THE SCHOOL FOR EXCELLENCE (TSFX)

UNIT 3 BIOLOGY 2009

WRITTEN EXAMINATION 1

Reading Time: 15 minutes
Writing Time: 1 hour 30 minutes

QUESTION AND ANSWER BOOK

Structure of Booklet

Section	*Number of questions*	*Number of questions to be answered*	*Number of marks*	*Suggested times (minutes)*
A	25	25	25	30
B	3	3	50	60
Total			75	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 allowed in this examination.

Materials supplied

- Question and answer book.

Instructions

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

At the end of the examination

- Place the answer sheet for the multiple-choice questions inside the front cover of this book.

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

THE SCHOOL FOR EXCELLENCE

UNIT 3 BIOLOGY 2009

Name: _____

SECTION A: ANSWER SHEET

Circle the letter corresponding to the best alternative.

1.	A	B	C	D
2.	A	B	C	D
3.	A	B	C	D
4.	A	B	C	D
5.	A	B	C	D
6.	A	B	C	D
7.	A	B	C	D
8.	A	B	C	D
9.	A	B	C	D
10.	A	B	C	D
11.	A	B	C	D
12.	A	B	C	D
13.	A	B	C	D
14.	A	B	C	D
15.	A	B	C	D
16.	A	B	C	D
17.	A	B	C	D
18.	A	B	C	D
19.	A	B	C	D
20.	A	B	C	D
21.	A	B	C	D
22.	A	B	C	D
23.	A	B	C	D
24.	A	B	C	D
25.	A	B	C	D

Section A:	**/25**
Section B:	**/50**
Total:	**/75**

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SECTION A – MULTIPLE-CHOICE QUESTIONS

Instructions for Section A

Answer all questions in pencil on the answer sheet for multiple-choice questions. A correct answer scores 1, an incorrect answer scores 0. Marks will **not** be deducted for incorrect answers. No marks will be given if more than one answer is completed for any question.

QUESTION 1
The formation of a polypeptide chain at a ribosome is due to a series of:

A Condensation reactions.
B Hydrolysis reactions.
C Exergonic reactions.
D Catabolic reactions.

QUESTION 2
Beta pleated sheets play an important role in providing strength and elasticity to spider webs. The beta pleated sheet is an example of a protein's:

A Secondary structure, which is the result of peptide linkages.
B Secondary structure, which is the result of hydrogen bonding.
C Tertiary structure, which is the result of hydrogen bonding.
D Tertiary structure, which is largely the result of disulphide bridges, ionic and hydrogen bonding and hydrophobic interactions.

QUESTION 3
Despite its undesirable reputation in the wider community, cholesterol is an important molecule in many organisms. One role of cholesterol is that it:

A Maintains membrane fluidity in plant and animal cells.
B Regulates the release of neurotransmitter molecules from axon terminals.
C Prevents solidification of animal cell membranes at very cold temperatures.
D Binds with three fatty acids to form a triglyceride molecule.

QUESTION 4
A series of experiments were conducted by scientists in order to determine the identity of an unknown organic molecule discovered in the fragment of an aquatic organism washed up on a beach. After initial tests were made, the only elements identified in the molecule were carbon, hydrogen, oxygen and nitrogen. Later testing determined that the molecule was a polysaccharide.

Scientist could therefore be confident in assuming the unknown molecule was:

A Cellulose.
B A polypeptide.
C Chitin.
D Glycogen.

QUESTION 5
A variety of organelles are involved in the synthesis and secretion of the peptide hormone, glucagon, from an alpha cell of the pancreas. A correct sequence of organelles involved could be:

A Nucleus → golgi apparatus → free ribosomes → golgi vesicles
B Nucleus → rough ER → smooth ER → lysosomes
C Nucleus → free ribosomes → golgi apparatus → golgi vesicles
D Nucleus → rough ER → golgi apparatus → golgi vesicles

QUESTION 6
Adenosine triphosphate (ATP) is a vital molecule for cellular functions. A net production of ATP molecules occurs during:

A The light-dependent reactions of photosynthesis.
B Phagocytosis of bacteria by a neutrophil.
C The synthesis of glucagon by the rough endoplasmic reticuli of alpha cells within the pancreas.
D The action of the sodium/potassium pump in restoring a resting axon membrane potential.

