. This question is about evolution.

   a. Distinguish between **each** of the following pairs:
      i. Allopatric and sympatric speciation.

_____

_____

_____

_____(2)

Question continues on next page

ii. Prezygotic reproductive isolation and postzygotic reproductive isolation.

_____

_____

_____

_____(2)

b. Determine whether the following are examples of prezygotic reproductive isolation or postzygotic reproductive isolation:

i. In Britain, the common marbled carpet moth (*Dysstroma truncata*) mates at different times of the year to the closely related dark marbled carpet moth (*Dysstroma citrata*).

_____ (1)

ii. When different species of tobacco plant hybridise, the hybrids develop tumours in their vegetative parts and die before flowering occurs.

_____(1)

iii. The Field Pansy (*Viola arvensis*) grows on calcareous soils whereas the Wild Pansy (*Viola tricolor*) grows on acid soils.

_____(1)

iv. The male palps of spiders, which are used to insert sperm into the epigyne (female genital opening) are extremely complex in shape and can only fit the complex epigyne of the specific female by a 'lock and key' mechanism.

_____(1)

v. A horse and a zebra can interbreed to form a sterile zebroid.

_____(1)

c. In the Maltese islands, there are four races of the Maltese Wall lizard, *Podarcis filfolensis*. These races are distributed as follows:

- Race A is found on the islands of Malta, Gozo and Comino and is generally greenish and speckled.
- Race B is found on Filfla (an islet 4.5 km to the south of Malta) and is blackish with blue spots.
- Race C is found on Selmunett Islands (St. Paul's Islands) and its colour varies from brown to grey and has black spots.
- Race D is found on Fungus Rock (an islet in Dwejra, Gozo) and is reddish with blue flanks.

These races can still interbreed successfully.

i. Give and explain a mechanism how these different races may have arisen.

_____

_____

_____

_____(3)

ii. Explain why these four races of the Maltese wall lizard are considered to belong to the same species.

_____(1)

iii. What type of speciation would occur if in the future these races will eventually form distinct species?

_____(1)

(Total: 14 marks)

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L-Università ta' Malta

MATRICULATION AND SECONDARY EDUCATION CERTIFICATE EXAMINATIONS BOARD

ADVANCED MATRICULATION LEVEL
2021 FIRST SESSION

SUBJECT:	**Biology**
PAPER NUMBER:	II
DATE:	4th June 2021
TIME:	16:00 p.m. to 19:05 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.

SECTION A

1. Read carefully the following extract. Then 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.

A symbol of hope

The Atlantic Forest extends from the far north-east of Brazil to the south along the coast as far as north-east Argentina and into eastern Paraguay. The forest is characterised by being a tropical and subtropical moist, montane, and lowland forest. It is perhaps the most striking example of a biodiversity hotspot with very high biodiversity and endemism. However, today it is largely decimated, with less than 8% of its original forest remaining in thousands of fragments and patches. It once covered 1.5 million square kilometres.

Twenty-three primates are found there. All species, except three, are found nowhere else. Among these are species of lion tamarins (*Leontopithecus*), a genus of small monkeys endemic to the Atlantic Forest.

Lion tamarins belong to the family Callitrichidae, comprising in all 50 species of pygmy marmosets, Amazonian marmosets, a dwarf marmoset, Goeldi's monkey and the tamarins of Amazonia. They are all small diurnal insectivores (also eating small lizards and frogs on occasion).

In the early 1970s, Dr Adelmar F. Coimbra-Filho, a renowned Brazilian primatologist, estimated that the population of the golden lion tamarin (*Leontopithecus rosalia*) had fallen to fewer than 200-300, restricted to forests in the state of Rio de Janeiro. By 1974, after Coimbra-Filho alerted the Government and the international conservation community of the golden lion tamarins endangered status, his efforts resulted in the creation of the Poço das Antas Biological Reserve. By the 1980s conservation efforts for the golden lion tamarin and the other species known at the time – the golden-headed lion tamarin (*L. chrysomelas*) and the black lion tamarin (*L. chrysopygus*) – were also being guided by international committees.

In the early 2000s, it was revealed that a private collector had released a number of the Bahian golden-headed lion tamarins into a forest not far from Poço das Antas. As their numbers had increased rapidly there was considerable concern that *L. chrysomelas* would eventually hybridise with, or entirely replace, the nearby population of *L. rosalia*.

