



SUBJECT: **Biology**  
 PAPER NUMBER: I  
 DATE: 10<sup>th</sup> May 2022  
 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	12	15	10	12	10	11	10	10	10	<b>100</b>

1. This question is about muscular contractions.

Both  $\text{Ca}^{2+}$  and  $\text{Mg}^{2+}$  work antagonistically to facilitate striated muscle contraction. These ions influence the excitation or inhibition of the neuromuscular junction as well as compete for the binding site of one of the protein complexes involved in filament movement.

a. What is meant by the term 'striated muscle'?

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

State whether the following observations induce contraction or relaxation of striated muscles and give a reason why:

b.  $\text{Ca}^{2+}$  levels surge within the sarcomere.

i. Contraction or Relaxation: \_\_\_\_\_ (1)

ii. Reason: \_\_\_\_\_  
\_\_\_\_\_ (1)

c.  $\text{Mg}^{2+}$  levels deplete within the sarcomere.

i. Contraction or Relaxation: \_\_\_\_\_ (1)

ii. Reason: \_\_\_\_\_  
\_\_\_\_\_ (1)

d. Insufficient ATP levels within the sarcomere.

i. Contraction or Relaxation: \_\_\_\_\_ (1)

ii. Reason: \_\_\_\_\_  
\_\_\_\_\_ (1)

e. Acetylcholine inhibition at the neuromuscular junction.

i. Contraction or Relaxation: \_\_\_\_\_ (1)

ii. Reason: \_\_\_\_\_  
\_\_\_\_\_ (1)

- f. Huntington’s disease influences the surface area of T-tubules by narrowing them. Briefly explain the impact of this physiological change on muscular contractions.

---

---

(2)

**(Total: 12 marks)**

2. This question is about reproduction in plants.

- a. Fill in the following table by identifying the typical differences between wind-pollinated and insect-pollinated flowers.

Table 1: Differences between wind and insect pollinated flowers

<b>Feature</b>	<b>Wind-pollinated flowers</b>	<b>Insect-pollinated flowers</b>
Petals		
Scent		
Stigmas		
Anthers		

(4)

- b. Differentiate between cross pollination and self-pollination.

---

---

---

(2)

**Question continues on next page**

---

c. Briefly explain how the following mechanisms favour cross pollination:

i. protandry and protogyny;

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

ii. self-incompatibility.

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

d. Discuss the following statements:

i. pollen grains of insect pollinated flowers are adapted for transfer.

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

ii. a flower's main role is seed production.

\_\_\_\_\_  
\_\_\_\_\_ (1½)

iii. a commercial flower grower wants his coloured flowers to reproduce asexually.

\_\_\_\_\_  
\_\_\_\_\_ (1½)

**(Total: 15 marks)**

3. This question is about the immune system.

a. Immunity may be described as active or passive. Both types may be acquired naturally or artificially. Explain the following types of immunity and give an example for **each**.

i. Natural active immunity.

explanation: \_\_\_\_\_  
\_\_\_\_\_ (1)

example: \_\_\_\_\_  
\_\_\_\_\_ (1)

DO NOT WRITE ABOVE THIS LINE

---

ii. Natural passive immunity.

explanation: \_\_\_\_\_  
\_\_\_\_\_ (1)

example: \_\_\_\_\_  
\_\_\_\_\_ (1)

iii. Artificial active immunity.

explanation: \_\_\_\_\_  
\_\_\_\_\_ (1)

example: \_\_\_\_\_  
\_\_\_\_\_ (1)

iv. Artificial passive immunity.

explanation: \_\_\_\_\_  
\_\_\_\_\_ (1)

example: \_\_\_\_\_  
\_\_\_\_\_ (1)

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

- b. The following image shows the outcome of vaccination for several infectious diseases. Vaccination for these diseases is normally administered once in an individual’s lifespan.

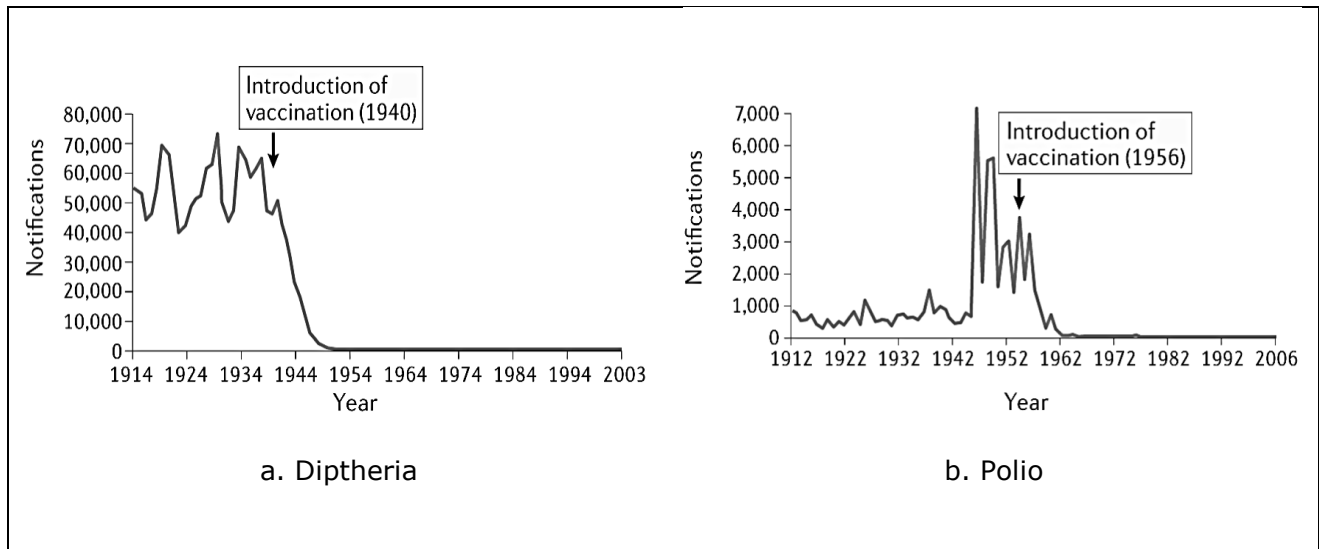


Figure 1: The introduction of vaccination against infectious diseases such as diphtheria and polio, led to a marked decrease in their incidence.  
(Adapted from: <https://www.nature.com>)

Discuss why the vaccination against the diseases in Figure 1 seem to work over a long period of time, but vaccination against the influenza virus works for a shorter period of time, usually a year.

---

---

---

---

---

---

---

---

(2)

**(Total: 10 marks)**

4. This question is about action potentials.

Healthy neurons are to exhibit the following permeability to ions when excited by a stimulus.

