



SUBJECT: **Biology**  
 PAPER NUMBER: I  
 DATE: 29<sup>th</sup> August 2024  
 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	13	11	16	11	14	13	12	10	<b>100</b>

1. This question is about cell structure and function.

a. List **TWO** features that prokaryotic and eukaryotic cells have in common.

\_\_\_\_\_ (1)

b. Describe **TWO** features that are different in prokaryotic and eukaryotic cells.

Feature 1: \_\_\_\_\_

\_\_\_\_\_

Feature 2: \_\_\_\_\_

\_\_\_\_\_ (2)

c. Figure 1 shows a part of a eukaryotic cell membrane.

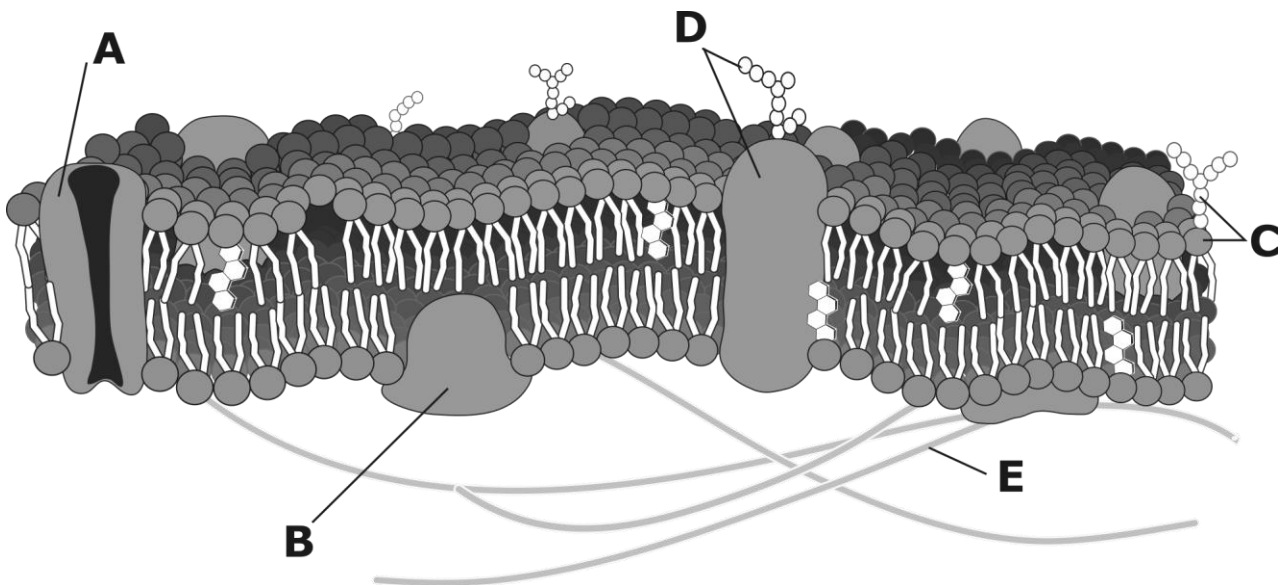


Figure 1: The eukaryotic cell membrane  
(Adapted from: <https://commons.wikimedia.org/>)

DO NOT WRITE ABOVE THIS LINE

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- i. The molecules labelled A and B are both membrane proteins. Identify these **TWO** membrane proteins and briefly state how they are functionally different.

Molecule A: \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

Molecule B: \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_ (4)

- ii. The molecules labelled C and D have carbohydrate chains. Identify these molecules and briefly state how their structures are different from each other.

Molecule C: \_\_\_\_\_  
\_\_\_\_\_

Molecule D: \_\_\_\_\_  
\_\_\_\_\_ (2)

- iii. Give **ONE** function for the structure labelled D.

\_\_\_\_\_  
\_\_\_\_\_ (1)

- iv. The filaments labelled E represent part of the cytoskeleton. Briefly describe its function.

\_\_\_\_\_  
\_\_\_\_\_ (1)

- d. In the space provided below, sketch a phospholipid molecule and indicate which end is hydrophobic and which end is hydrophilic.

(2)

**(Total: 13 marks)**

***Please turn the page.***

2. This question is about biomolecules.

a. Lipids may be composed of three fatty acid chains bonded to a glycerol molecule.

i. What type of lipid is formed from three fatty acid chains bonded to a glycerol molecule?

\_\_\_\_\_ (1)

ii. Name the type of reaction that combines the three fatty acids to the glycerol molecule to form the type of lipid mentioned in part (i).

\_\_\_\_\_ (1)

iii. What is the main role of these lipids in the human body?

\_\_\_\_\_ (1)

b. Lipids may be composed of carbon rings. List **TWO** such lipids and name **ONE** function for each.

Example 1: \_\_\_\_\_

\_\_\_\_\_

Example 2: \_\_\_\_\_

\_\_\_\_\_ (3)

c. Nucleotides are the building blocks of polynucleotides, such as DNA and RNA.

i. Name the bond that forms between nucleotides to create a polynucleotide.

\_\_\_\_\_ (1)

ii. Explain the significance of hydrogen bonding in DNA structure.

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_ (2)

iii. Describe **TWO** structural differences between mRNA and DNA.

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_ (2)

**(Total: 11 marks)**

3. This question is about transport in mammals.

Mammalian transport systems are adapted to alter the pressure exerted on the transporting medium. The graph below shows the pressure exhibited in a double circulatory system.

