



L-Università
ta' Malta

MATRICULATION AND SECONDARY EDUCATION CERTIFICATE
EXAMINATIONS BOARD

**INTERMEDIATE MATRICULATION LEVEL
2021 SECOND SESSION**

SUBJECT: **Biology**
DATE: 11th October 2021
TIME: 4:00 p.m. to 7:05 p.m.

Directions to Candidates

- Write your index number in the space at the top left-hand corner of this page.
- Answer **ALL** questions in Section A and **TWO** questions from Section B.
- Write all your answers to questions from Section A in the spaces provided in this booklet. Candidates are advised that under no circumstances should answers to Section A be submitted in the separate answer booklet provided.
- Write all your answers to questions from Section B in the separate answer booklet provided.
- If more than two questions from Section B are attempted, only the first two answers 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.

For examiners' use only:

Question	1	2	3	4	5	6	7	8	9	10	Total
Score											
Maximum	8	7	9	9	17	25	25	25	25	25	100

SECTION A: Answer ALL questions in this section.

1. This question is about the chemistry of life.

a. Distinguish between an atom and an ion.

(1)

b. The three commonest elements are carbon, hydrogen and oxygen. A variety of other elements are important to life on earth. Mention another **TWO** elements needed by living organisms.

Element 1: _____ (½)

Element 2: _____ (½)

Water is a molecule made up of two hydrogen atoms and an oxygen atom. It has a v-shaped structure and is a polar molecule which can form hydrogen bonds. This enables water to have various unique properties.

c. Briefly describe **THREE** unique properties of water referring to hydrogen bonding.

Property 1:

(1)

Property 2:

(1)

Property 3:

(1)

d. Describe the significance of water to organisms as:

i. a transport medium;

_____ (1)

ii. a coolant;

_____ (1)

iii. a habitat.

_____ (1)

(Total: 8 marks)

2. This question is about the cell theory.

a. Cells can be classified as either prokaryotic and eukaryotic. These cells have various structures and organelles in common. List **FOUR** structures found in both prokaryotic and eukaryotic cells.

_____ (2)

b. What is an organelle?

_____ (1)

c. Name a non-membrane bound organelle and give its function.

_____ (1)

d. Name a membrane bound organelle found in both eukaryotic animal and eukaryotic plant cells and give its function.

_____ (1)

This question continues on the next page.

e. Why is it important for eukaryotic cells to have membrane bound organelles?

_____ (2)

(Total: 7 marks)

3. This question is about gaseous exchange in humans.

Figure 1 shows how the respiratory system of a healthy individual and a person who suffers from pulmonary fibrosis are different from each other.

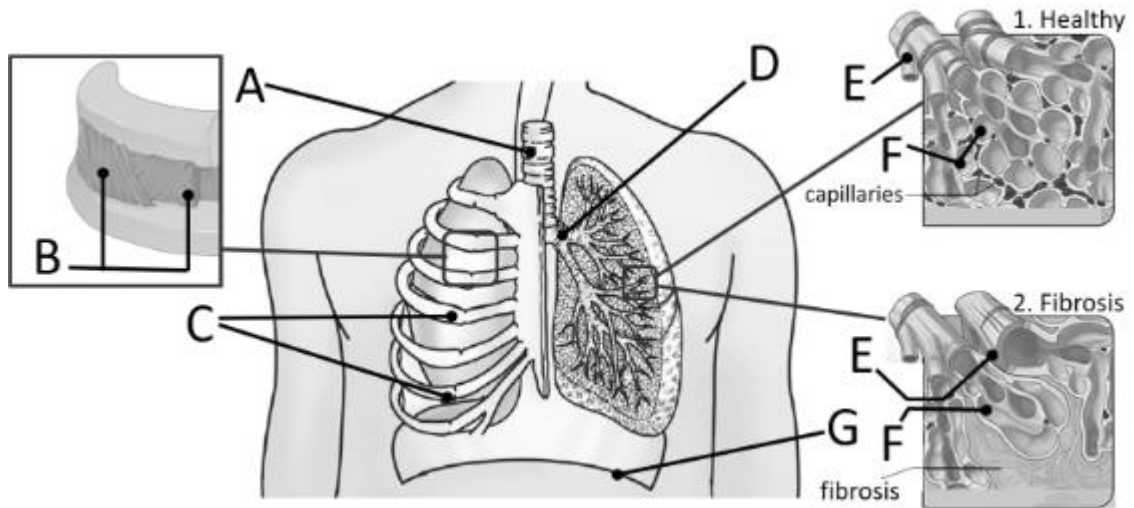


Figure 1: Respiratory system of 1. Healthy lungs; 2. Lungs with Pulmonary Fibrosis
Adapted from: <https://gentleforindustrial.blogspot.com/>

a. Name the following structures:

Label on Figure 1	Name of structure
A	
D	
E	
F	

(2)

b. Briefly explain the importance of having a ventilation system.