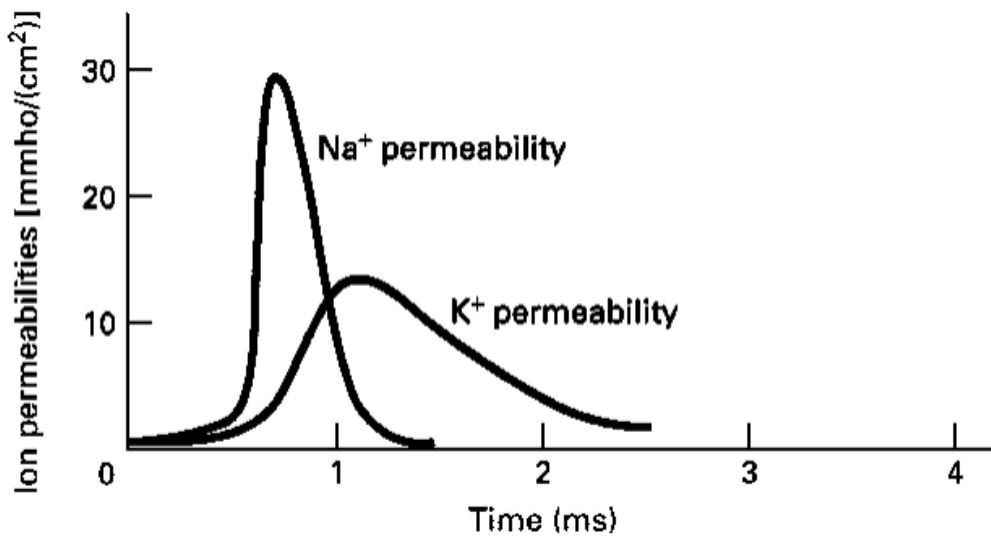


Figure 2: The relative permeability of ions involved in action potentials  
(Adapted from: <https://www.zoology.ubc.ca>)

a. What type of proteins are responsible for altering the permeability of an axon during excitation?

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

b. What would happen to the Na<sup>+</sup> permeability of the axon should it be stimulated by a stronger stimulus? Give a reason for your answer.

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

c. Why would an increase in K<sup>+</sup> permeability be detrimental to action potentials?

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

**Question continues on next page.**

DO NOT WRITE ABOVE THIS LINE

The tables below show the relative concentration of ions of a neuron of two individuals, when at rest.

Table 2. Relative concentrations of potassium and sodium in patient A when at rest.  
(Adapted from: [https:// its.caltech.edu](https://its.caltech.edu))

Patient A	Extracellular (mM)	Intracellular (mM)
K <sup>+</sup>	5	100
Na <sup>+</sup>	15	150

Table 3. Relative concentrations of potassium and sodium in patient B when at rest.  
(Adapted from: [https:// its.caltech.edu](https://its.caltech.edu))

Patient B	Extracellular (mM)	Intracellular (mM)
K <sup>+</sup>	90	20
Na <sup>+</sup>	150	15

d. Name the channel and/or carrier protein/s responsible for the maintenance of resting membrane potentials when at rest.

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

e. By making reference to Figure 2 and your answer to part (d), explain how resting membrane potentials are maintained.

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

f. From the above tables, determine which patient is exhibiting imbalanced K<sup>+</sup> concentrations. Give a reason for your answer.

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

g. From the above tables, determine which patient is exhibiting imbalanced Na<sup>+</sup> concentrations. Give a reason for your answer.

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


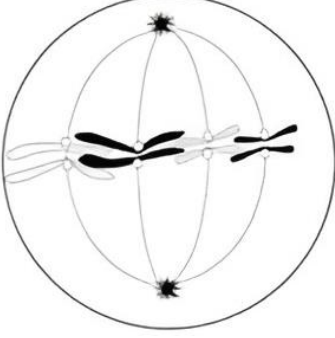
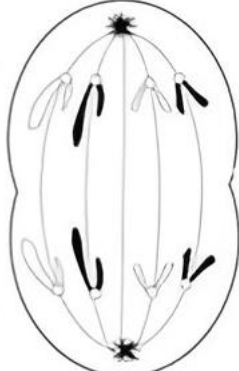
**(Total: 12 marks)**



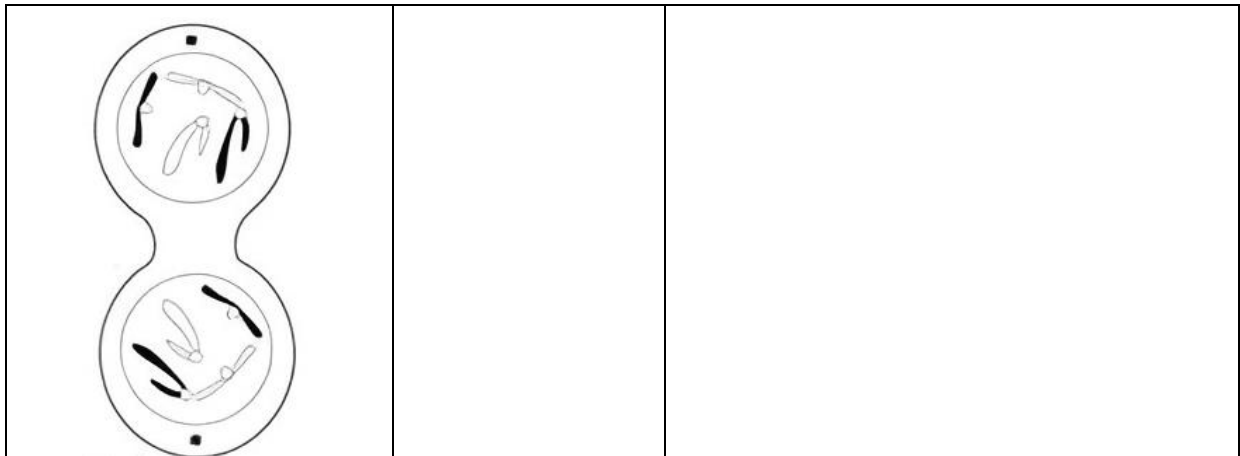
5. This question is about nuclear divisions.  
 A scientist drew diagrams showing the different stages of mitosis.

a. Identify the stages of mitosis shown in Table 4 and indicate the distinctive features that identify each particular stage.

Table 4. The stages of mitosis  
 (Obtained from <https://www.shutterstock.com/search/mitotic>)

Diagram	Stage of Mitosis	Distinctive Features
		
		
		

***Please turn the page.***



(4)

b. Figure 3 shows a particular process that takes place during meiosis.