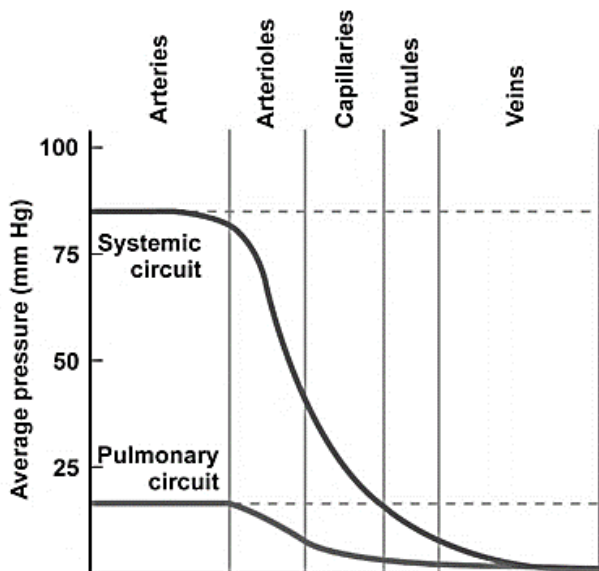


Figure 2: Graph showing different pressures in the mammalian circulatory system  
(Adapted from: <https://quizlet.com>)

a. By using information from the graph (Figure 2), briefly explain the following observations:

i. The pressure in the systemic circuit is higher than the pressure in the pulmonary circuit.

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(2)

ii. Arterial pressure in both systems is higher than venous pressure.

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(2)

iii. Arterioles exhibit the highest pressure loss.

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(2)

**Question continues on the next page.**

b. Based on your knowledge of the human circulatory system, identify the blood vessels that exhibit the following properties, and in each case, provide an explanation for your answer.

i. Exhibits the slowest blood flow.

Vessel/s: \_\_\_\_\_

Explanation: \_\_\_\_\_

\_\_\_\_\_ (2)

ii. Have muscular elastic walls.

Vessel/s: \_\_\_\_\_

Explanation: \_\_\_\_\_

\_\_\_\_\_ (2)

iii. Have valves that prevent the backflow of blood.

Vessel/s: \_\_\_\_\_

Explanation: \_\_\_\_\_

\_\_\_\_\_ (2)

iv. Supply the heart with oxygen and nutrients.

Vessel/s: \_\_\_\_\_

Explanation: \_\_\_\_\_

\_\_\_\_\_ (2)

v. Are made only of simple squamous epithelial cells.

Vessel/s: \_\_\_\_\_

Explanation: \_\_\_\_\_

\_\_\_\_\_ (2)

**(Total: 16 marks)**

4. This question is about the autonomic nervous system in humans.

a. Define what is meant by the term 'autonomic nervous system'.

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(2)

b. The autonomic nervous system is divided into the sympathetic and parasympathetic nervous systems. Briefly describe the key differences between the sympathetic and parasympathetic nervous systems in terms of their function in the body.

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(2)

c. List **TWO** responses controlled by the sympathetic nervous system.

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(2)

d. List **TWO** responses controlled by the parasympathetic nervous system.

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(2)

e. Suggest why the development of an autonomic nervous system is considered an evolutionary advantage for organisms.

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(3)

**(Total: 11 marks)**

***Please turn the page.***

5. This question is about photosynthesis.

- a. Photosynthetic prokaryotes may have different photosynthetic pigments. Two such examples include cyanobacteria, which carry chlorophyll a, and *Halobacterium*, which carries bacteriorhodopsin.

Figure 3 depicts the absorption spectra of these two photosynthetic pigments, chlorophyll a and bacteriorhodopsin.

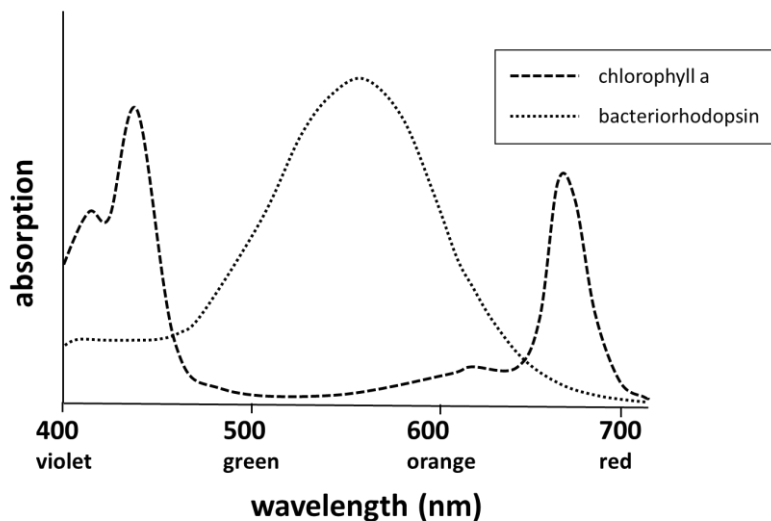


Figure 3: The graph represents the absorption spectrum of chlorophyll a and the absorption spectrum of bacteriorhodopsin. On the x-axis, the graph includes the colour associated with the indicated wavelengths. (Adapted from: <http://hyperphysics.phy-astr.gsu.edu>)

- i. What are the main differences in the absorption spectra of chlorophyll a and bacteriorhodopsin as depicted in Figure 3?

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(2)

- ii. Suggest how the presence of different photosynthetic pigments affects the visible colour of cyanobacteria and *Halobacterium*.

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(2)



b. Plants typically have multiple photosynthetic pigments, including chlorophylls, and accessory pigments such as carotenoids.

i. Describe **TWO** functions of accessory pigments in plants.

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_ (2)

ii. Suggest why carotenoids are usually masked by the green chlorophylls but become visible in leaves before the leaves fall.

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_ (2)

c. Fill in Table 1 by indicating whether the characteristic is associated with cyclic phosphorylation or non-cyclic phosphorylation or both (use ✓ to mark the positive occurrences).

Table 1: Comparison between cyclic and non-cyclic phosphorylation.

Characteristic	Cyclic phosphorylation	Non-cyclic phosphorylation
Both Photosystem I and II are involved.		
Reaction centre is P680.		
Electrons released are cycled back.		
Photolysis of water takes place.		
Only ATP is synthesised.		
Does not require an external electron donor.		

(3)

**Question continues on the next page.**

d. Briefly explain the importance of Photosystem I and Photosystem II in the light-dependent reactions of photosynthesis.

