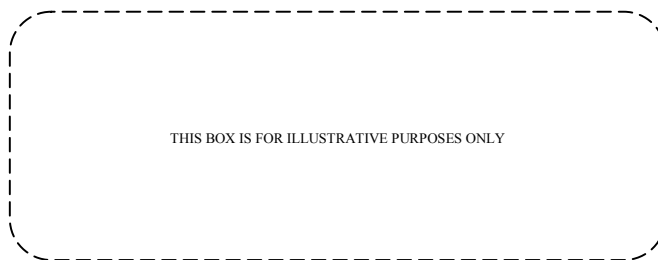




2021 Trial Examination



THIS BOX IS FOR ILLUSTRATIVE PURPOSES ONLY

STUDENT
NUMBER

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Letter

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BIOLOGY

Unit 3 – Written Examination

Reading time: 15 minutes

Writing time: 1 hour and 30 minutes

Question & Answer Book

Structure of book

<i>Section</i>	<i>Number of questions</i>	<i>Number of questions to be answered</i>	<i>Number of marks</i>
A	20	20	20
B	7	7	70
			Total 90

- Students are permitted to bring into the examination room: pens, pencils, highlighters, erasers, sharpeners and rulers
- Students are NOT permitted to bring into the examination room: blank sheets of paper and/or white out liquid/tape.
- No calculator is permitted in this examination.

Materials supplied

- Question and answer book of 21 pages.

Instructions

- Print your name in the space provided on the top of this page.
- All written responses must be in English.

Students are NOT permitted to bring mobile phones and/or any other unauthorised electronic communication devices into the examination room.

SECTION A – Multiple-choice questions

Instructions for Section A

Answer all questions in Section A by circling the correct answer

Choose the response that is correct, or that best answers the question

A correct answer will be awarded 1 mark, and incorrect answer will score 0 marks

Marks will not be deducted for incorrect answers

No marks will be awarded if more than one answer is selected for any question

Question 1

NADH is a coenzyme that plays a critical role in biochemical pathways. Which of the following processes produces the greatest number of NADH molecules?

- A. synthesis of glucose in photosynthesis
- B. the breakdown of glucose into pyruvate
- C. the production of oxygen in photosynthesis
- D. the electron transport chain in cellular respiration

Question 2

When a cell is infected by a virus, it often secretes chemical signal molecules to alert surrounding cells of the presence of a virus. This can trigger surrounding, healthy cells to put up defences to prevent being infected by the virus themselves. These defences could include

- A. releasing hormones to recruit macrophages
- B. reducing the permeability of their cell membranes
- C. inhibiting their own MCH I markers
- D. releasing enzymes to initiate cell lysis

Question 3

Which form of cell membrane transport would most likely be used by a sodium ion moving down its concentration gradient into a cell?

- A. facilitated diffusion
- B. osmosis
- C. active transport
- D. simple diffusion

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Question 4

The plasma membrane is composed of a double layer of phospholipids. Which is true for the phosphate head of a phospholipid molecule?

- A. it is hydrophilic and non-polar
- B. it is hydrophobic and non-polar
- C. it is hydrophilic and polar
- D. it is hydrophobic and polar

Question 5

Photosynthesis is an essential process for plants and algae, and has two main stages, one requiring sunlight and one that does not. Where do the light-dependent reactions of photosynthesis occur?

- A. at the stomata
- B. in the stroma of chloroplasts
- C. within the cytosol
- D. at the thylakoid membranes

Question 6

Thyroid stimulating hormone (TSH) stimulates the thyroid gland to produce thyroxine, which stimulates metabolism in body cells. TSH binds to an extracellular receptor on its target cells. What does this suggest about the TSH hormone?

- A. it is lipophilic
- B. it is hydrophobic
- C. it is steroid based
- D. it is hydrophilic

Question 7

When glycogen and fat energy stores are too low, the body may start to break down amino acids to use as a source of energy. The products of this breakdown are then used to produce glucose. Based on this information, which of the following statements is correct?