(3)

c. Pulmonary Fibrosis describes a condition in which the lung tissue becomes thickened, stiff and scarred. The tissue can be seen labelled in Figure 1 as fibrosis.
 Explain why people with Pulmonary Fibrosis often complain about shortness of breath and fatigue (tiredness).

(2)

d. With millions of people across the world battling COVID-19 infections, many of them struggling to breathe, ventilators have become a top priority. A ventilator takes over the body's breathing process when lungs start to fail.

Modern ventilators work by pumping oxygen-rich air into the lungs, a system known as positive-pressure ventilation. Why is the air pumped in enriched with extra oxygen?

(2)

(Total: 9 marks)

4. This question is about protein synthesis and mutations.

Figure 2 below, shows how a certain enzyme is synthesised in cells.

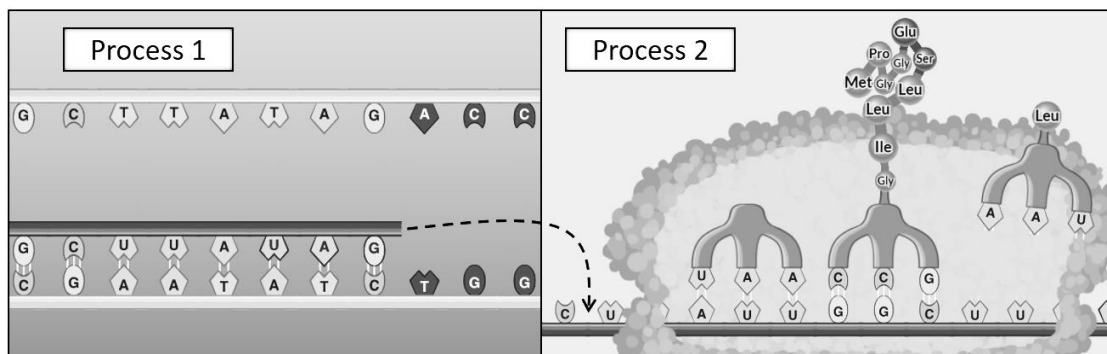


Figure 2: Synthesis of an enzyme
 adapted from: <https://www.biologycorner.com/worksheets/DNA-sim.html>

This question continues on next page.

a. Name Process 1 and Process 2.

Process 1: _____ (1/2)

Process 2: _____ (1/2)

b. Where exactly in the cell do these processes happen?

Process 1: _____ (1/2)

Process 2: _____ (1/2)

c. Briefly explain what is happening in Process 1.

 _____ (1)

d. Briefly explain what is happening in Process 2.

 _____ (1)

Following exposure to a mutagen, the cell stopped producing functional copies of the enzyme.

e. What is a mutagen? Give **ONE** example.

 _____ (1)

The following diagram shows the enzyme produced before and after exposure to the mutagen:

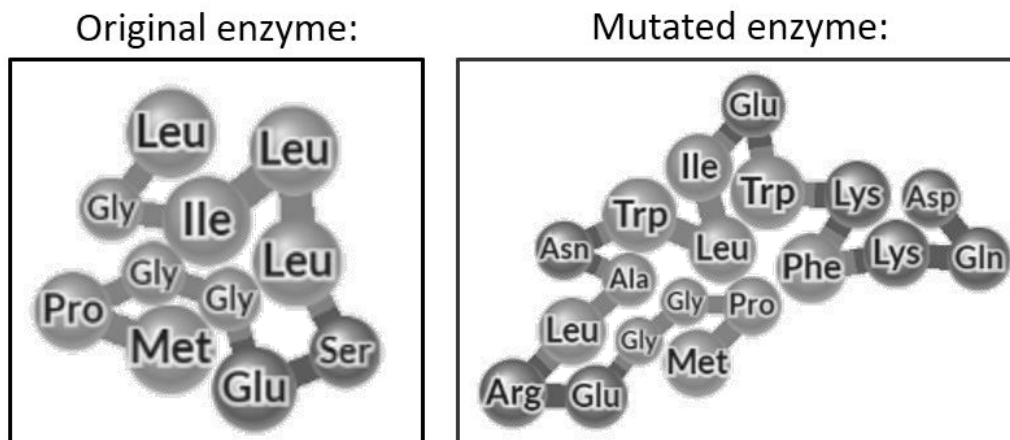


Figure 3: Before and after exposure to a mutagen
 adapted from: <https://www.biologycorner.com/worksheets/DNA-sim.html>

f. The original enzyme consists of 11 amino acids. How many bases (nucleotides) code for this enzyme? (Do not take into account the bases that make the stop codon)

_____ (1)

g. Given that the first amino acid is Methionine (Met) and that only **ONE** mutation happened, on which codon did the mutation occur.