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(3)

**(Total: 14 marks)**

6. This question is about gamete formation in humans.

The diagram below shows a cross-section of a structure that forms part of the male reproductive system.

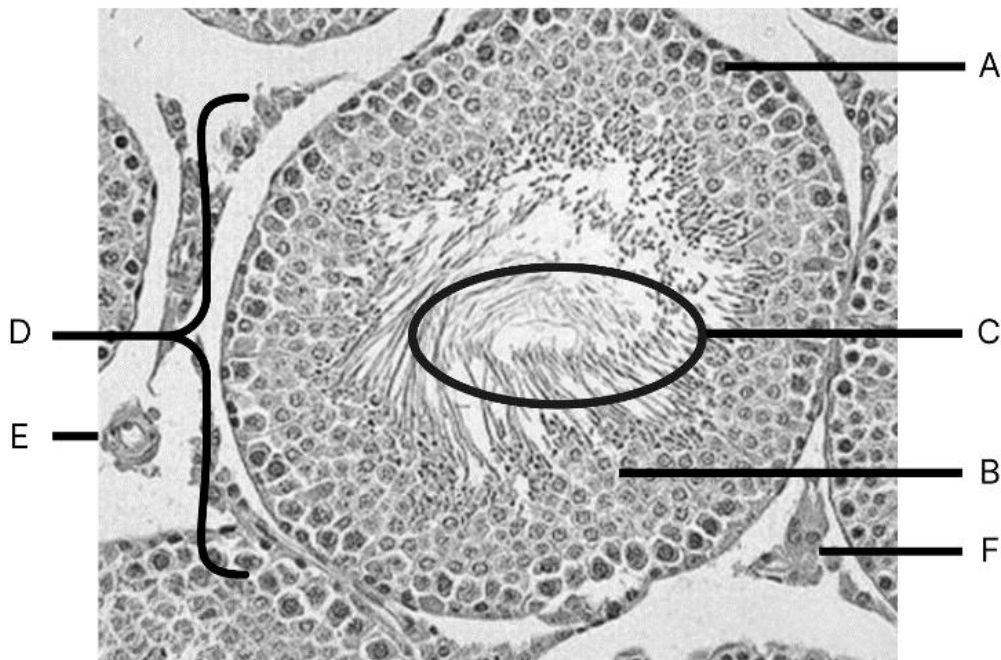


Figure 4: A cross-section from a human reproductive organ.  
(Adapted from: <https://quizlet.com>)

a. Identify where the structure shown in Figure 4 would be found in the male human body.

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(1)

b. Provide a label for structure D.

\_\_\_\_\_ (1)

c. Provide a label for the following cell types, and in each case indicate whether the labelled cells are haploid or diploid.

Label	Cell types	Haploid or Diploid cells
A		
B		
C		
F	Leydig cells	

(5)

d. List **TWO** changes that cells undergo as they develop from cell B to cell C.

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_ (2)

e. Explain the role of cells F in the development of cells C.

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_ (2)

f. Structure E is a capillary. How may the reproductive process be affected should structure E become blocked?

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_ (2)

**(Total: 13 marks)**

***Please turn the page.***

7. This question is about the immune system in humans. Determine whether the following underlined key terms are correctly or incorrectly used in each statement. In the space provided, give a reason for your answer.

a. Antibodies are chemicals that the body recognises as foreign and therefore stimulate an immune response.

Correct or Incorrect: \_\_\_\_\_

Reason: \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_ (2)

b. An example of an adaptive defence mechanism that utilises antibodies is cell-mediated response.

Correct or Incorrect: \_\_\_\_\_

Reason: \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_ (2)

c. Histamine aids in immune responses by inducing vasodilation.

Correct or Incorrect: \_\_\_\_\_

Reason: \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_ (2)

d. Administering live-attenuated vaccine particles to patients is a form of active immunity.

Correct or Incorrect: \_\_\_\_\_

Reason: \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_ (2)

e. Juvenile diabetes is an acquired autoimmune disease.

Correct or Incorrect: \_\_\_\_\_

Reason: \_\_\_\_\_

\_\_\_\_\_  
\_\_\_\_\_ (2)

f. Fibrin needs to be soluble to function effectively.

Correct or Incorrect: \_\_\_\_\_

Reason: \_\_\_\_\_

\_\_\_\_\_  
\_\_\_\_\_ (2)

**(Total: 12 marks)**

8. This question is about the evolutionary significance of certain structures or body plans.

a. Explain the evolutionary significance of the pentadactyl limb in tetrapods.

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_ (3)

b. Explain the evolutionary significance of triploblastic organisation in animals.

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_ (4)

**Question continues on the next page.**

c. Explain the evolutionary significance of jointed appendages in arthropods.

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(3)

**(Total: 10 marks)**

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SUBJECT:	<b>Biology</b>
PAPER NUMBER:	II
DATE:	30 <sup>th</sup> August 2024
TIME:	9:00 a.m. to 12:05 p.m.

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### **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.
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**SECTION A**

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

**How long do new species take to evolve?**

Charles Darwin was amazed by the vast diversity of life forms that evolution has produced on Earth. But how long does it take for species to evolve? The answer is as varied as the organisms themselves and depends on factors such as reproductive rates and environments, with evolutionary timescales ranging from a few years to tens of millions of years.

- 5 One crucial aspect influencing the rate of evolution is the speed at which organisms reproduce, known as generation time. For instance, bacteria, can evolve into new varieties within years or even days. A study noted that a lineage of *E. coli* evolved the ability to use citrate as a food source within a few years, potentially marking the onset of a new species.

- 10 Plants can undergo polyploidy, resulting in the creation of an entirely new species in just one generation. Additionally, many plants can self-fertilise thus facilitating the establishment of a new polyploid species within the parent population.

- 15 Insects with short generation times show how speciation can occur within human-observable timescales. Apple maggot flies, historically feeding on hawthorn fruit, shifted to domesticated apples in the mid-1800s. Over time, these groups became reproductively isolated, marking the first steps toward speciation, a process driven by the fact that apples ripen in summer, while hawthorns ripen late summer to early fall.