- A. synthesis of glucose is an exergonic reaction
- B. the breakdown of amino acids is a catabolic reaction
- C. the body uses proteins as a primary source of energy
- D. glucose manufacture is catabolic process

Question 8

Antidiuretic hormone (ADH) is a peptide hormone that plays an important role in water balance in the body. The reaction that takes place to join the subunits of this hormone can be describe as a/an

- A. condensation polymerisation reaction
- B. exergonic, catabolic reaction
- C. condensation exergonic reaction
- D. hydrolysis polymerisation reaction

Question 9

Most eukaryotic cells respire aerobically. However, during heavy exercise, human muscle cells may switch to anaerobic respiration. Which of these is true for muscle cells that are undergoing anaerobic respiration?

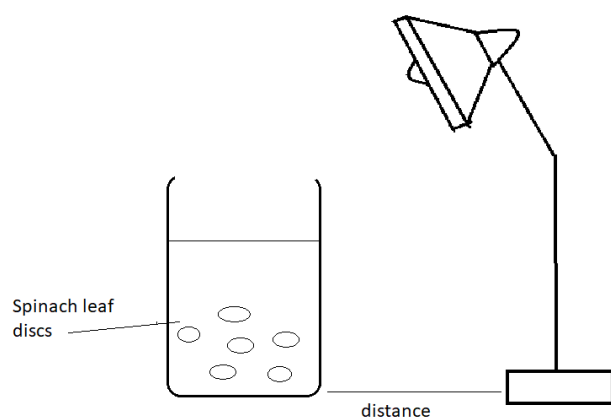
- A. muscle cells can be described as obligate anaerobes
- B. anaerobic respiration is preferable in muscle cells as it is more efficient
- C. when oxygen is not available to muscle cells, cellular respiration occurs in the cytosol
- D. anaerobic respiration involves the glycolysis and Krebs cycle only

The following information applies to Questions 10 – 12

An experiment was set up to test the effect of light intensity on the rate of photosynthesis in spinach leaf discs. Four beakers were prepared, each with 20 spinach leaf discs which had the air removed from them.

White light from a lamp was shone on each beaker. The rate of photosynthesis in the spinach leaves in each beaker was measured by the number of floating leaf discs after 10 minutes.

Light intensity was varied by changing the distance of the lamp from the beakers. Three trials were run for each distance. The figure below illustrates the experimental setup.



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The following results were obtained

Distance of lamp from beaker	Number of floating discs after 10 minutes			
	Trial 1	Trial 2	Trial 3	Average
10 cm	16	18	19	17.7
20 cm	14	14	13	13.7
30 cm	11	15	12	12.7
40 cm	6	4	7	5.7

Question 10

Which set of results is the most reliable?

- A. 10 cm
- B. 20 cm
- C. 30 cm
- D. 40 cm

Question 11

As the distance of the lamp increased, the number of floating discs after 10 minutes reduced.
From the experimental setup, we may conclude that this is because

- A. lower light intensity reduced the amount of energy available to the light-independent reactions, reducing the amount of glucose produced
- B. lower light intensity reduced the amount of NADPH available to the light-dependent reactions
- C. lower light intensity prevented the chloroplasts from absorbing any light energy
- D. lower light intensity reduced the amount of energy available to the light dependent reactions, reducing the amount of oxygen released into the leaf discs

Question 12

Which of the following would need to be a controlled variable in this experiment?

- A. oxygen production
- B. temperature
- C. light intensity
- D. glucose synthesis

Question 13

Protein synthesis consists of two stages: transcription and translation. Which of the following occurs during transcription?

- A. codons and anticodons match up at the ribosomes
- B. a guanine tail is added to a pre-mRNA molecule
- C. DNA polymerase moves along the gene, building an mRNA molecule
- D. RNA polymerase binds to the promoter region of a gene

Question 14

The lac operon is found in many prokaryotes. When the operon is active, proteins are produced that enable the cell to metabolize lactose. When lactose is not present, the operon is not active. Which of these is true for the lac operon in a cell that is metabolizing lactose?

- A. allolactose is bound to the repressor
- B. the repressor is bound to the operator
- C. the repressor is bound to the promoter
- D. DNA polymerase is bound to the operator

Question 15

Proteins form part of the structure of:

- A. phospholipids
- B. messenger RNA
- C. polysaccharides
- D. RNA polymerase

Question 16

The human immune system consists of both immune cells and complementary proteins. One method by which the complement system may attack pathogens is through the formation of a membrane attack complex. Which of the following would result from the formation of a membrane attack complex on a bacterial pathogen?