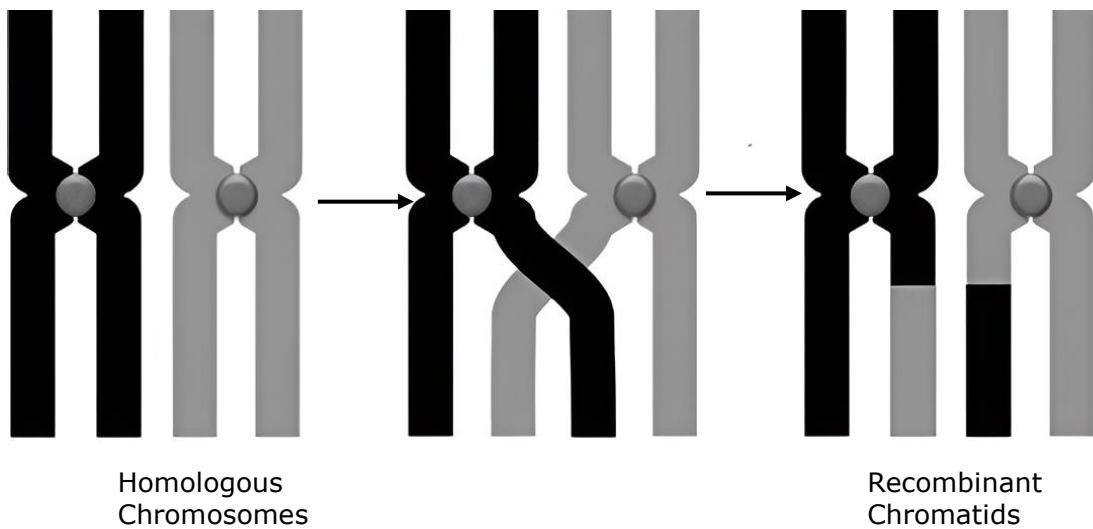


Figure 3: Process during meiosis  
 (Obtained from <https://www.vedantu.com>)

i. What is this process called?

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

ii. State the meiotic stage during which the process in Figure 3 occurs.

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

iii. Explain the process shown in Figure 3 and discuss its role in increasing genetic diversity in future generations.

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

iv. List **TWO** other mechanisms that occur during meiosis, that contribute to genetic variation. State during which meiotic stages do each of these mechanisms occur.

---

---

(2)

**(Total: 10 marks)**

6. This question is about evolution.

Evolution is shaped by various environmental stressors, that in turn alter the gene pool of a particular organism resulting in phenotypic variations. The following example shows one possibility of speciation whereby beak morphology and feather colouration have been altered, with Amakihi finch exhibiting vivid yellow feathers and Nihoa finch exhibiting darker yellow with black/grey variations, depending on their location within their habitat.

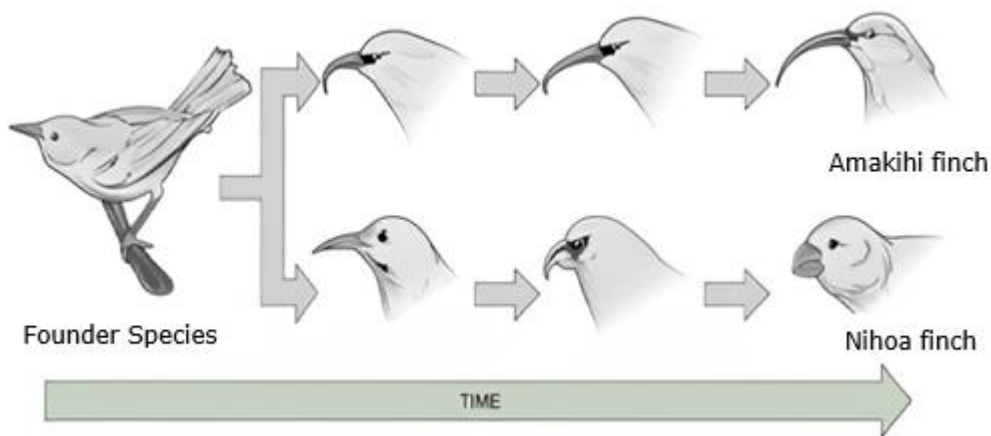


Figure 4: Changes in beak morphology

*(Obtained from [vivaopen.oercommons.org/courseware/lesson/526/overview](http://vivaopen.oercommons.org/courseware/lesson/526/overview))*

a. Determine which type of speciation is being exhibited in the diagram above.

---

(1)

b. What happens to the organisms' niche breadth during each stage of speciation? Use evidence from the diagram to support your answer.

---

---

(2)

c. Name and explain **ONE** survival factor influenced by feather colouration.

---

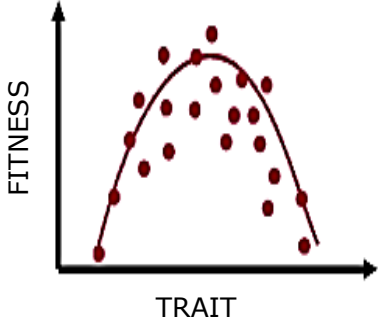
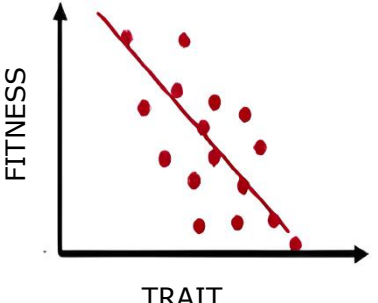
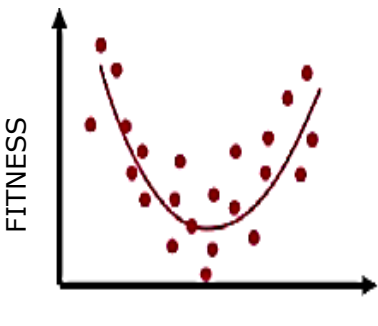
---

(2)

**Question continues on next page.**

The graphs depicted in Table 5 show the fitness levels of organisms that exhibit a particular trait. Using the graphs below determine which selection pressure is being exhibited and give a reason for your answer.

Table 5: Various fitness levels of three different traits

	<p>Selection pressure: _____</p> <p>Explanation: _____</p> <p>_____</p> <p>_____ (2)</p>
	<p>Selection pressure: _____</p> <p>Explanation: _____</p> <p>_____</p> <p>_____ (2)</p>
	<p>Selection pressure: _____</p> <p>Explanation: _____</p> <p>_____</p> <p>_____ (2)</p>

**(Total: 11 marks)**

7. This question is about protein synthesis.

Organelle Y combines tRNA with an mRNA strand consisting of 660 bases, to produce the growing protein. Proteins are later modified and sent to their destination, where needed.