In 2014, a survey of the golden lion tamarins throughout their geographic distribution indicated a much larger population than had been expected: 3,706 individuals living in 414.11 square kilometres of forest, albeit not all connected and protected. However, there was a new hazard for the lion tamarins: the doubling in width of an interstate toll road that passed right by the Poço das Antas Biological Reserve, isolating the reserve from lion tamarins living just outside its boundary. After seven years (2011-2018) of negotiations with the Rio de Janeiro state environmental and development agencies, a mandatory condition was established that a wildlife bridge must be included in the planning applications.

In 2018, there was another major setback to the conservation programme when a yellow-fever epidemic that started in south-east Brazil reached the golden lion tamarins. It reduced the wild population of *L. rosalia* by 32% to an estimated 2,516 individuals. Fortunately, there is now such

a strong population of golden lion tamarins in Brazil and around the world that they could once again be reintroduced if populations disappear or drop to critically low numbers in the wild.

(Adapted from Mallinson, J. (2020). A symbol of hope. The Biologist*, 67(6), pp.22-25)*

a. The Atlantic forest has been described as a biodiversity hotspot (line 4). Define biodiversity and list the **THREE** levels in which it can be expressed. (2)

b. Endemism (line 4) is when a species is restricted to a limited geographical area. Mention **ONE** feature of the Atlantic forest that would promote endemism. (1)

c. Explain the term population (line 14). Use **ONE** example from the extract to sustain your answer. (2)

d. Define and briefly explain how the following factors can affect the population size of the lion tamarins:
   i. natality and mortality: (2)
   ii. immigration and emigration: (2)

e. i. Compare density-dependent and density-independent factors that can affect the population of *Leontopithecus rosalia*. (2)

   ii. Is the yellow-fever epidemic outbreak of 2018, density-dependent or density-independent? (1)

   iii. List **ONE** density-dependent and **ONE** density-independent factor. Your answer should **not** include the example given in part (ii) and not necessarily from the text. (2)

f. Identify and explain **ONE** interspecific interaction indicated in line 12. (2)

g. The extract states that "there was a new hazard for the lion tamarins: the doubling in width of an interstate toll road that passed right by the Poço das Antas Biological Reserve" (line 27-29). Give and explain **TWO** intraspecific problems that this hazard causes to the population of golden lion tamarins. (4)

h. Explain in detail how the release of the Bahian golden-headed lion tamarins *(L. chrysomelas)* into a forest not far from Poço das Antas (lines 21-22) could affect the population of the golden lion tamarin (*L. rosalia*). (2)

i. Golden lion tamarins can be "reintroduced if populations disappear or drop to critically low numbers in the wild" (line 37). Given that this population can be introduced in a new environment where resources can be limited, sketch the growth curve that the "reintroduced" population can depict. Label the **FOUR** different stages typical of this graph. (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. The liver is often described as an organ of homeostasis. Discuss the function of the liver in relation to the: a) metabolism of carbohydrates; b) metabolism of protein and c) metabolism of fat.

2. Compare and contrast the processes of respiration and photosynthesis.

3. One of the major problems that organisms had to overcome in the gradual adaptation to life on land involved reproduction. Discuss this statement by providing an overview of sexual reproduction and strategies used for gamete transfer and fertilisation in animals.

4. Give a detailed account on how gene sequences are expressed.

(Total: 50 marks)

SECTION C
Answer ONE question from this section.

1. Write brief notes on the evolutionary significance of the following:
   a. cleidoic egg; (5)

   b. endosymbiotic origin of plastids and mitochondria; (5)

   c. metameric segmentation; (5)

   d. the pentadactyl tetrapod limb; (5)

   e. compartmentalisation in eukaryotic cells. (5)

OR

2. Use your knowledge of Biology to explain the following statements:
   a. Not all feedback mechanisms act to counter the stimulus that instigates them. (5)

   b. Both allele and genotype frequencies may be disrupted by various factors. (5)

   c. Homosporous plants have a slightly altered life cycle than heterosporous plants. (5)

   d. Proteins embedded within cell membranes influence the membrane's degree of permeability. (5)

   e. Both strength and flexibility are variables that make for good support structures in animals and plants. (5)

(Total: 25 marks)

Index No.:_____ AM 05/III.21m

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MATRICULATION AND SECONDARY EDUCATION CERTIFICATE EXAMINATIONS BOARD

ADVANCED MATRICULATION LEVEL
2021 FIRST SESSION

SUBJECT:	**Biology**
PAPER NUMBER:	III
DATE:	8th June 2021
TIME:	9:00 a.m. to 12:05 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	1	**Total**
Score					
Maximum	12	20	18	40	**90**

Section A: Answer all questions.