- A. it would send a signal to the pathogen to undergo apoptosis
- B. it would release large quantities of histamine
- C. it would cause the bacterial pathogen to lyse
- D. it would cause the bacterial pathogen to shrink and form blebs

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Question 17

A section of a DNA double helix is 100 nucleotide pairs long and contains 30 cytosine bases. How many thymine bases does this double helix section contain?

- A. 30
- B. 35
- C. 70
- D. 60

The following information applies to Questions 18 – 20

COVID-19 is a respiratory disease caused by the virus SARS-COV-2. People who have been infected by SARS-COV-2 develop antibodies against the virus. A potential treatment for people suffering from COVID-19 is to administer antibodies directly into their system. These antibodies are sourced from other people who have successfully recovered from COVID-19.

Question 18

What type of immunity is acquired from injecting covid-19 patients with antibodies?

- A. active, natural immunity
- B. active, artificial immunity
- C. passive, natural immunity
- D. passive, artificial immunity

Question 19

When comparing the people who were infected with SARS-COV-2 and produced their own antibodies, with those who received the antibodies, which of these statements is correct?

- A. those who received antibodies directly would have longer lasting immunity
- B. those who received the antibodies directly would produce more memory cells
- C. those who were infected with SARS-COV-2 would have longer lasting immunity
- D. there would be no expected difference in the immunity between the two groups

Question 20

How do antibodies protect the body against SARS-COV-2?

- A. they initiate infected cells to undergo apoptosis
- B. they cause infected cells to lyse
- C. they target specific viral antigens
- D. they release histamine

END OF SECTION A

SECTION B – Short Answer Questions

Instructions for Section B

Answer all questions in the spaces provided

Unless otherwise indicated, diagrams are not drawn to scale

Question 1 (10 marks)

Living things cannot survive without the presence of enzymes. Enzymes are critical to the catalysation of biochemical reactions. For example, in humans, trypsin, an enzyme found in the small intestine, breaks proteins down into amino acids. The body then uses these amino acids to construct the proteins it needs.

- a.** The shape of an enzyme determines its function; in particular, the shape of its active site. Explain the purpose of an enzyme's active site, and why its shape is critical to its function.

2 marks

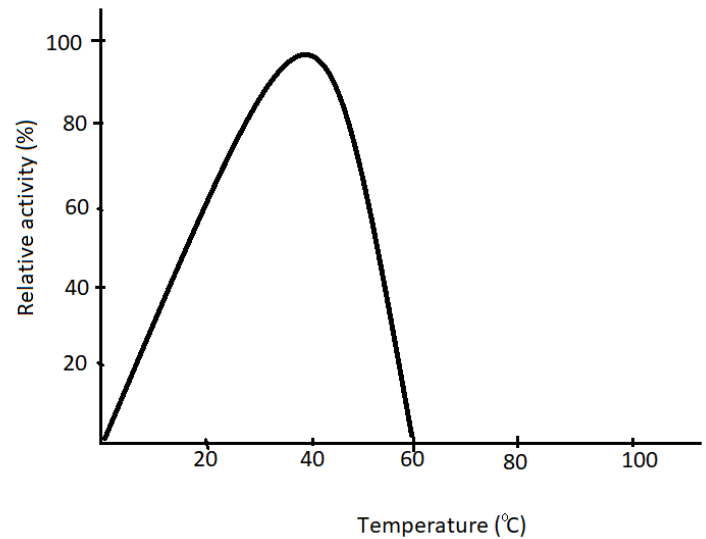
- b.** Trypsin has a quaternary structure. Explain what this means in terms of protein structure.

1 mark

- c.** Imagine there was an error in the transcription stage of the synthesis of trypsin. Describe how, and why, this might affect the structure and function of the enzyme.

3 marks

The following graph shows the activity of trypsin as a function of temperature.



d. Explain the shape of the graph.

2 marks

e. Name two other factors that would affect the activity of trypsin.

2 marks

Question 2 (10 marks)

The human immune system is a complex system that includes a number of immune cells. The immune response can be categorized into the cell-mediated response and the humoral response.

- a. Identify two types of immune cells that play a role in the *adaptive* cell-mediated response, and two types of immune cells that play a role in the *adaptive* humoral response. Briefly describe their functions.