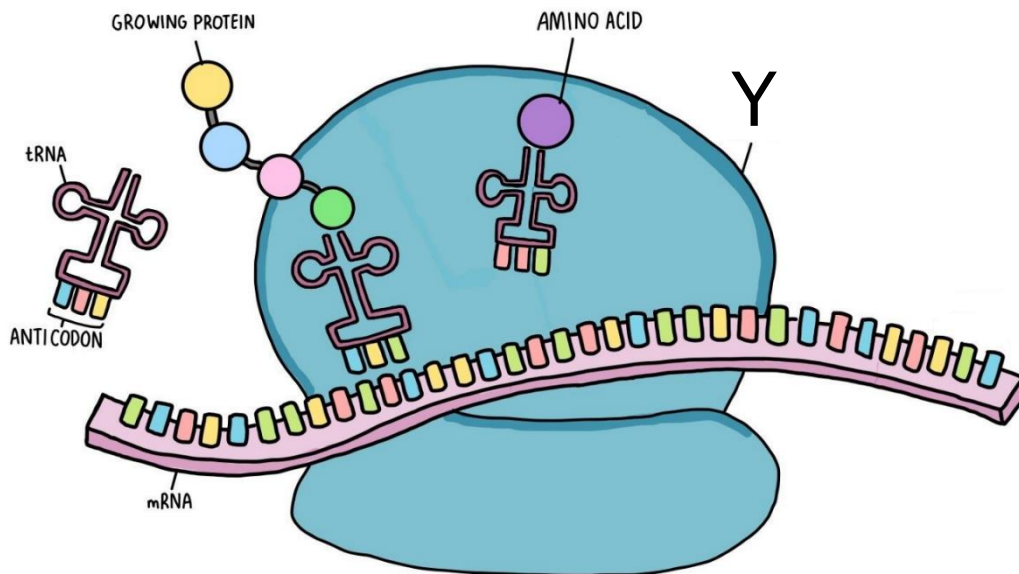


Figure 5: Organelle Y  
 (Obtained from <https://www.thesciencehive.co.uk/dna-replication-a-level>)

a. Name organelle Y.

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

b. Complete the sentences below:

The process by which DNA is copied to messenger RNA (mRNA) is called \_\_\_\_\_, and the process by which mRNA is used to produce proteins is called \_\_\_\_\_.

(1)

c. Complete Table 6 below to show the base sequence of the messenger RNA transcribed from this DNA strand.

Table 6: The base sequence of DNA to be transcribed into mRNA

Base sequence on coding strand of DNA	A	C	G	T	T	C
Base sequence of mRNA						

(1)

**Question continues on next page.**

DO NOT WRITE ABOVE THIS LINE

- 
- d. What is the maximum number of amino acids in the protein translated from the above piece of mRNA? Explain your answer.

Maximum number of amino acids: \_\_\_\_\_

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

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

- e. Fill in Table 7 below to provide **TWO** differences between the structure of mRNA and the structure of transfer RNA (tRNA).

Table 7: Differences between mRNA and tRNA

mRNA	tRNA

(2)

Cycloheximide is an antibiotic produced by the bacterium *Streptomyces griseus*. It kills cells by interfering with translation. It binds to mRNA and causes a base to be missed out during translation.

- f. Explain how cycloheximide causes cells to produce non-functional proteins.

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

**(Total: 10 marks)**

8. This question is about biotechnology.

In some genetic engineering processes, a human gene is inserted into a bacterial cell. This process is shown in the diagram below.

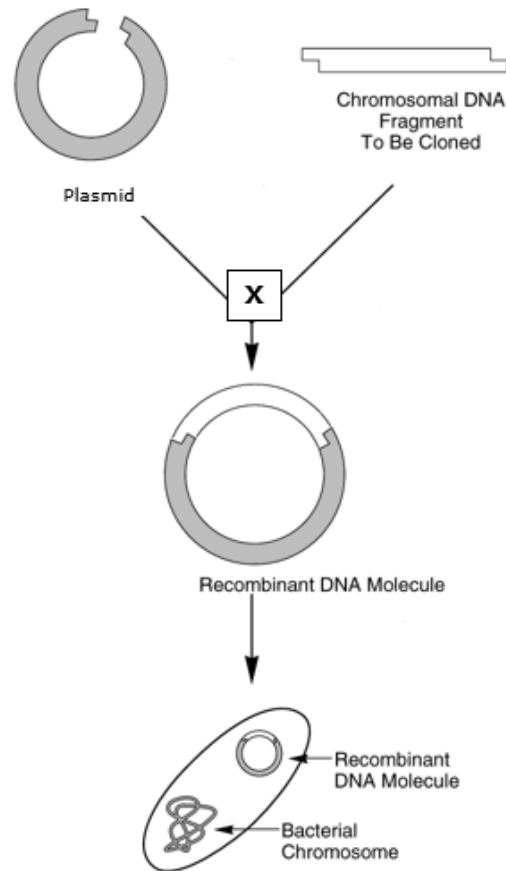


Figure 6: Human gene inserted into a bacterial cell  
(*Recombinant DNA and genetic techniques for schools and colleges | Virtual Genetics Education Centre | University of Leicester*)

- a. What term is used to describe the role of the plasmid in the process?  
\_\_\_\_\_ (1)
- b. Name another structure that can carry out the same function as the plasmid in Figure 6?  
\_\_\_\_\_ (1)
- c. Enzyme X is used to anneal the sticky ends together to form recombinant DNA. What is the name of enzyme X?  
\_\_\_\_\_ (1)
- d. List **TWO** ways by which the recombinant plasmid is inserted into the bacterial cells.  
\_\_\_\_\_  
\_\_\_\_\_ (2)

**Question continues on next page.**

- 
- e. Genetically engineered human insulin is used in the treatment of diabetes. State **THREE** advantages of using this type of insulin.

---

---

---

(3)

- f. Genetic engineering has also yielded genetically modified crops, such as pest resistant crops and nutrient enriched crops.

List **TWO** environmental concerns related to the use of genetically modified crops.

---

---

---

(2)

**(Total: 10 marks)**

- 9. This question is about environmental biology.

- a. Carbon is a crucial element for all living things; it provides the chemical framework to form the molecules that make up living organisms.

- i. Describe **TWO** processes that release carbon dioxide in the atmosphere.

---

---

---

(2)

- ii. Predict the consequences of carbon cycling if there were no decomposers present in an ecosystem.

---

---

(1)

- iii. Explain how oceans are important carbon "sinks".

---

---

---

(2)



---

b. Another essential element is nitrogen; it forms an important part of the structure of proteins and nucleic acids.

i. Describe **THREE** instances in the nitrogen cycle where bacterial action is important. Include the name of **each** of the processes and the changes to the form of nitrogen involved.

---

---

---

---

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

ii. Identify the main reservoir that provides a source of nitrogen.

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

iii. Explain why farmers may plough a crop of legumes into the ground rather than harvest it.

---

---

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

**(Total: 10 marks)**

**Blank Page**

**Blank Page**

**Blank Page**



---

SUBJECT:	<b>Biology</b>
PAPER NUMBER:	II
DATE:	10 <sup>th</sup> May 2022
TIME:	4:00 p.m. to 7:05 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.