_____ (1)

h. Explain why the mutated enzyme was not "functional".

_____ (2)

(Total: 9 marks)

5. This question is about human impact on the environment and evolution.

Human-induced trait changes have nowadays been documented in various ecosystems: a 2011 study concluded that around 82% of findings in which modern-day trait changes had been documented in the wild were linked to human activity.

5 For example, in 2001 a group of scientists showed that **eutrophication** caused *Daphnia* to evolve resistance to toxic cyanobacteria. In 2003, another group of scientists suggested that **trophy-hunting** in a population of bighorn sheep (*Ovis canadensis*) drove reductions in horn and body size while a separate study also showed how **elevated carbon dioxide levels in the atmosphere** has altered the nitrogen composition in plant leaves.

Adapted from: <https://onlinelibrary.wiley.com/doi/epdf/10.1111/j.1752-4571.2011.00212.x>

a. Define evolution.

_____ (2)

b. The author of the paper was careful to refer to current examples as "human-induced trait changes" (line 1) rather than "evolution". With reference to the definition provided in part (a), explain why not all trait changes may be examples of evolution.

_____ (2)

This question continues on the next page.

c. Briefly explain what eutrophication (line 5) is and how humans cause it.

(3)

d. Trophy-hunting is the killing of wild animals as trophies, with the whole or parts of the hunted animal kept and usually displayed to represent the success of the hunter. Using your knowledge of the evolutionary process, briefly explain how trophy-hunting of bighorn sheep could result in the evolution of smaller horns.

(4)

e. The authors of this paper concluded that reducing the horn and body size of bighorn sheep could influence their population growth since it removes mate attracting males from the population. Briefly explain how a reduction in reproduction rate affects population growth.

(2)

f. Explain why "elevated carbon dioxide levels in the atmosphere" (lines 8-9) is listed as a human activity.

(4)

(Total: 17 marks)

SECTION B:

Answer any TWO questions from this section; each question carries 25 marks. If more than two questions are attempted, only the first two answers shall be taken into consideration.

Write all your answers to questions from this section in the separate answer booklet provided.

6. This question is about transport mechanisms in organisms.
- A unicellular organism like Amoeba transports a variety of substances into, across and out of its cell, yet it does not have a heart. Explain. (5)
 - Describe the function of **each** of the following in the human circulatory system:
 - valves; (5)
 - coronary vessels; (3)
 - heart septum; (4)
 - vena cava; (3)
 - muscular wall of the left ventricle. (3)
 - If a heart is taken out of the body, it will continue beating until its ATP reserves run out. Explain. (2)

(Total: 25 marks)

7. This question is about the reproductive systems of males and females.
- For **each** of the following, give **ONE** similarity and **ONE** difference:
 - testes and ovaries; (2)
 - urethra in males and urethra in females; (2)
 - vas deferens and fallopian tubes; (2)
 - testosterone in males and oestrogen in females; (2)
 - secondary sexual characteristics in males and females. (2)
 - Describe the journey of a sperm from the moment it is produced to the moment it meets and fertilises an ovum. In your description, mention all the structures it passes through and ways in which its surroundings help or hinder its movement. (12)
 - List **THREE** ways in which sexual reproduction leads to genetic variation. (3)

(Total: 25 marks)

Please turn the page.

8. This question is about enzymes involved in gene technology.

A lab technician bought a DNA recombination kit that contained, among other things, EcoRI (a restriction endonuclease / restriction enzyme), DNA polymerase and reverse transcriptase.

- a. What is recombinant DNA technology? (4)
- b. An enzyme is like a key that only fits one lock. EcoRI works on the G-A bond in the base sequence GAATTC. Explain the function of restriction endonucleases in recombinant DNA technology and use the information given to link EcoRI to the formation of sticky ends. (6)
- c. Name **ONE** other type of enzyme that you would expect to find in the kit and briefly describe its role in the process. (3)
- d. The kit contained the following guidelines:
- Break down DNA at 37°C for 30 minutes or overnight at room temperature (25°C).
 - Do NOT exceed 45°C!
 - Maintain surroundings at pH 8.8.

Using your knowledge on enzymes, explain the instructions listed above. Sketch graphs to illustrate your answer. (12)

(Total: 25 marks)

9. This question is about photosynthesis.

- a. Distinguish between autotrophs and heterotrophs. (2)
- b. Leaves of plants are adapted to carry out photosynthesis. Discuss. (8)
- c. Draw an annotated diagram of the organelle responsible for photosynthesis. (10)
- d. Outline the process of photosynthesis. (5)

(Total: 25 marks)

10. This question is about the carbon and nitrogen cycles.

- a. Give a detailed explanation of the carbon cycle. (10)
- b. Give a detailed explanation of the nitrogen cycle. (15)

The explanation should include flow diagrams and explanation of **each** process to support your answers to parts (a) and (b).

(Total: 25 marks)

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