QUESTION 7
The human body produces many more cells than it can afford to continuously support. Programmed cell death, apoptosis, occurs at different periods of our life to ensure that only the cells required by the body are maintained. Which of the following is not an example of apoptosis?

A Skin cells are destroyed when Jimmy falls off his bike.
B Individual plasma cells perish 2-3 days after their production.
C Unconnected embryonic brain cells die before birth.
D A viral-infected cell dies before the virus has a chance to spread.

QUESTION 8
Electron acceptor molecules play vital roles during cellular reactions. The processes of respiration and photosynthesis could not occur without them. In performing their roles:

A NADH delivers hydrogen atoms to the Krebs cycle.
B NADPH and $FADH_2$ deliver hydrogen atoms to the Krebs cycle
C NADPH delivers hydrogen atoms to the Calvin cycle.
D $NADH_2$ and FADH deliver hydrogen atoms to the electron transport chain of respiration.

QUESTION 9
The small, understorey plants of tropical rainforests receive minimal quantities of light. They survive in wet, humid and relatively dark environments on the forest floor. As such, most of these plants would be expected to possess:

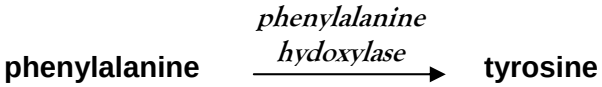
A Dark green leaves and perform C_3 photosynthesis.
B Dark green leaves and perform CAM photosynthesis.
C Light green leaves and perform C_3 photosynthesis.
D Light green leaves and perform C_4 photosynthesis.

QUESTION 10
In the process of cellular respiration, the cristae of mitochondria are the sites of:

A The Krebs cycle, yielding 2 ATP molecules per glucose split.
B The electron transport chain, yielding 32 – 34 ATP molecules per glucose split.
C Glycolysis, yielding 2 ATP molecules per glucose split.
D Lactic fermentation, which yields no further ATP molecule production.

Questions 11-13 refer to the following information:

Phenylalanine hydroxylase catalyses the conversion of phenylalanine to tyrosine:



A student obtained a sample of human phenylalanine hydroxylase, and designed an experiment to investigate the action of this enzyme on phenylalanine at 37°C. The results are illustrated in ***Figure 1:***

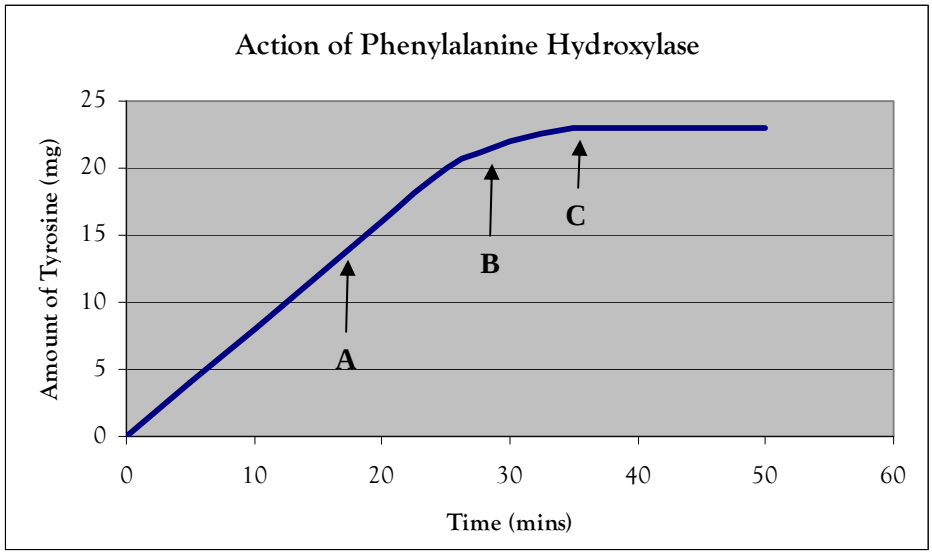


Figure 1

QUESTION 11
The graph indicates that at point C:

A The rate of reaction has reached its peak.
B The rate of reaction would be greater if the experiment was conducted at 40°C.
C pH levels are optimum for this reaction.
D No more substrate is available.

QUESTION 12
Enzyme concentration is a limiting factor at:

A Point A.
B Point B.
C Point C.
D No stage of the experiment.