**When ants 'move house'**

*Myrmica rubra* is a small, red-brown, shiny ant that is found all over Europe. The casual turning over of stones disturbs the creatures underneath and exposes them to predators. But if done very carefully and quickly, it allows one to map the composition, density and geography of nests over a given area before placing the stone back.

- 5 Back in 1977, Mike Brian noted that in some areas there was another species of ant together with *M. rubra*: *Lasius flavus*, commonly known as the little meadow ant. Studies have shown that over the years, *L. flavus* nests have become significantly closer to *M. rubra* nests. Some even occupy the same nest. This is surprising for two species not only belonging to different genera, but *L. flavus* is monogynous (just a single queen per nest) and produces cocoons, while *M.*
- 10 *rubra* is polygynous and produces pupae. These ants do, however, have different food sources and it is possible that they can cohabit the same area without conflict. Environmental pressures seem to have caused them to live under one roof. After all, why waste energy finding a suitable area and building another nest, when your existing home has lost its roof, when you can share a home with your neighbour?
- 15 The movement and relocation of nest following disturbance is difficult to monitor in the field, but a combination of observations over the years and laboratory studies using whole nests have helped to understand how *M. rubra* colonies move to a new position. The time it takes to move to a new site varies, depending on the composition of the colony and distance to a new site, but generally the ants can pack up and move house within an hour.
- 20 The successful growth of a colony is dependent on a number of factors. Food, climate and competition are probably the three biggest influences. However, land management and other human activities can also have a dramatic impact.

25 The relocation of *M. rubra* colonies requires energy, leaving less to feed larvae and egg-laying queens. This reduces colony growth, leading to an overall decrease in population density. This results in an imbalance in the ratio of colony members, such as fewer brood and queens. This makes it a less well-organised colony that is slower to relocate. This leaves the moving ants open to predation by birds or further trampling by cattle who are not affected by the ants whatsoever. Brood care becomes difficult to manage, particularly if food sources become scarce and worker numbers low.

- 30 Should these ants need to move again, it seems a smaller colony is much easier to move than a larger one. It would be interesting to see what further changes climate and landscape might have on the complex but highly sophisticated world of social insects.

(Adapted from <https://thebiologist.rsb.org.uk/biologist-features/why-do-ants-move-house-2>)

- a. Using the extract, identify **TWO** abiotic and **TWO** biotic factors that may influence the successful growth of a colony of *M. rubra*. (4)
- b. Explain **TWO** interspecific interactions mentioned in the extract, that can negatively affect *M. rubra*. (4)
- c. Do *M. rubra* and *L. flavus* exhibit the Principle of Competitive Exclusion? Use the extract to justify your answer. (3)
- d. The extract explains what happens when an ant colony relocates. Define the following terms and explain the implications on a population:
- i. Immigration (2)
  - ii. Emigration (2)
- e. The extract states that "the movement and relocation of nest following disturbance is difficult to monitor in the field" (line 15). There are a number of techniques used to study communities. One such technique is transect sampling.
- i. Explain why populations are sampled. (2)
  - ii. Discuss how a line transect and a belt transect are different from one another. (2)
  - iii. Identify **ONE** disadvantage of belt transects. (1)
  - iv. Explain why line transects may give an unrealistic sample of a community. (1)
  - v. State how belt transects overcome this problem. (1)
  - vi. Describe a situation where the use of transects to sample a community would be inappropriate. (1)
  - vii. Justify how you could test whether or not a transect sampling interval was sufficient to accurately sample a community. (2)

**(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. In vascular plants there are three basic types of specialised tissues: dermal tissues, vascular tissues and ground tissues. Discuss how ground tissues provide support in plants.
2. Compare and contrast the transport systems of fish and mammals.
3. Give an overview of the sources and effects of secretions concerned with the chemical digestion of carbohydrates, lipids and proteins in the human alimentary canal.
4. Proteins involved in catabolic and signaling systems are heavily reliant on molecular shape. Discuss this statement.

**(Total: 50 marks)**

***Please turn the page.***

**SECTION C**

**Answer ONE question from this section.**

1. Use your knowledge of Biology to explain the following statements:
  - a. Mitochondria and chloroplasts are now two organelles found in eukaryotic cells. (5)
  - b. Internal fertilisation is an adaptation to terrestrial life. (5)
  - c. The development of a coelom was a significant evolutionary step. (5)
  - d. Viruses are considered as borderline parasites. (5)
  - e. All lysogenic cycles will eventually lead to lytic pathways but never the other way round. (5)

**OR**

2. Use your knowledge of Biology to explain the following statements:
  - a. A farmer noticed that a black-feathered rooster and a white-feathered chicken had speckled chicks (having a mixture of white feathers and black feathers). The farmer also observed that a long-tailed female dog and a short-tailed male dog produced puppies having medium-length tails. (5)
  - b. Malta's terrestrial habitats are considered to resemble more a mosaic pattern rather than being distinct from one another. (5)
  - c. Knowing the chemistry of plasmid DNA is more relevant for recombinant applications rather than nucleoid DNA. (5)
  - d. Marfan's syndrome is a genetic disorder that affects connective tissue. It is caused by mutations in the FBN1 gene found on chromosome 15, and males and females have an equal chance of inheriting the faulty allele. On the other hand, Duchenne muscular dystrophy is a genetic disorder characterised by progressive muscle degeneration. This condition is caused by mutations in the X chromosome and males are more likely to be affected by this disease. (5)
  - e. Due to their nature of response, reflex arcs do not make use of the brain. (5)

**(Total: 25 marks)**






---

SUBJECT: **Biology**  
 PAPER NUMBER: III  
 DATE: 11<sup>th</sup> May 2022  
 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	21	15	14	40	<b>90</b>

**SECTION A: Answer ALL questions.**

1. This question is about anaerobic respiration in yeast.

A biology student wanted to investigate the effect of temperature on the rate of anaerobic respiration in yeast.

a. Describe the process of anaerobic respiration as carried out by yeast and explain how this differs from aerobic respiration.

---

---

---

---

---

(4)

b. The student decided to determine the rate of respiration by a colorimetric method, using phenolphthalein indicator to mark the end point of the reaction. During the experiment, phenolphthalein indicator changes colour from pink in alkaline conditions to colourless in acidic conditions. Explain why this indicator is suitable for this reaction.

---

---

---

(2)

The following three test tubes were prepared:

Table 1: Preparation of test-tubes

<b>Test tube X</b>	5 cm <sup>3</sup> of yeast suspension, 5cm <sup>3</sup> of glucose solution, 5 cm <sup>3</sup> of phenolphthalein indicator and 5 cm <sup>3</sup> of dilute hydrochloric acid
<b>Test tube 1</b>	5 cm <sup>3</sup> of yeast suspension
<b>Test tube 1A</b>	5 cm <sup>3</sup> of glucose solution, 5 cm <sup>3</sup> of phenolphthalein indicator and 5 cm <sup>3</sup> of distilled water

c. What is test tube X called, and why is it important for the purpose of this experiment?