- 20 Vertebrates generally undergo speciation more slowly, but instances such as a Galapagos finch producing a new lineage within a few generations showcase the potential for rapid evolutionary change. Similarly, cichlid fishes in Africa's Lake Victoria explosively diversified into 300 species from a single ancestor within just 12000 years.

However, speciation can also take vast stretches of time, especially when geographical barriers come into play. For instance, in snakes, the divergence of boas and pythons following the separation of South America from Africa likely took tens of millions to 100 million years.

- 25 Estimating the average time for speciation is challenging, but research suggests it generally spans millions of years, with some models proposing around 2 million years, with environmental pressures and reproductive isolation being key drivers. In summary, evolutionary timescales are diverse and dependent on many factors, highlight life's remarkable adaptability and resilience.

*(Adapted from an article published on LiveScience by Michael Dhar on September 17<sup>th</sup>, 2022  
<https://www.livescience.com/how-long-new-species-take-to-evolve>)*

- a. Charles Darwin was amazed by the vast diversity of life forms that evolution has produced on Earth (line 1 – 2). These life forms are what we now refer to as species. Define the term 'species'. (2)
- b. In the article, it is suggested that the speciation in bacteria can occur in a matter of years or even days (line 6 – 7). Using concepts mentioned in abstract, provide a brief explanation to this observation. (2)
- c. List **TWO** other taxonomic groups where speciation may occur at a similar rate as that noted in bacteria. (2)
- d. Speciation is influenced by mutations. Briefly explain the importance of mutations in the speciation process. (3)
- e. Define 'polyploidy' (line 9). (1)
- f. A polyploid organism is isolated from the parent population even though they may occur in the same environment. Name the type of isolating mechanism and type of speciation noted in such instances. (2)
- g. Explain why self-fertilisation (line 10) is necessary for the creation of a new species through polyploidy. (2)
- h. Explain **ONE** potential evolutionary disadvantage of self-fertilisation in plants. (2)
- i. Explain **ONE** way through which fruit flies living on apple plants could have become isolated from the original fruit fly populations living on hawthorn plants (line 14). (2)
- j. Suggest **TWO** environmental pressures that could have driven speciation in cichlid fishes in Lake Victoria (lines 19 – 20). (2)
- k. Suggest **ONE** behavioural change that could have driven speciation in cichlid fishes in Lake Victoria (lines 19 – 20). (1)
- l. Discuss how geographical barriers contributed to the divergence of boas and pythons (lines 22 – 23). (3)
- m. Despite their adaptability and resilience, species are threatened by human activities. Name **TWO** human pressures that may negatively impact species diversity. (1)

**(Total: 25 marks)**

***Please turn the page.***

## SECTION B

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

1. Discuss the role of enzymes in digestion in the human body.
2. Compare and contrast mitosis and meiosis.
3. Provide a comparative account of the relationship between protein structure and function.
4. Discuss interspecific interactions and their impacts on trophic relationships.

**(Total: 50 marks)**

## SECTION C

**Answer ONE question from this section.**

1. Use your knowledge of biology to explain the following statements:
  - a. Natural terrestrial habitats in the Maltese Islands appear in different stages of ecological succession. (5)
  - b. In Malta, the coastal-marine area is divided into zones where environmental conditions are relatively homogenous in one zone but different from adjacent zones due to environmental discontinuities. (5)
  - c. Cliffs and screes represent an important natural habitat characterised by several endemic flora and fauna, particularly adapted to live in such environments. (5)
  - d. The nitrogen cycle prominently showcases the indispensable role of bacteria. (5)
  - e. Transgenic organisms may alter natural gene pools if left unattended. (5)

**(Total: 25 marks)**

**OR**

2. Use your knowledge of biology to explain the following statements:
  - a. Water has good thermoregulatory properties. (5)
  - b. The structure of glucose polymers is dependent on the structure of their monomers. (5)
  - c. DNA ligase is essential during DNA replication. (5)
  - d. The expression of the lac operon is influenced by a repressor protein. (5)
  - e. Enzymes are essential for making plasmid vectors. (5)

**(Total: 25 marks)**



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SUBJECT: **Biology**  
PAPER NUMBER: III  
DATE: 2<sup>nd</sup> September 2024  
TIME: 9:00 a.m. to 10:35 a.m.

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**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.
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- 

**For examiners' use only:**

<b>Question</b>	1	2	3	<b>Total</b>
<b>Score</b>				
<b>Maximum</b>	15	17	18	<b>50</b>

1. This question is about species diversity.

a. Figure 1 and Figure 2 represent two marine organisms.



Figure 1

(obtained from: <https://upload.wikimedia.org>)



Figure 2

(obtained from: <https://stock.adobe.com/>)

i. Name the phylum and class of the organisms in Figure 1 and Figure 2.

	Figure 1	Figure 2
Phylum		
Class		

(2)

ii. List **TWO** visible features that are characteristic of the class represented by Figure 1.

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(1)

iii. Describe the symmetry in the organisms represented in Figure 1 and Figure 2. Explain any differences, if any.

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(2)

iv. The organism represented in Figure 2 is a motile species. Give the name of the structures used by the organism to move around.

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(1)

v. The organism represented in Figure 1 has cells that contain specialised organelles that aid in its predatory activity. Name this organelle.

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(1)

b. Figure 3 and Figure 4 represent two species that belong to the same phylum.