1. This question is about classification of living organisms.

   a. All the organisms shown in Figures 1 to 6 belong to the same class. Identify the phylum and class to which they belong.

   Phylum: _____(1)

   Class: _____(1)

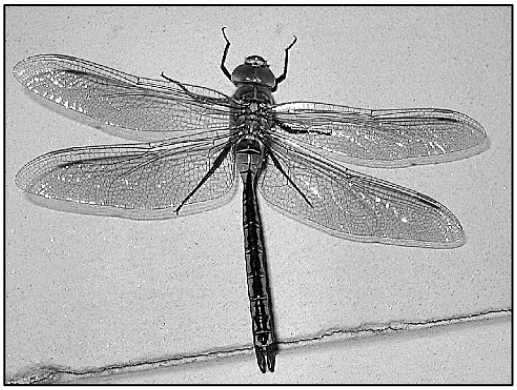

Figure 1: Organism A
(Source: https://tinyurl.com/hbbc9yj7)

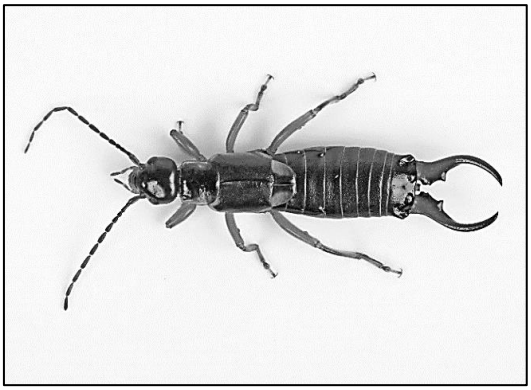

Figure 2: Organism B
(Source: https://knockoutpest.com)

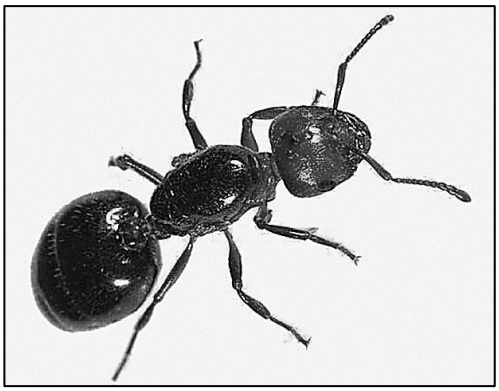

Figure 3: Organism C
(Source:https://www.larcadinoe.com)

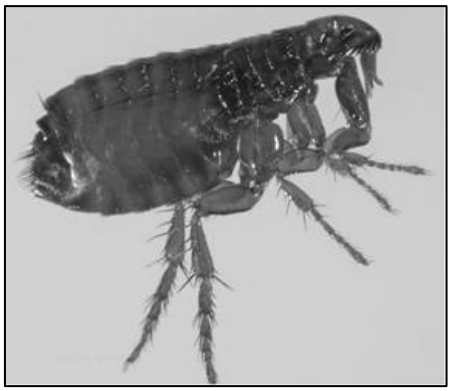

Figure 4: Organism D
(Source: https://bugguide.net)

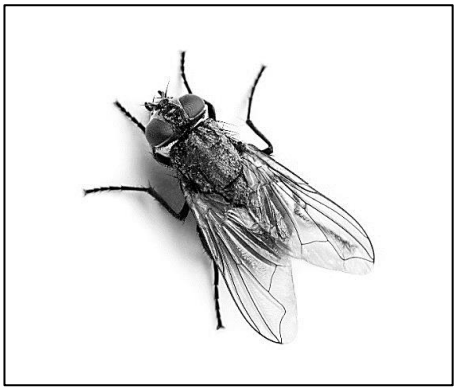

Figure 5: Organism E
(Source: https://www.pestworld.org/)