---

---

---

(2)

A water bath was prepared at 15 °C.

Test tubes 1 and 1A were placed in a water bath at 15 °C and allowed to stand for 5 minutes. The contents of the test tubes were then mixed, and the timer was started. The time taken for the phenolphthalein indicator to change colour was noted.

- d. Why did the student leave test tubes 1 and 1A in the water bath for some time before mixing?

(1)

Using the same batch of yeast, the experiment was repeated two more times at 15 °C. Then the whole experiment was repeated at 25 °C, at 35 °C and at 45 °C.

- e. Why was it important to conduct all the experiments using the same batch of yeast?

(1)

The results of the experiment were recorded and tabulated as shown in Table 2 below.

Table 2: The Effect of Temperature on Rate of Anaerobic Respiration in Yeast – Experiment Results

Time (in minutes) for completion of reaction	15 °C	25 °C	35 °C	45 °C
1 <sup>st</sup> reading	25	11.5	6.5	19
2 <sup>nd</sup> reading	27	12	5	20
3 <sup>rd</sup> reading	26	11	5	19.5
Average time (T) (minutes)				
Rate of respiration (1/T) (minutes <sup>-1</sup> )				

**Question continues on next page.**

- 
- f. Complete Table 2 by calculating the average time of reaction and the rate of respiration (to 2 decimal places) for each test temperature. Show your working below.

---

---

---

(2)

- g. Using graph paper provided on the next page, plot a graph for rate for respiration against temperature. (4)

- h. Explain the pattern of the graph plotted in the previous question.

---

---

(1)

- i. Explain the biology behind the trends observed in the graph.

---

---

---

---

(3)

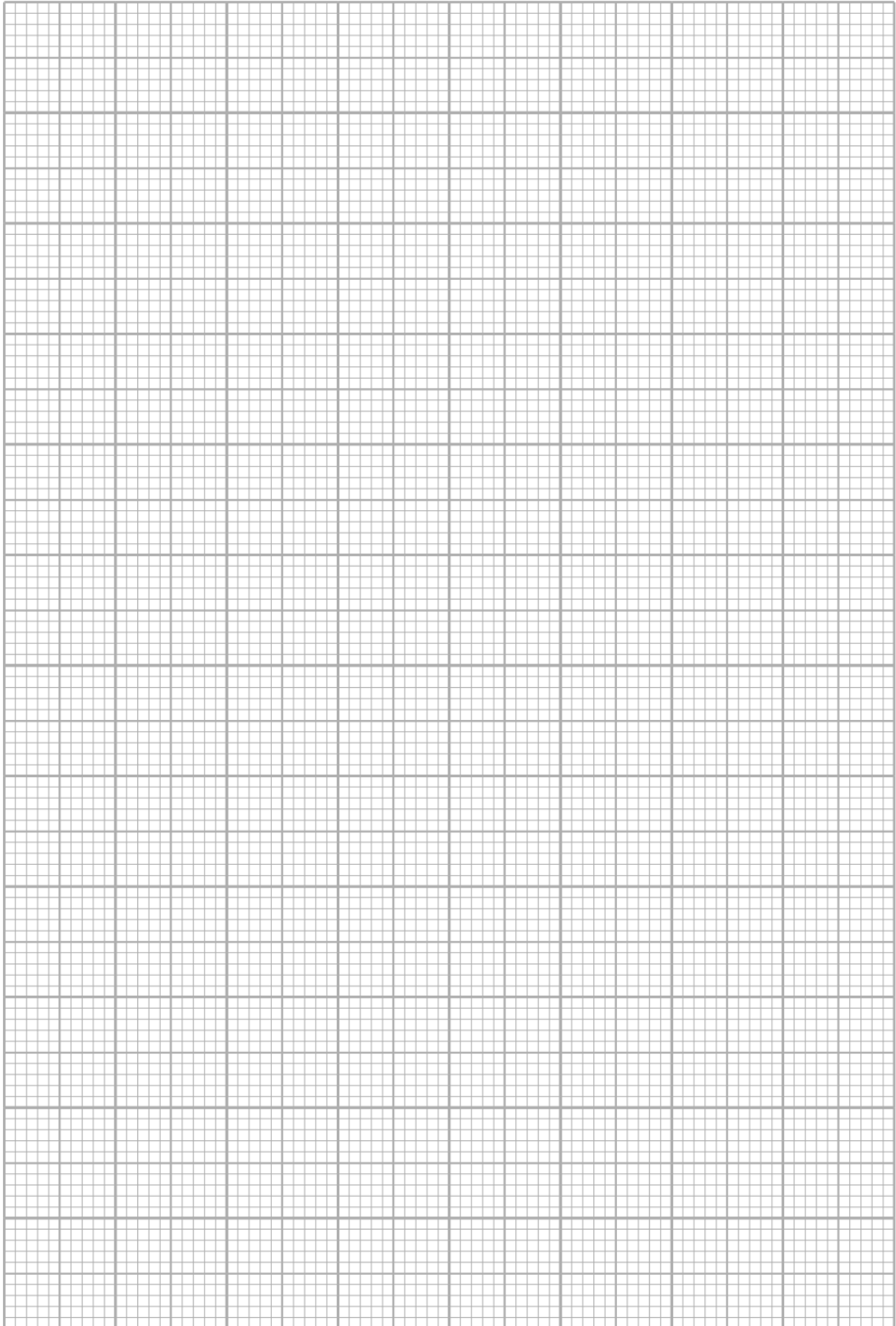
- j. Would you expect these results to change if all the contents of the test tubes were increased to 7.5 cm<sup>3</sup> instead of 5 cm<sup>3</sup>? Explain.