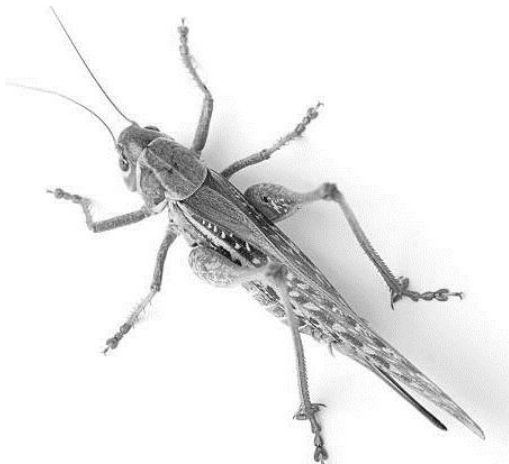


Figure 3  
(obtained from: <https://www.istockphoto.com/>)



Figure 4  
(obtained from: <https://stock.adobe.com/>)

i. Name the classes represented by the organisms in Figure 3 and Figure 4, respectively.

Figure 3: \_\_\_\_\_ Figure 4: \_\_\_\_\_ (1)

ii. List **TWO** visible features that are characteristic of the class represented by Figure 3.

\_\_\_\_\_  
\_\_\_\_\_ (1)

iii. Though not visible in the figures, the species shown in Figure 3 and Figure 4 have different organs for gaseous exchange. Name the respiratory organ for **each** respective species.

Figure 3: \_\_\_\_\_ Figure 4: \_\_\_\_\_ (1)

iv. Briefly discuss the limitations of the respiratory organ of the organism in Figure 4 for survival in terrestrial environments.

\_\_\_\_\_  
\_\_\_\_\_ (2)

**Question continues on the next page.**

c. The organisms shown in Figure 5 and Figure 6 belong to the phylum Annelida.



Figure 5

(obtained from: <https://www.nationalgeographic.com/>)



Figure 6

(obtained from: <https://species.wikimedia.org/wiki/>)

i. Compare cephalisation in the organisms shown in Figure 5 and Figure 6.

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(1)

ii. Which of these two figures (Figure 5 or Figure 6) shows an organism that has parapodia? Name **TWO** functions of these structures.

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(2)

**(Total: 15 marks)**



2. This question is about supporting tissue in plants and animals.
- a. Figure 7 shows a transverse section through a *Ranunculus* root as seen under the microscope, with the insert focusing on the central part of the transverse section.

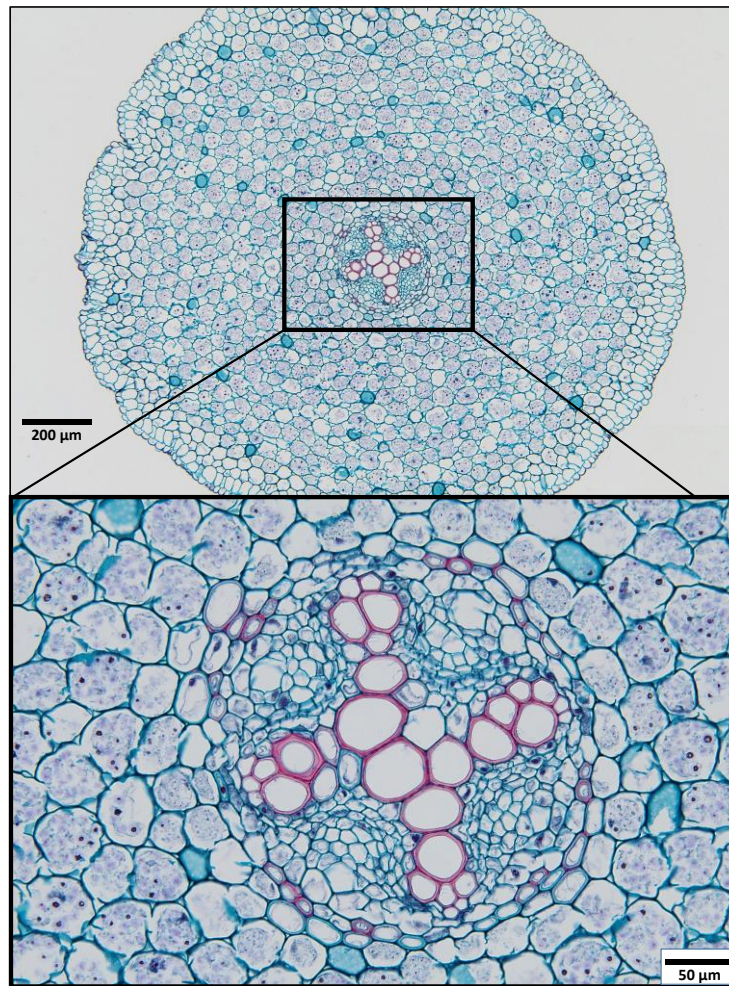


Figure 7: A high power photomicrograph showing the transverse section of a *Ranunculus* root  
(Adapted from: <https://schulte.faculty.unlv.edu/Anatomy/>)

- i. In Figure 7, label and annotate the following terms: endodermis, epidermis, xylem, phloem and parenchyma. In your annotations, include the main function or role of each label. Use the lower image to label structures that are visible towards the centre of this transverse section. (5)
- ii. Indicate whether *Ranunculus* is a monocot or a dicot. Explain your answer through details visible in Figure 7.

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(2)

**Question continues on the next page.**

- b. Figure 8 shows a longitudinal section from a human femur. Label the **TWO** types of bone found in this structure.

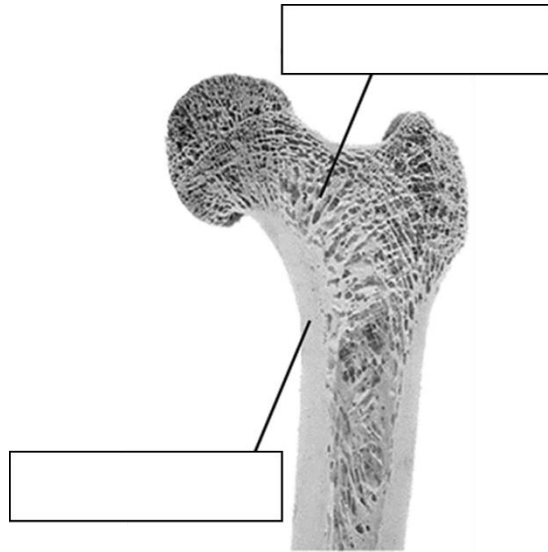


Figure 8: A longitudinal section through a human femur.  
(Adapted from: DOI: 10.1093/ejo/cjt093)

(1)

- c. Figure 9 shows a photomicrograph through human compact bone.