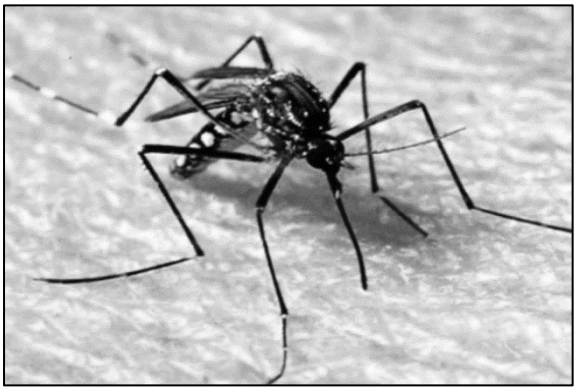

Figure 6 : Organism F
(Source: https://www.abc.net.au)

b. Use visible morphological features to construct a dichotomous key that may be used to identify amongst the six organisms shown in Figures 1 to 6.

(10)

(Total: 12 marks)

Questions continue on next page

2. This question is about transpiration in plants.

Figure 7 shows the setup used in order to measure the rate of transpiration in plants.

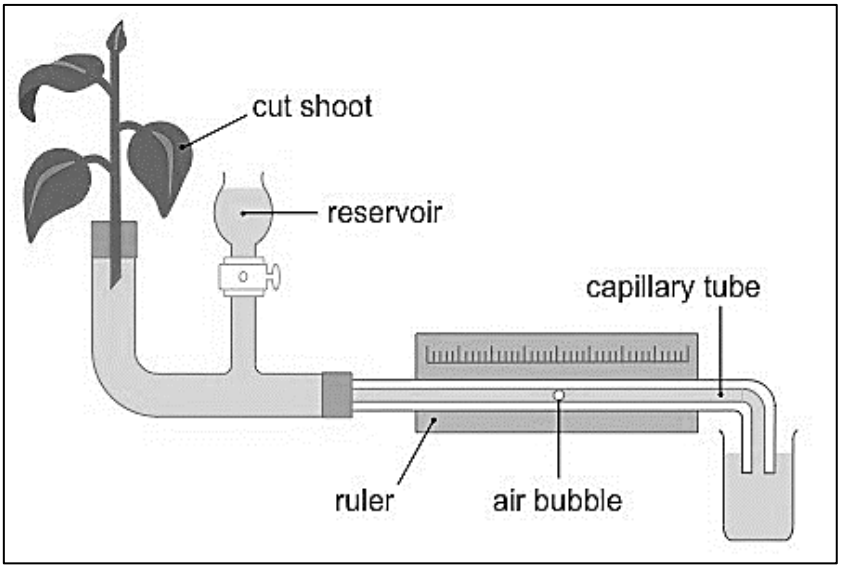

Figure 7: Setup used in order to study the rate of transpiration in plants.
(Source: https://ib.bioninja.com.au/)

a. What is the name of the apparatus shown in Figure 7?

_____ (1)

b. Explain in detail how the device shown in Figure 7 is used to study the rate of transpiration in plants.

_____

_____

_____

_____

_____

_____(3)

c. A Biology student carried out an experiment using the setup depicted in Figure 7. The same shoot was used throughout the investigation and temperature and light intensity were kept constant. The results of his experiment are shown in Figure 8 (next page).

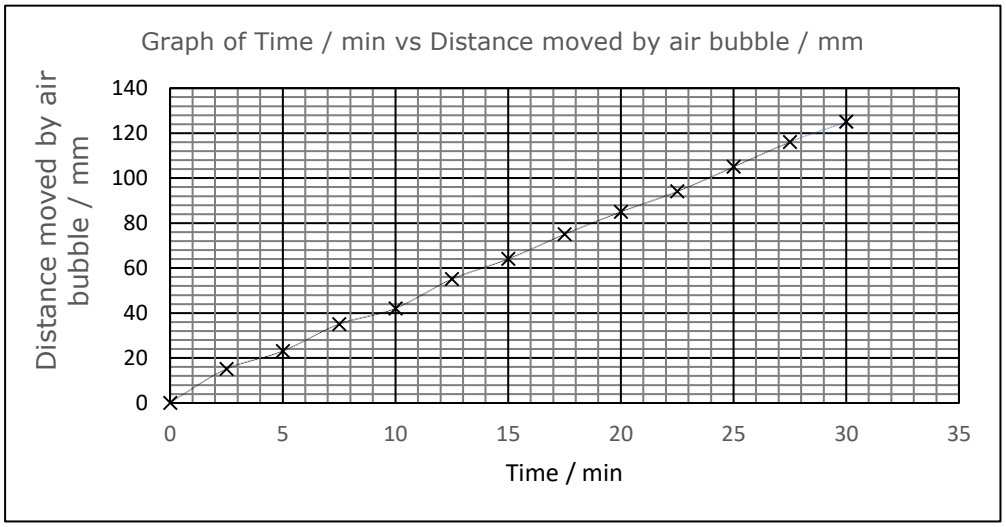

Figure 8: Graph showing the results obtained when the student carried out the experiment

The cross-sectional area of the bore of the capillary tube is 0.8 mm^2. Use the graph in Figure 8 to calculate the rate of water uptake by the shoot during the experiment. Show your working.