QUESTION 13
A ground squirrel, with a usual body temperature of 38°C, has a hibernation temperature of only 4°C. Body fat is very slowly consumed during hibernation. When compared to their activity at 38°C, the enzymes responsible for the breakdown of body fat cannot be very active at 4°C as:

A They begin to denature.
B The motion of enzyme and substrate molecules is greatly reduced.
C Competitive inhibitors are activated to prevent excessive respiration.
D Peptide linkages within the enzymes are broken down to provide valuable sources of energy.

A target cell for both a specific peptide hormone and a particular steroid hormone is represented in ***Figure 2*** below. A steroid and peptide hormone have both signalled the cell in the diagram.

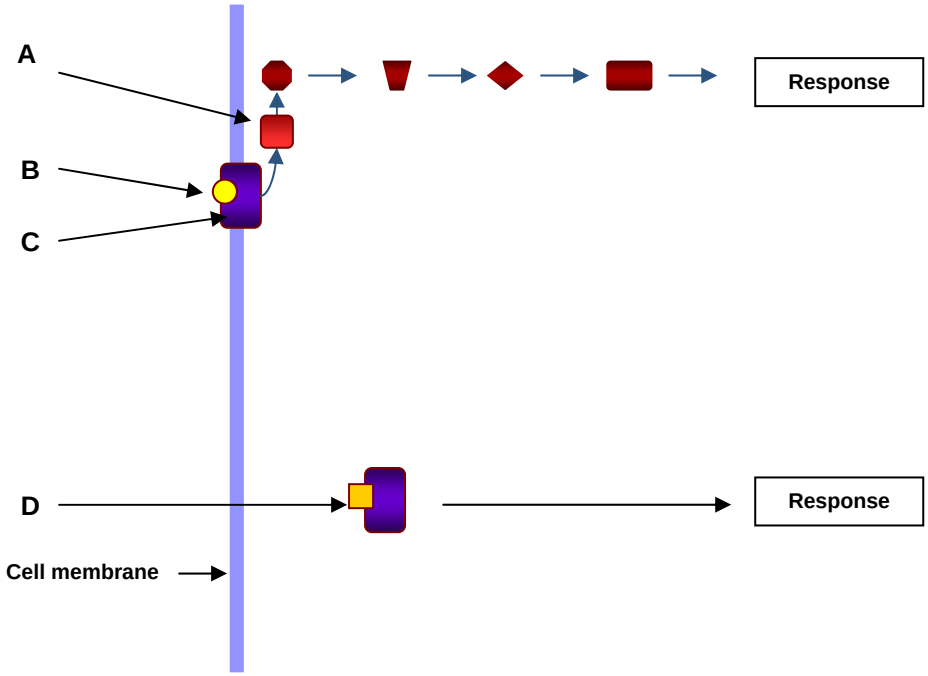


Figure 2

QUESTION 14
Structures A, B, C and D represent the following molecules:

A A = receptor, B = steroid hormone, C = hormone-receptor complex, D = peptide hormone.
B A = G protein, B = receptor, C = hormone-receptor complex, D = cyclic AMP
C A = receptor, B = peptide hormone, C = G protein, D = steroid hormone.
D A = G protein, B = peptide hormone, C = receptor, D = steroid hormone.

QUESTION 15
Signal transduction pathways can involve the response of millions of molecules to a single chemical messenger molecule. For instance, one molecule of adrenalin causes the breakdown of 100,000,000 molecules of glucose from the glycogen store in a liver cell.

If the activation of a cytoplasmic receptor initiates a signal transduction pathway, the original signal could have been provided by:

A A neurotransmitter such as acetylcholine (ACh).
B A steroid hormone such as cortisone.
C A peptide hormone such as insulin.
D A protein hormone such as thyroid stimulating hormone.

QUESTION 16
The following statement is true of plant hormones:

A Auxins cause increased levels of mitosis resulting in phototropic responses.
B Ethylene is a gaseous hormone that is used to prevent stored fruit from ripening.
C With rising temperatures in spring, abscisic acid overrides the inhibitory influence of gibberellins within seeds, thereby stimulating germination.
D Cytokinins delay leaf death (senescence).

QUESTION 17
The term “hormone” is applied to chemical messenger molecules in both plants and animals. One difference in the action of plant and animal hormones is that:

A Some plant hormones exert opposite effects on target cells in different parts of the same organism.
B Plant hormones do not travel in the vascular system.
C Plant hormones are inorganic.
D Animal hormones are exclusively endocrine.