Each cell type can only be used once

8 marks

	Cell Type 1	Cell Type 2
Humoral Response		
Cell-mediated Response		

- b. Describe two differences between the innate immune response and the adaptive, or specific, immune response.

2 marks

Question 3 (10 marks)

A population of a species of starfish are dark red in colour. However, in some individuals, a gene mutation causes them to be white. A section of the normal gene for pigmentation has the following sequence:

5'	AUG	GGU	CCG	AUA	GCA	UUA	CCA	CCC	3'
----	-----	-----	-----	-----	-----	-----	-----	-----	----

The codon table below can be used to determine the corresponding amino acid sequence of the gene.

1st position (5' end) ↓	2nd position				3rd position (3' end) ↓
	U	C	A	G	
U	phe	ser	tyr	cys	U
	phe	ser	tyr	cys	C
	leu	ser	STOP	STOP	A
	leu	ser	STOP	trp	G
C	leu	pro	his	arg	U
	leu	pro	his	arg	C
	leu	pro	gln	arg	A
	leu	pro	gln	arg	G
A	ile	thr	asn	ser	U
	ile	thr	asn	ser	C
	ile	thr	lys	arg	A
	met	thr	lys	arg	G
G	val	ala	asp	gly	U
	val	ala	asp	gly	C
	val	ala	glu	gly	A
	val	ala	glu	gly	G

a. Determine the amino acid sequence of the normal gene.

2 marks

b. In the starfish with the mutation, the fifth nucleotide has the nitrogenous base cytosine instead of guanine. Explain how this would alter the amino acid sequence of the protein.

1 mark

c. Identify the type of mutation described above.

1 mark

d. Explain how this mutation may alter the final tertiary structure of the protein.

2 marks

e. In another type of mutation, an additional cytosine base is inserted between the two cytosine bases of the third codon. Name this type of mutation and explain why this is likely to have more of an effect on the structure of the final protein, compared to the previously described mutation.

3 marks

f. Some mutations have no effect on the sequence of amino acids of the protein. Explain why.

1 mark

Question 4 (10 marks)

Yeast is a single-celled eukaryotic organism capable of both aerobic and anaerobic respiration. An experiment was conducted to investigate the effect of temperature on the rate of respiration in yeast.

A sample of yeast was placed in three airtight containers, and a glucose solution was added. The containers were sealed shut. One beaker was kept at 10⁰C, one at 35⁰C, and the third at 70⁰C. The levels of oxygen and ethanol were monitored over a period of 90 minutes. The initial and final percentages of oxygen and ethanol in the sealed containers were recorded.

Temperature	Initial % of Oxygen	Final % of Oxygen	Initial % of Ethanol	Final % of Ethanol
10 ⁰ C	21	19	0	2
35 ⁰ C	21	15	0	6
70 ⁰ C	21	21	0	0

- a. Explain the changes in the levels of oxygen and ethanol over the 90-minute period for the 35⁰C container.

2 marks

- b. Suggest why the changes in oxygen and ethanol levels were smaller in the 10⁰C container compared to the 35⁰C container.

2 marks

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c. Suggest why there was no change in oxygen and ethanol levels in the 70⁰C container.

1 mark

d. Identify two variables that would have needed to be controlled for in this experiment.

2 marks

e. Compare aerobic and anaerobic respiration in terms of speed and efficiency

2 marks

f. How would you expect the carbon dioxide levels in the 35⁰C container to change over the 90-minute period?

1 mark

Question 5 (10 marks)

Apoptosis, or programmed cell death, can be initiated from within the cell or from a signal that comes from outside the cell.

- a.** Identify two reasons why a cell may undergo apoptosis.

2 marks

- b.** Describe a situation that would result in a cell undergoing the extrinsic pathway of apoptosis and identify an immune cell that would initiate this process.

2 marks

- c.** Describe three changes that occur inside a cell when it undergoes the intrinsic pathway of apoptosis.

3 marks

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- d.** Malfunctions in apoptosis can lead to cancerous tumors. Describe the links between rates of apoptosis, cell growth, and tumor growth.

2 marks

- e.** Explain the difference between apoptosis and necrosis.

1 mark

Question 6 (10 marks)

During certain times of the year, many people suffer from hay fever. A common cause of hay fever is pollen. The pollen causes an allergic reaction in the body.