_____

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_____

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_____(3)

d. The student then wanted to investigate whether the rate of transpiration varies with light intensity. This was done by placing the plant shoot at varying distances from a lamp. How will the rate of transpiration change with distance? Explain your answer.

_____

_____

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_____

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_____(3)

Question continues on next page

e. In another investigation, the student encased the plant shoot in a transparent plastic bag and observed changes, if any, to the rate of transpiration.

i. Which factor or variable is the student introducing?

_____ (1)

ii. How would this set-up affect the rate of transpiration by the shoot? Explain your answer.

_____

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_____

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_____(3)

f. i. Wind is another variable known to affect the rate of transpiration in plants. Explain.

_____

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_____(2)

ii. How can the set-up of this experiment be changed in order to test for the effect of wind on transpiration?

_____ (1)

g. Finally, the student changed the set-up of the experiment again by coating the leaves of the plant shoot with vaseline. Would the rate of transpiration increase, decrease or remain unchanged? Explain your answer.

_____

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_____

_____ (3)

(Total: 20 marks)

3. This question is about animal histology.

   a. Figure 9 shows a transverse section of a type of epithelial tissue as seen under the microscope.

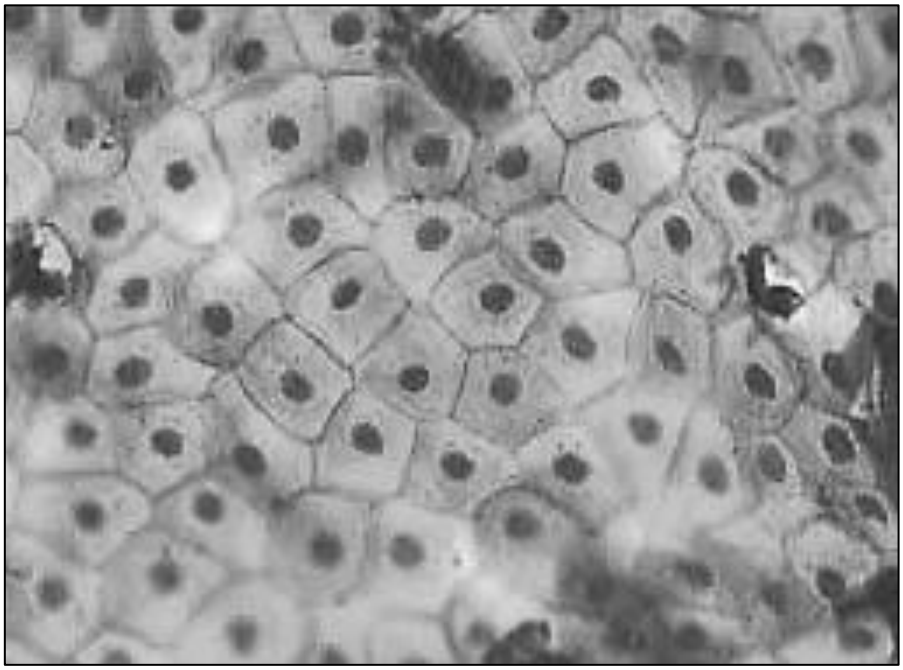

Figure. 9: A transverse section of a type of epithelial tissue (Magn. X400).
(Source: https://i.pinimg.com/originals)

   a. i. Identify the type of epithelial cells shown in Figure 9.

_____(1)

   ii. These cells occur in areas such as the alveoli of the lungs and the blood capillary walls. Explain this in terms of the shape of these cells in relation to their function.

_____

_____

_____

_____(2)

Question continues on next page

b. Figure 10 shows a transverse section through simple columnar epithelial cells that line the ileum of the small intestines.