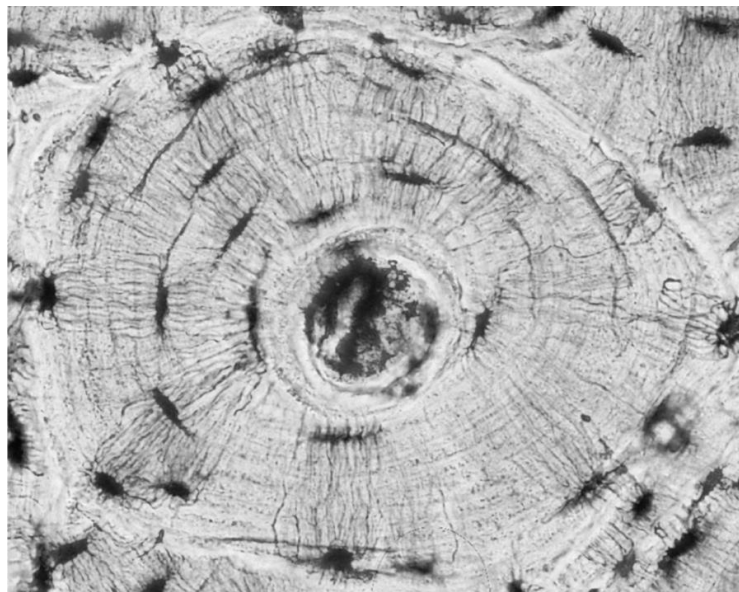


Figure 9: A high power photomicrograph of a transverse section of compact bone  
(Adapted from: <https://schulte.faculty.unlv.edu/Anatomy/>)

In the space provided below, draw and annotate a low power plan for the section of compact bone shown in Figure 9.



(6)

d. Figure 10 shows a longitudinal section of a skeletal muscle.

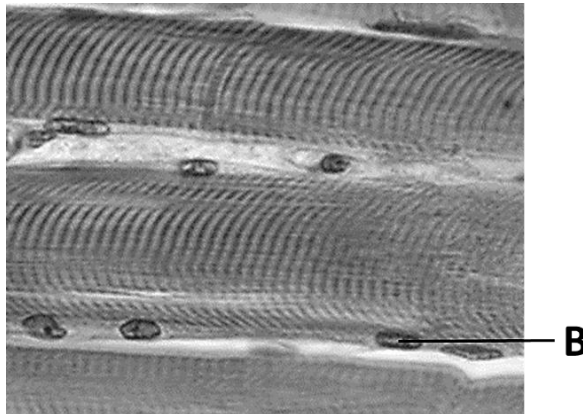


Figure 10: A high power photomicrograph of a longitudinal section of skeletal muscle  
(Adapted from: <https://www.sciencephoto.com/>)

i. On Figure 10, label an A-band and an I-band. (2)

ii. Identify structure B.

(1)

**(Total: 17 marks)**

***Please turn the page.***

3. This question is about inheritance.

- a. A dihybrid cross was carried out between the two chickens shown in Figures 10 and 11. The chicken in Figure 10 is a pure-bred white feathered chicken with a single comb type while the other chicken in Figure 11 is a pure-bred dark coloured chicken with a pea comb type. The two genetic traits studied in this cross were the colour of the feathers and the type of comb. Genetically, the white colour (D) is dominant to the dark colour (d) and the pea combs type (T) is dominant to the single comb type (t).



Figure 10  
(Obtained from: <https://www.heritageacresmarket.com/>)



Figure 11  
(Obtained from: <https://img1.wsimg.com/>)

- i. Explain the meaning of the term 'dihybrid cross'.

\_\_\_\_\_ (1)

- ii. When crossing the two individuals above, all F1 offspring had the same phenotype and genotype for the tested traits. Use the space below to perform a dihybrid cross and determine the genotype and phenotype of the F1 generation.

Genotype of the F1 generation: \_\_\_\_\_

Phenotype of the F1 generation: \_\_\_\_\_ (3)

- b. The same traits indicated in part (a) were tested in another cross between two individuals, each with the genotype DdTt.

Assuming that the two traits (feather colour and comb type) assort independently during gamete formation, the expected phenotypic ratio should have been:

white with pea combs	:	white with single comb	:	dark with pea combs	:	dark with single comb
9	:	3	:	3	:	1

- i. Given that in this second cross there were 192 offspring, use the ratios above to calculate the **expected number** of offspring per phenotype. In your answer, show your working and insert the expected values in the space below.

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

white with pea combs	:	white with single comb	:	dark with pea combs	:	dark with single comb
_____	:	_____	:	_____	:	_____

(2)

In the real experiment, the **observed number** of offspring for the different phenotypes were:

white with pea combs	:	white with single comb	:	dark with pea combs	:	dark with single comb
117	:	38	:	31	:	6

These observed numbers show differences from the expected numbers in part (i), leading to uncertainty about whether the two genetic traits under study assort independently.

To resolve this issue, a chi-squared ( $X^2$ ) test can be used to determine whether the differences between the observed and expected numbers are statistically significant or simply due to chance. The equation used for this test is given below:

$$X^2 = \sum \frac{(\text{Observed value} - \text{Expected value})^2}{\text{Expected value}}$$

Note: The symbol  $\Sigma$  means 'sum of'. Therefore, calculate  $\frac{(\text{Observed value} - \text{Expected value})^2}{\text{Expected value}}$  for each phenotype and then add the results to find the chi-squared value.

**Please turn the page.**

ii. Propose a suitable null hypothesis for this test.

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(1)

iii. Using the observed and expected numbers for each of the four phenotype categories, calculate the chi-squared value for this data set. Show all your working and give your final answer to three decimal places.