QUESTION 18
Neurotransmitter molecules have a very short lifespan once they have attached to a receptor on a postsynaptic membrane. Enzymes will rapidly degrade the neurotransmitter molecules, and the breakdown products may be returned to the presynaptic cell.

Some insecticides act as competitive inhibitors on the enzymes responsible for the breakdown of excitatory neurotransmitters. The insecticide kills the insect by:

A Preventing impulses from being generated in the postsynaptic cells.
B Preventing the release of more neurotransmitter across the synapses.
C Overstimulating the postsynaptic cells.
D Interfering with the release of inhibitory neurotransmitters of pain control pathways.

QUESTION 19
Interneurons occur within the grey matter of animal nerve tissues. An interneuron:

A Is the most common type of neuron in the human body.
B Only produces myelin when part of a reflex arc.
C Contains many dendrites and axons.
D Uses nodes of Ranvier to speed up impulse transmission.

QUESTION 20
A wide variety of natural and artificial molecules have been used to destroy pathogenic bacteria. One group of molecules, typically alcohol-based, that are used on superficial wounds of the skin are:

A Antiseptics.
B Antibiotics.
C Disinfectants.
D Antibodies.

QUESTION 21
The smallest known pathogens are viroids. They have been responsible for diseases in a variety of plants, including the deaths of millions of coconut palm trees in the Philippines. Viroids are non-cellular pathogens, as each type of viroid is composed of:

A A protein molecule.
B A few peptide-linked amino acids.
C A piece of RNA.
D A piece of DNA.

Questions 22-23 refer to the following information:

The activation of the third line of defence is depicted in ***Figure 3*** below:

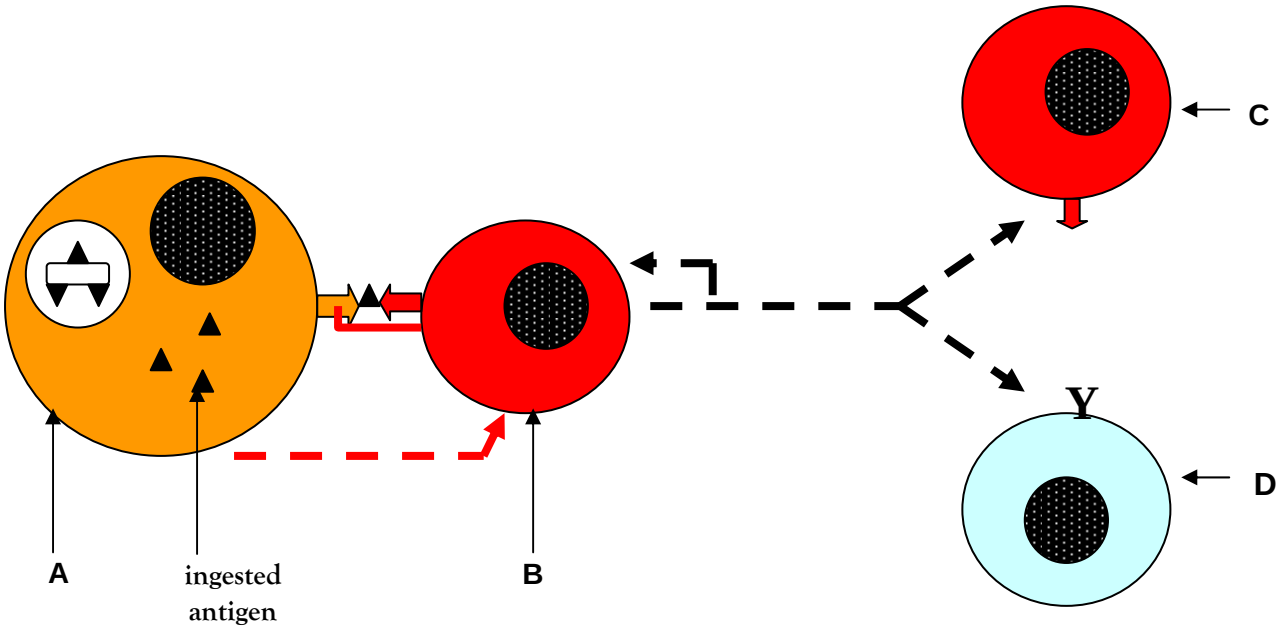


Figure 3: Activation of the third line of defence

QUESTION 22
Using ***Figure 3*** as a guide, which of the following statements is correct?