Figure. 10: Transverse section through simple columnar epithelial cells lining the ileum of the small intestines (Magn. X400).
(Source: http://apsubiology.org/anatomy)

i. In the space provided on the next page, draw high power details of the section shown in Figure 10. Label your diagram. (4)

ii. With reference to **TWO** structural modifications of these epithelial cells, describe the main function of these cells in the small intestines.

_____

_____

_____

_____ (2)

Question continues on next page

c. Figure 11, below, shows a transverse section through a type of specialised epithelial cells.

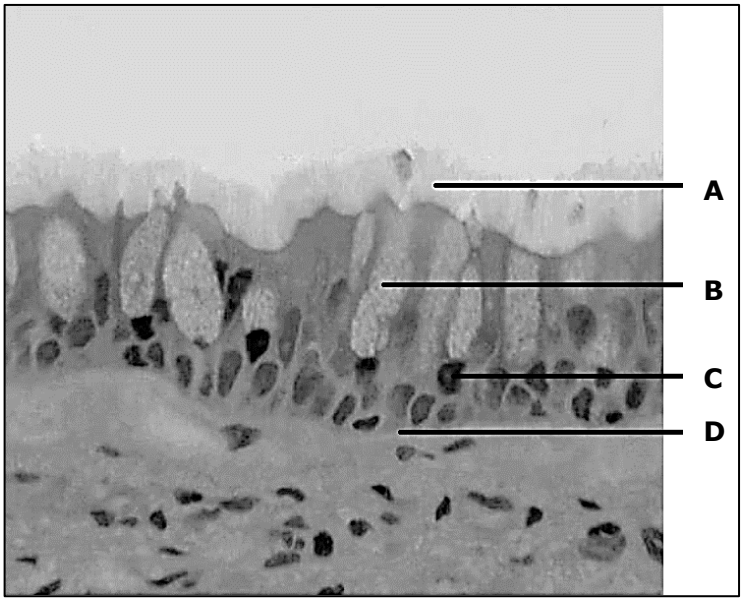

Fig. 11: Transverse section through a type of specialized epithelial cells (Magn. X400)
(Source: http://www.doctorc.net)

i. Which type of cells make up the epithelial tissue shown in Figure 11?

_____ (1)

ii. Identify structures A to D (Figure 11).

A: _____(1)

B: _____(1)

C: _____(1)

D: _____(1)

iii. The epithelial cells shown in Figure 11 line the respiratory passages such as the trachea and nasal cavity. Explain how structures A and B identified in part c (ii) enable these cells to carry out their functions in the nasal cavity.

_____

_____

_____

_____ (2)

iv. The epithelial tissue shown in Figure 11 is categorised as pseudostratified. Explain this term.

_____

_____

_____

_____ (2)

(Total: 18 marks)

Section B: Answer all parts to this question.

1. Trypsin is a protease enzyme which hydrolyses proteins into peptides. Casein is a protein found in milk that is broken down by trypsin. When casein is broken down, the opaque white colour of the milk is replaced by a clear solution.

   You are required to devise an experiment to determine the effect of temperature on the rate of reaction of the enzyme trypsin.

   You are provided with the following materials:

   - 0.5% trypsin solution;
   - 3% skimmed milk powder solution;
   - pH 8 buffer;
   - pipettes;
   - large test-tubes;
   - water-baths that can be set up at different temperatures;
   - other laboratory apparatus as required.

   Important note:

   In your design, it is advised to use the following volumes:

   - 10 cm^3 milk solution;
   - 2 cm^3 trypsin solution;
   - 2 cm^3 pH 8 buffer solution.

   a. State the aim of your biological investigation.

   _____

   _____

   _____ (1)

Question continues on next page

b. Suggest suitable null and alternative hypotheses for this investigation.

_____

_____

_____

_____ (2)

c. List and justify **TWO** precautions that should be taken.

_____

_____

_____

_____

_____

_____ (4)

d. Why is it important to use the pH buffer provided?

_____(1)

e. Using the material provided, devise and describe an experimental procedure that may be used in order to investigate the effect of temperature on the rate of trypsin activity.