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(5)

iv. How many degrees of freedom are associated with this chi-squared test?

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(1)

Table 1: Critical Values of the Chi-Square Distribution

Degrees of freedom	Level of significance				
	0.90	0.10	0.05	0.025	0.01
1	0.016	2.706	3.841	5.024	6.635
2	0.211	4.605	5.991	7.378	9.210
3	0.584	6.251	7.815	9.348	11.345
4	1.064	7.779	9.488	11.143	13.277
5	1.610	9.236	11.070	12.833	15.086

(Adapted from: <https://www.ttable.org>)

v. Using chi-squared distribution in Table 1, determine the critical value for  $X^2$  for a level of significance  $P = 0.05$ .

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(1)

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vi. Based on your answers to part (iii) and part (v), would you accept or reject the null hypothesis at a significance level of  $P = 0.05$ ? Provide an explanation for your answer.

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(2)

vii. Explain what your answer to part (vi) suggests about the assortment of the genes associated to the two traits studied here.

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(2)

**(Total: 18 marks)**

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L-Università  
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MATRICULATION AND SECONDARY EDUCATION CERTIFICATE  
EXAMINATIONS BOARD

**ADVANCED MATRICULATION LEVEL  
2024 SECOND SESSION**

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SUBJECT: **Biology**  
PAPER NUMBER: IV – *Practical*  
DATE: 28<sup>th</sup> August 2024  
TIME: 1 hour 35 minutes

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### 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

1. During fermentation, the yeast *Saccharomyces cerevisiae* uses sugars and converts them into carbon dioxide and ethanol. This process is essential in baking, brewing, and winemaking.

When fermentation occurs in a liquid environment, the carbon dioxide produced by the yeast rises to the surface and creates foam. This foam indicates that the fermentation process is underway, and the quantity of foam formed provides an indication of the rate of fermentation.

You are required to devise and implement an experimental procedure to investigate the effect of different ethanol concentrations on the rate of fermentation in yeast.

You are provided with the following materials:

- 20% ethanol solution;
- sucrose powder;
- yeast powder;
- teaspoons;
- distilled water;
- other laboratory apparatus as required.

- a. Suggest a suitable null hypothesis for this investigation.

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(1)

- b. Describe the function of sucrose during the experiment.

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(1)

- c. You are provided with a 20% ethanol solution and distilled water. By filling the table below, show how you would prepare three 20 mL solutions with ethanol concentrations of 15%, 10% and 5%, respectively.

Final ethanol concentration	Volume of 20% ethanol solution (mL)	Volume of distilled water (mL)	Total volume (mL)
15%			20
10%			20
5%			20

(3)

**Prepare the 20 mL ethanol solutions as indicated in part (c). Use the provided syringes to measure volumes and place the prepared 20 mL solutions in the boiling tubes provided.**

- d. Using the materials provided, devise and describe an experimental procedure to investigate the effect of different ethanol concentrations (0%, 5%, 10%, 15% and 20%) on the rate of fermentation.

It is recommended that for each test you:

- use a levelled teaspoon of sucrose powder;
- dissolve the sucrose;
- use a levelled teaspoon of yeast powder;
- stop the experiment after a maximum of 15 minutes.

For easier transfer of solids, it is recommended to first place the measured quantities of solids from the levelled teaspoon into a weighing boat, and then pour them into the boiling tube.

While it is advisable to mix the contents initially when setting up the experiment, it is recommended not to mix further once the experiment is running.

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(10)

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

Precaution 1: \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_ (2)

Precaution 2: \_\_\_\_\_

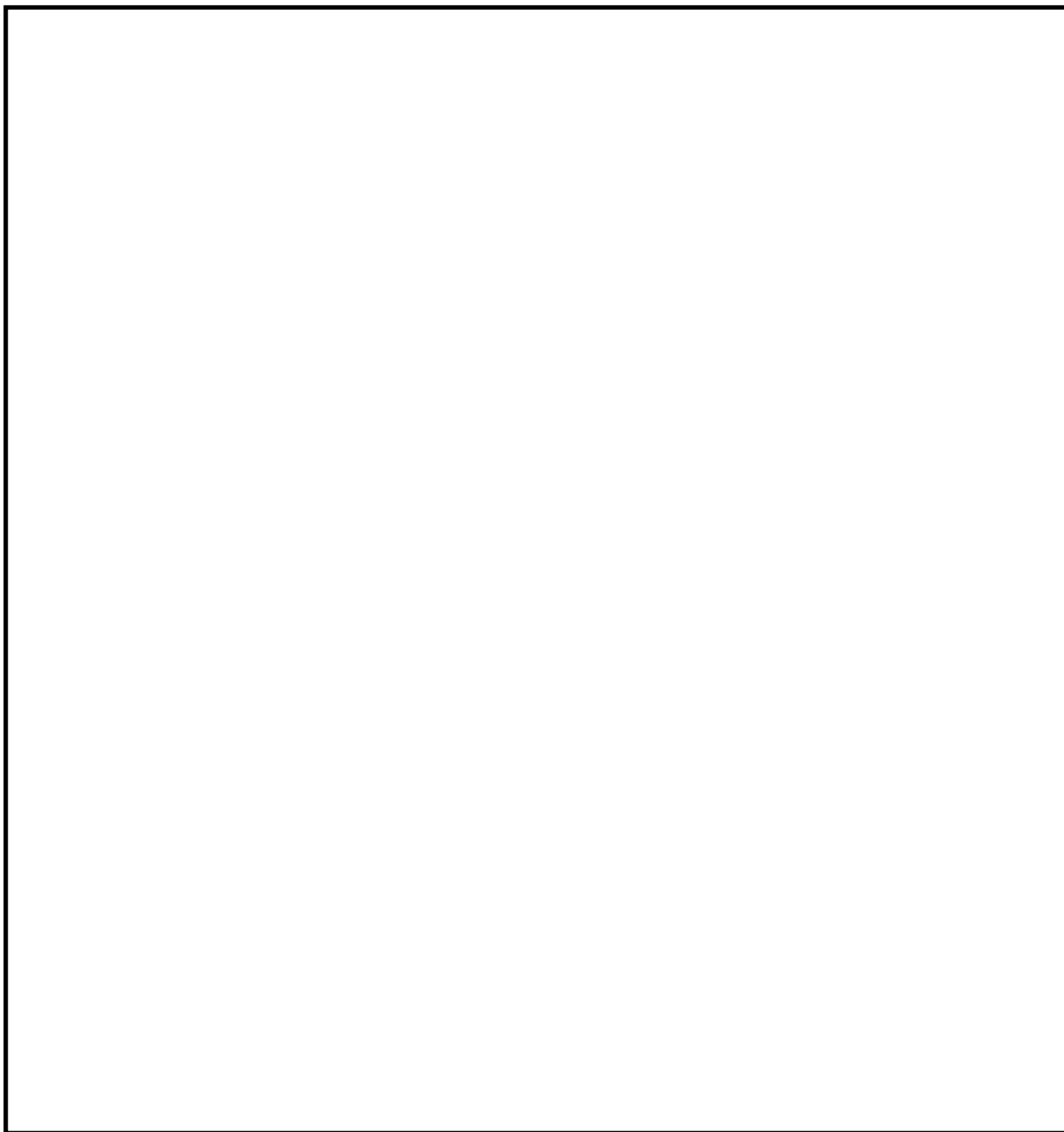
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\_\_\_\_\_ (2)