A A macrophage (cell A) stimulates a cytotoxic T cell (cell B) via presentation of an antigen fragment and the release of interleukin-1.
B A macrophage (cell A) stimulates a helper T cell (cell B) via presentation of an antigen fragment and the release of interleukin-1.
C A helper T cell (cell A) stimulates a cytotoxic T cell (cell B) via presentation of an antigen fragment and the release of interleukin-1.
D A macrophage (cell A) stimulates a helper T cell (cell B) via presentation of an antibody fragment and the release of interleukin-1.

QUESTION 23
Cell D matures in the bone marrow. It plays a very important role in disease defence by

A Specifically attaching to and destroying viral-infected cells with the use of perforin.
B Non-specifically attaching to and destroying viral-infected cells with the use of perforin.
C Activating a widespread attack on pathogens by neutrophils.
D Producing antibodies which specifically bind to pathogens.

QUESTION 24
Knowledge of the ABO and Rhesus blood groups has allowed for thousands of successful blood transfusions in Australia each year. In the nineteenth century, the success of blood transfusions for women losing significant quantities of blood during childbirth was risky, as blood types of both the donor and recipient were unknown.

Today it is recognised that A and B antigens exist for the ABO gene. Any person of Type O simply lacks both antigens. There is no such molecule as a Type O antigen.

Positive antigens (+) may be produced by a form of the Rhesus gene. Individuals who are Rhesus negative (-) simply don't possess the positive antigen. There is no negative antigen.

In which of the following cases should the blood transfusion be successful?

	Blood Type	
	Donor	**Recipient**
A	O^+	O^-
B	A^-	AB^-
C	AB^+	B^+
D	O^+	AB^-

QUESTION 25
Immunoglobulin G (IgG) is the most abundant of the circulating antibodies. It easily crosses capillary walls to enter tissue fluids, and it also crosses the placenta to confer immunity on a developing foetus. IgG protects against bacteria, viruses and toxins in the blood and lymph, as well as activating complement proteins.

What type of immunity is conferred on the foetus by IgG antibodies?

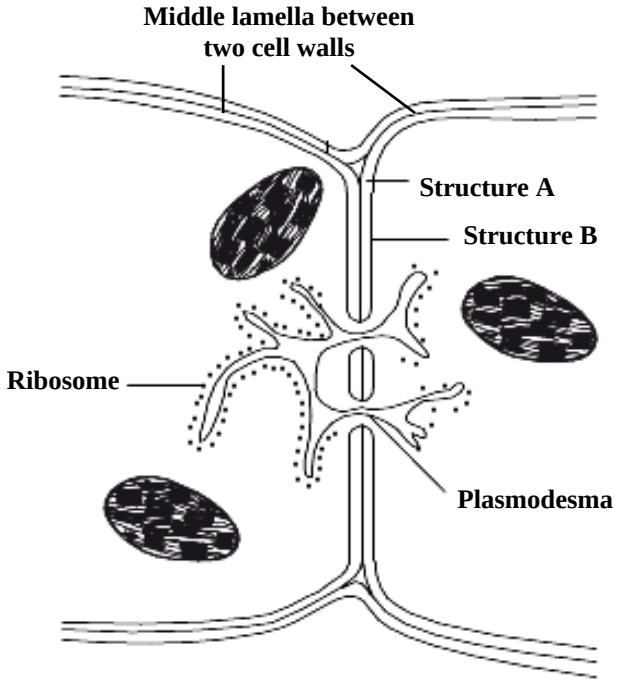
A Natural passive immunity.
B Induced passive immunity.
C Natural active immunity.
D Induced active immunity.

SECTION B: EXTENDED RESPONSE QUESTIONS

Instructions for Section B

Answer this section in pen.
Answer all questions in the spaces provided.

QUESTION 1
Some plant cells have connections through their cell walls called plasmodesmata.



(a) Suggest a likely function of plasmodesmata.

_____

_____

1 mark

(b) i. What is the chemical composition of the Structure A in the diagram above?

_____

_____

1 mark

ii. Explain how the chemical composition of Structure A facilitates its role in the plant cell.

_____

_____

2 marks

(c) i. What is the chemical composition of Structure B?