- a.** In the allergic response, the pollen interacts with a specific type of immune cell when it enters the body. The allergic response follows.

i) Name this immune cell.

1 mark

ii) Name the proteins that attach to this immune cell to cause an allergic reaction.

1 mark

iii) Name the chemical released by this immune cell when it encounters a pollen particle and describe the effects of this chemical on the body.

2 marks

- b.** Describe the order of events that occur during an allergic reaction, including what occurs during the first and second exposure to the allergen.

4 marks

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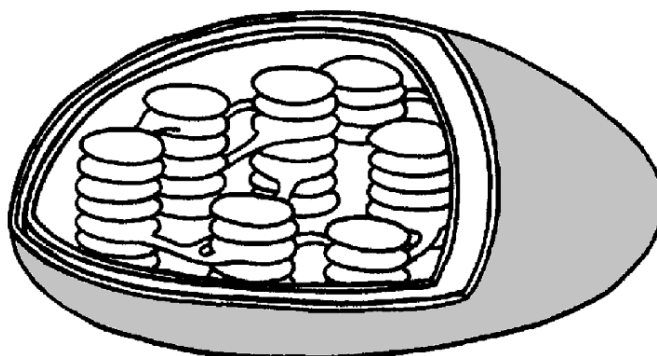
- c. Identify one way in which a person with a pollen allergy could reduce the severity of their hay fever and explain why this would reduce their hay fever.

2 marks

Question 7 (10 marks)

Photosynthesis is an essential process for plants and algae. Photosynthesis consists of two main stages: the light-dependent reactions and the light-independent reactions.

- a. On the diagram of a chloroplast below, circle a region in which the light-dependent reactions would occur. Name this structure.



2 marks

- b. What is the purpose of photosynthesis?

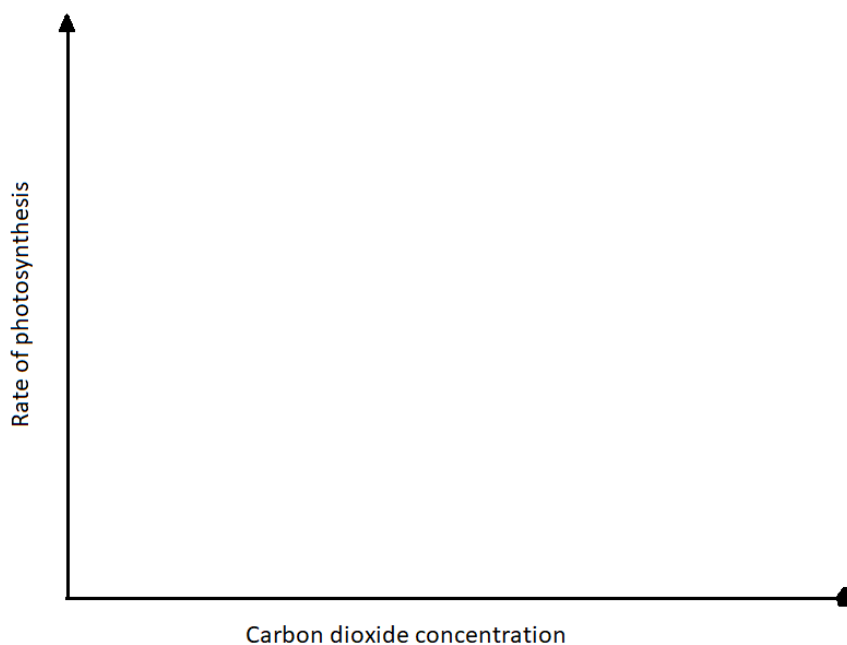
1 mark

- c. The light-dependent reactions of photosynthesis produce energy-carrying molecules. Name one of these molecules.

1 mark

- d. Carbon dioxide is a limiting factor to photosynthesis. On the axes below, draw a graph showing how rate of photosynthesis would be expected to vary with carbon dioxide concentration.

1 mark



- e. Explain the shape of the graph you drew in part d).

2 marks

- f. Identify another limiting factor of photosynthesis.

1 mark

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- g.** The endosymbiotic theory proposes that chloroplasts evolved from free-living prokaryotic organisms. Describe two pieces of evidence for this theory.

2 marks

END OF QUESTION AND ANSWER BOOK