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**Carry out the investigation that you devised in part (d) 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.*



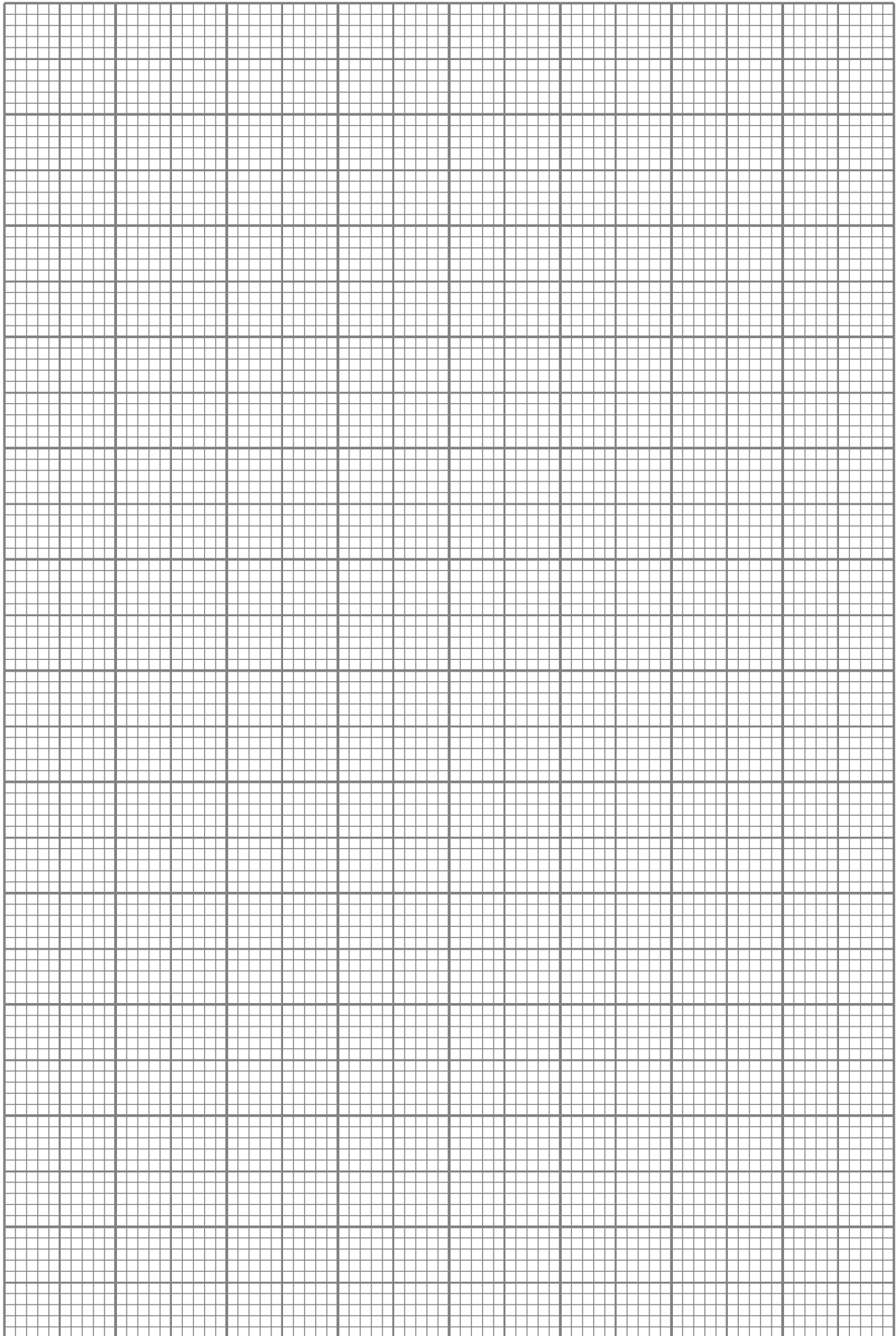
(5)

- g. Draw a graph to represent your results on the graph paper provided on the following page. (6)

***Question continues on the next page.***

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h. Describe any pattern that emerges from your results.

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(2)

i. Give a biological interpretation to your results.

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(3)

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

Source of error 1: \_\_\_\_\_

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(1)

Source of error 2: \_\_\_\_\_

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(1)

***Question continues on the next page.***

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- k. During normal fermentation, the alcohol concentration increases as fermentation progresses. Explain why most wines tend to have similar alcohol concentrations, and based on your results, propose what that concentration range might be.

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(3)

**(Total: 40 marks)**