_____

_____

1 mark

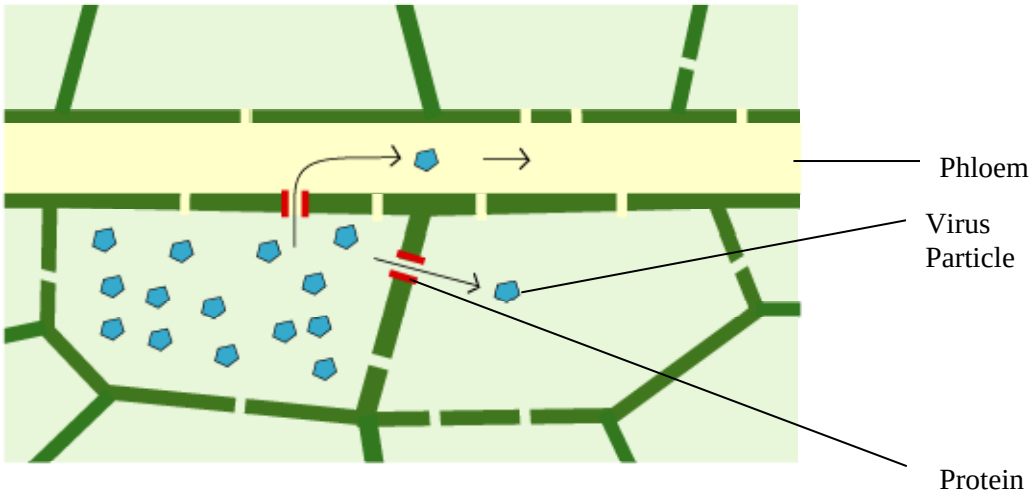
ii. Explain how the chemical composition of Structure B facilitates its role.

_____

_____

2 marks

In order to spread through the plant, viruses take advantage of the plant's own transport system. This involves using the plasmodesmata which connect individual cells, and the phloem vessels which can transport the virus to distant parts of the plant. Virus particles must modify plasmodesmata before they can pass through them. They do this by producing proteins which increase the size of the plasmodesmata.



(d) What is a virus?

_____

_____

1 mark

(e) Explain how the virus is able to produce the protein to increase the size of the plasmodesmata.

_____

_____

_____

_____

2 marks

(f) Outline one way the plant could respond to minimise damage from this virus.

_____

_____

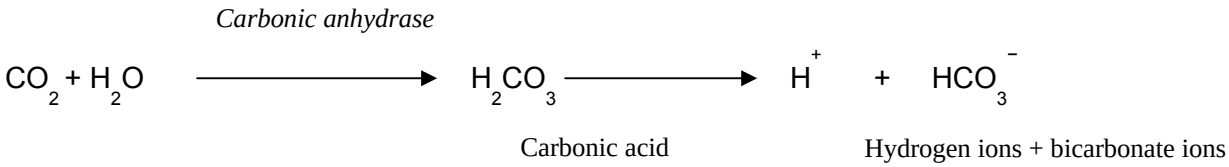
1 mark

Total: 11 marks

QUESTION 2

Carbonic anhydrase is an enzyme found in the cytosol of red blood cells. The primary function of the enzyme is to maintain acid-base balance in blood and other tissues, and to help transport carbon dioxide out of tissues. The active site of carbonic anhydrase contains a zinc ion and a specificity pocket for carbon dioxide.

The reaction catalyzed by carbonic anhydrase is shown below:



(a) Why are enzymes necessary in living organisms?

_____

_____

1 mark

(b) Suggest a purpose for the zinc ion at the active site.

_____

_____

1 mark

(c) How does the shape of the active site of carbonic anhydrase affect its function?

_____

_____

_____

_____

1 mark

(d) Red blood cells mature in the bone marrow where they eject their nuclei before entering the bloodstream. Suggest an advantage in relation to the function of the red blood cell for not having a nucleus.

_____

_____

1 mark

Carbonic anhydrase inhibitors are a class of pharmaceuticals that suppress the activity of carbonic anhydrase. Their clinical use has been established in the management of mountain sickness. Although treatable to some extent by the administration of oxygen, most of the symptoms of mountain sickness do not appear to be caused by low oxygen, but rather by the low CO_2 levels causing a change in blood pH.

(e) What change would a decrease in CO_2 have on the pH of the blood?