---

---

(1)

**(Total: 21 marks)**



2. Cross section through a human liver.

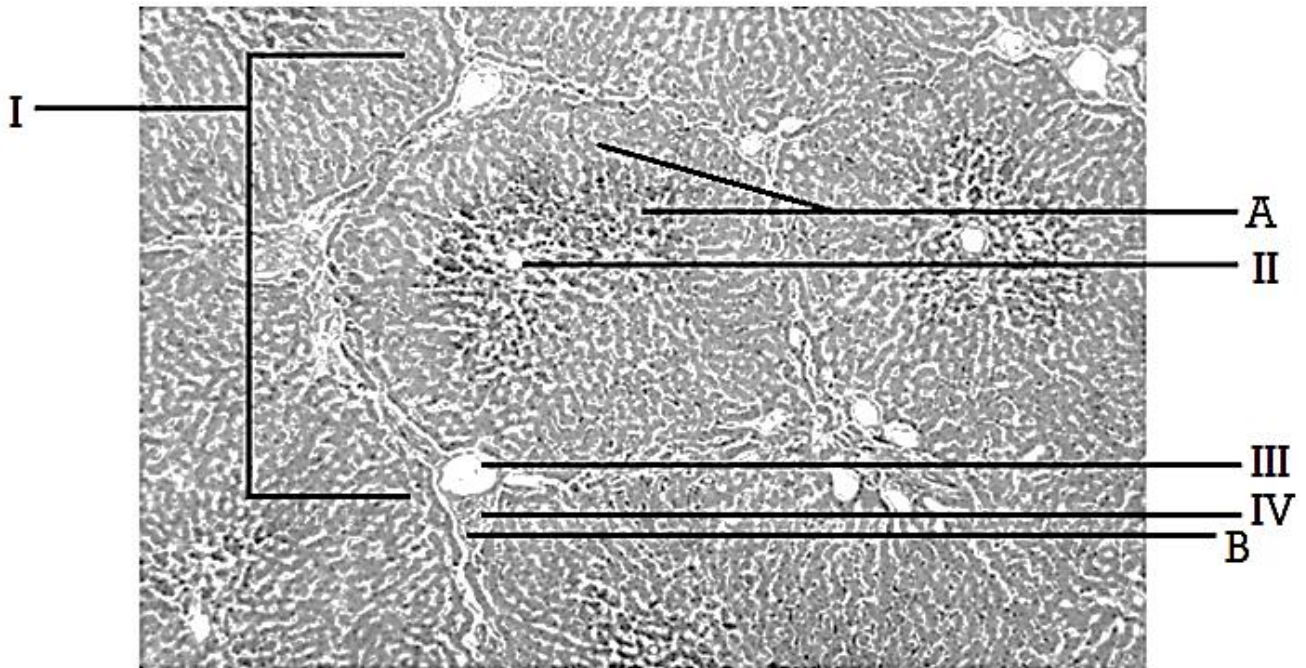


Figure 1: Cross-section through a human liver mag. X400

(Obtained from <http://www.meddean.luc.edu/lumen/MedEd/orfpath/images/fig02x.jpg>)

a. Label and annotate structures I to IV.

Structure	Label	Annotation
I		
II		
III		
IV		

(6)

b. Structures A and B show the sinusoids and bile duct respectively. Describe the function of each of these two structures:

i. Sinusoids:

---

---

---

ii. Bile duct:

---

---

---

(2)

c. The liver generates circa 800 mL to 1000 mL of bile per day. Where is this stored?

---

(1)

d. Figure 2 is a graphical representation of the changes in the levels of blood sugar and insulin for a non-diabetic adult, as measured over 24 hours. The mealtimes (namely breakfast, lunch and supper) and night-time were recorded and included in the graph.

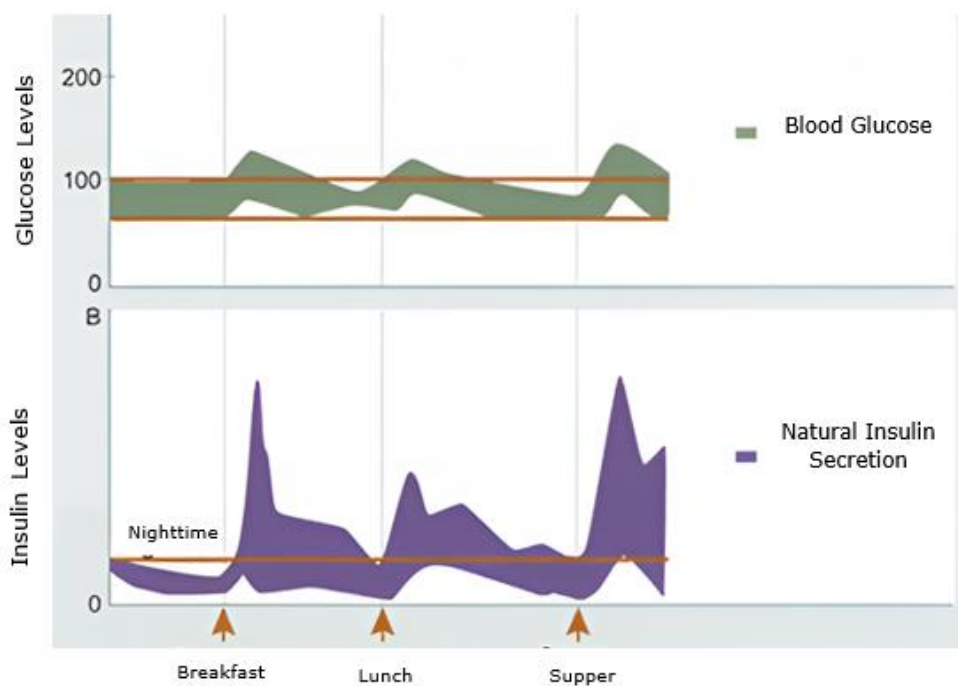


Figure 2: A Graph showing Non-Diabetic Blood Glucose and Insulin Levels over 24 Hours

(Obtained from: <http://diabeticmealsplan.blogspot.com/2016/07/normal-blood-sugar-graph-24-hours.html>)

**Please turn the page**

- i. Using the data provided in this graph, give an account of the role of the liver, together with the pancreas, in the homeostasis of blood glucose after meals.

---

---

---

---

---

(3)

- ii. How do the liver and pancreas regulate blood sugar levels during night-time?

---

---

---

---

---

(3)

**(Total: 15 marks)**

3. This question is about the diversity of living organisms.

Figure 3 is an electron microscope image of *Escherichia coli*.

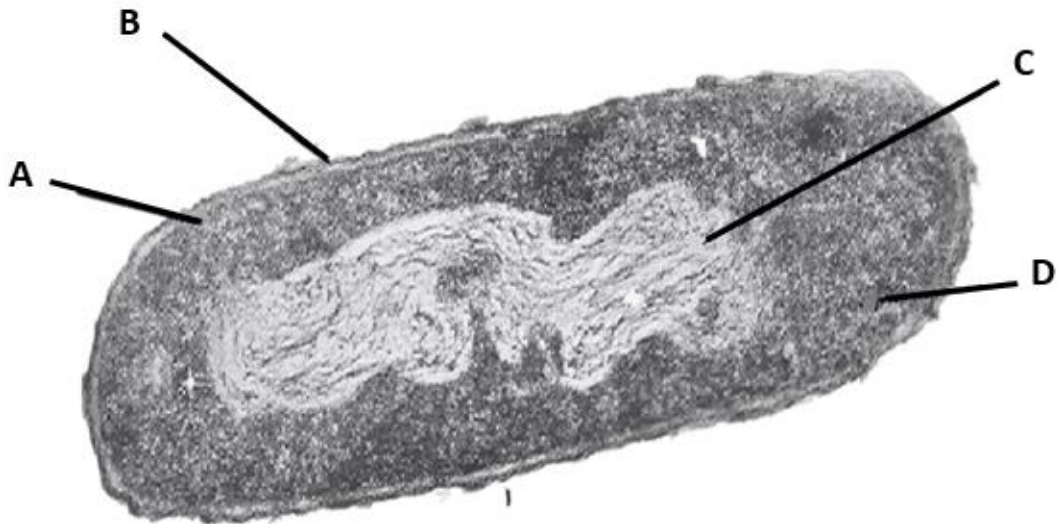


Figure 3: Image of *Escherichia coli*

(Obtained from <https://slidetodoc.com/the-ultrastructure-of-cells-topic-1-2-1/>)



a. To which kingdom or division does this species belong?