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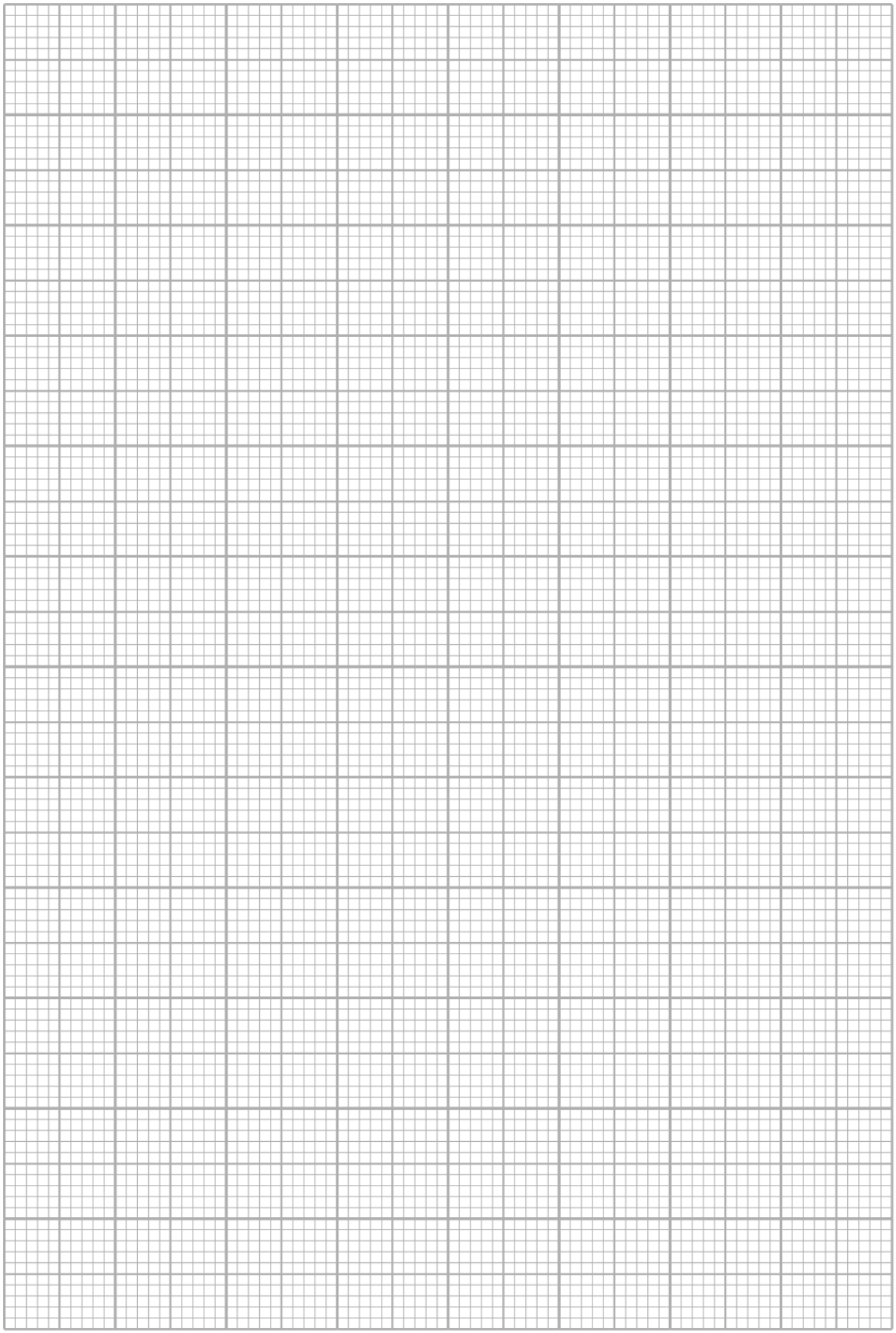
(10)

Question continues on next page

f. The results obtained in an experiment showing the time taken for trypsin to break down casein are shown in Table 1. Complete the table by filling in the average time taken and the rate of reaction. (6)

Temperature (°C)	**Time 1 (s)**	**Time 2 (s)**	**Time 3 (s)**	**Average time (s)**	**Rate of reaction (s^{-1})**
20	250	246	255		
30	123	128	127		
40	67	59	64		
50	127	122	128		
60	263	267	258		
70	416	423	413		

g. Use the graph paper (next page) to draw a graph of rate of reaction against temperature. (6)



Question continues on next page

h. Briefly describe any trend that emerges from your graph.

(3)

i. Use your biological knowledge to give a detailed explanation of your results.

(5)

j. List **TWO** sources of error in your investigation.

(2)

(Total: 40 marks)