(1)

b. Identify structure A-D in Figure 3.

Structure	
A	
B	
C	
D	

(4)

c. Figures 4 and 5 represent two species that belong to the same phylum.

i. To which phylum do the species in Figures 4 and 5 belong?

(1)



Figure 4  
(Obtained from

<https://store.prod.carolina.com/images/product/large/30-6124.jpg>)



Figure 5

(Obtained from

[https://species.wikimedia.org/wiki/Aurelia\\_aurita](https://species.wikimedia.org/wiki/Aurelia_aurita))

**Question continues on next page.**

ii. Mention one feature visible in **both** species, that is characteristic of this phylum.

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

iii. Which are the dominant polymorphic stages exhibited by each of these two species in Figures 4 and 5?

Figure 4: \_\_\_\_\_

Figure 5: \_\_\_\_\_ (1)

d. Figures 6 to 8 represent three species that belong to the same phylum.

i. Name the phylum to which the three species belong and identify the class linked to **each** figure. (2)

Phylum: \_\_\_\_\_

Class for Figure 6: \_\_\_\_\_

Class for Figure 7: \_\_\_\_\_

Class for Figure 8: \_\_\_\_\_



Figure 6  
(Obtained from <https://encrypted-tbn0.qatatic.com>)



Figure 7  
(Obtained from <http://naturaimalta.blogspot.com>)



Figure 8: (Obtained from <https://www.warrenphotographic.co.uk>)

ii. How many tagmata do each of these three species have?

Figure 6: \_\_\_\_\_

Figure 7: \_\_\_\_\_

Figure 8: \_\_\_\_\_(3)

iii. Mention **ONE** visible morphological feature, common for all these three organisms, that is characteristic of this phylum.

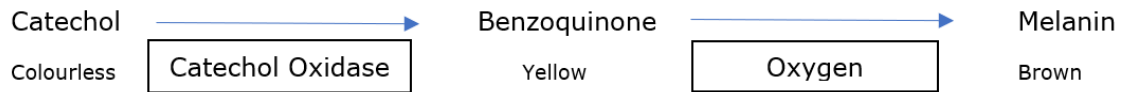
\_\_\_\_\_  
\_\_\_\_\_ (1)

**(Total: 14 marks)**

***Questions continue on next page.***

**SECTION B: Answer all parts to this question.**

1. Some fruits and vegetables, such as bananas and potatoes contain an enzyme called catechol oxidase. This enzyme facilitates the browning of cut or bruised produce. It acts on its substrate catechol, to form a yellow compound which then reacts with oxygen in the air to form brown melanin pigments, responsible for the dark colour of fruits.



Para-hydroxybenzoic acid (PHBA) is known to inhibit the enzyme catechol oxidase. This experiment is trying to find out the minimum concentration of PHBA that fully inhibits a known concentration of catechol oxidase. A colorimeter will measure the intensity of the brown colour formed by calculating % transmittance at the end of the experiment. This will indicate how active the enzyme is.

You are required to devise an experiment to determine the volume of PHBA that fully inhibits catechol oxidase.

You are provided with the following materials:

- Buffer solution pH 7
- Catechol solution (potato juice)
- 1 M stock solution of PHBA
- Syringes
- Test-tubes and rack
- Pipettes
- Colorimeter
- Marker pen

**Suggested volumes:**

0.5 cm<sup>3</sup> of 1 M catechol oxidase with 2.5 cm<sup>3</sup> of buffer

3.0 cm<sup>3</sup> of catechol

3.0 cm<sup>3</sup> of 1 M PHBA

- a. State the aim of your biological investigation.

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

\_\_\_\_\_

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

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

\_\_\_\_\_

- c. Complete the diagram below by including the mixture composition and concentration of PHBA for each test-tube. Briefly describe the method used to prepare a serial dilution of 1 M PHBA.

<p><b>Mixture Composition:</b></p> <p>10cm<sup>3</sup> of 1M PHBA</p> <p><b>Concentration of PHBA:</b></p>	<p><b>Mixture Composition:</b></p> <hr style="width: 80%; margin: 0 auto;"/> <p><b>Concentration of PHBA:</b></p>	<p><b>Mixture Composition:</b></p> <hr style="width: 80%; margin: 0 auto;"/> <p><b>Concentration of PHBA:</b></p>	<p><b>Mixture Composition:</b></p> <hr style="width: 80%; margin: 0 auto;"/> <p><b>Concentration of PHBA:</b></p>
<b>Test-tube 1</b>	<b>Test-tube 2</b>	<b>Test-tube 3</b>	<b>Test-tube 4</b>

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_ (6)

- d. Using the material provided, devise and describe an experimental procedure that may be used to find the concentration of PHBA that fully inhibits the action of catechol oxidase enzyme.

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

**Question continues on next page.**



e. The results obtained from the experiment indicated above are the following:

Test-tube	Concentration of PHBA	% Transmittance			Average
		Reading <sub>1</sub>	Reading <sub>2</sub>	Reading <sub>3</sub>	
1		97	98	97	
2		98	98	97	
3		52	48	51	
4		35	34	32	

(4)

f. List and justify **TWO** precautions for this investigation.

---



---



---



---

(2)

g. List and justify **TWO** errors for this investigation.

---



---



---

(2)

h. What is the function of the pH buffer in this experiment?

---



---

(1)

i. Explain the trend that emerges from your data and provide an explanation for your results.

---



---



---



---



---

**Question continues on next page.**

---

---

---

---

\_\_\_\_\_ (6)

j. What is the minimum concentration of PHBA that fully inhibits catechol oxidase?

---

---

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

k. In a separate experiment, the concentration of catechol oxidase was doubled. Here, it was noted that in test-tube 2, the average percentage transmittance was down to 65%. What type of inhibitor is PHBA for catechol oxidase? Explain your answer.

---

---

---

---

---

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

**(Total: 40 marks)**