_____

_____

1 mark

(f) When CO_2 levels in the body fluctuate, the nervous and endocrine systems work together to restore homeostasis. Define homeostasis.

_____

_____

_____

_____

1 mark

(g) Explain how a carbonic anhydrase inhibitor could be used to treat mountain sickness.

_____

_____

_____

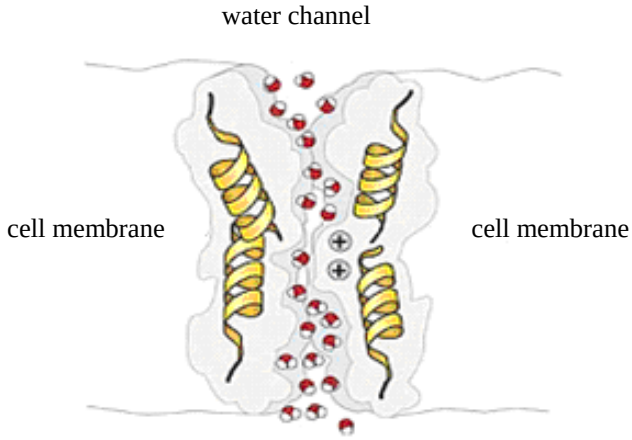
_____

2 marks

Total: 8 marks

QUESTION 3

Biochemists Peter Agre and Roderick MacKinnon used a synchrotron for their discovery of aquaporins, the molecular channels that regulate water transport across cell membranes. They earned the 2003 Nobel Prize for Chemistry for their important research. The selectivity of these channels for water is determined by the chemical architecture and electrically charged sections of the channel molecules.



(a) What class of biomacromolecule are aquaporins likely to be?

_____

1 mark

(b) What type of diffusion describes the movement of water through the aquaporins?

_____

1 mark

(c) Name another method of diffusion involving the movement of water molecules through the plasma membrane?

_____

1 mark

(d) What properties of other biomolecules would prevent them from passing through the aquaporins?

_____

_____

1 mark

(e) Suggest a reason why the discovery of aquaporins could be important in molecular medicine.

_____

_____

_____

_____

1 mark

During their research into aquaporins, the molecule was isolated from cells in renal tubules. Evidence that the molecule was a component of cellular water channels then came in an experiment with frogs' eggs bathed in water solution. One group of eggs were injected with aquaporin RNA while the other group were not.

(f) Explain why renal tubules were selected to isolate the aquaporins.

_____

_____

1 mark

(g) Write a hypothesis based on what you think would happen to the two different groups of eggs.

_____

_____

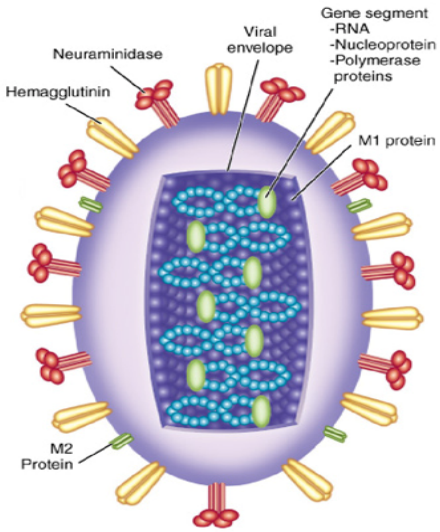
_____

2 marks

Total: 8 marks

QUESTION 4

There are two kinds of protein on the surface of the influenza virus. They play different roles in the infection of a cell. Haemagglutinin is active in gaining entry to a cell, whereas neuraminidase allows for the exit of new virus particles from a cell, freeing them up to infect other cells. The influenza drug *Relenza* works by binding to the active sites of neuraminidase.



(a) Neuraminidase is a protein, which is described as a polymer composed of a series of monomers. Draw a labelled diagram of a protein monomer.

2 marks

(b) Explain how the rationally designed drug *Relenza,* prevents the influenza viruses from infecting other cells after successfully reproducing in the first cells, thereby preventing influenza.

_____

_____

_____

_____

_____

_____

_____

_____

2 marks

(c) The further a virus must travel to reach its target cell, the more likely it is to be destroyed before it gets there. If the influenza virus infects the nose and throat and a person develops the flu, describe two ways in which the body has failed to prevent infection at both the first and second line of defence.

_____

_____

_____

_____

_____

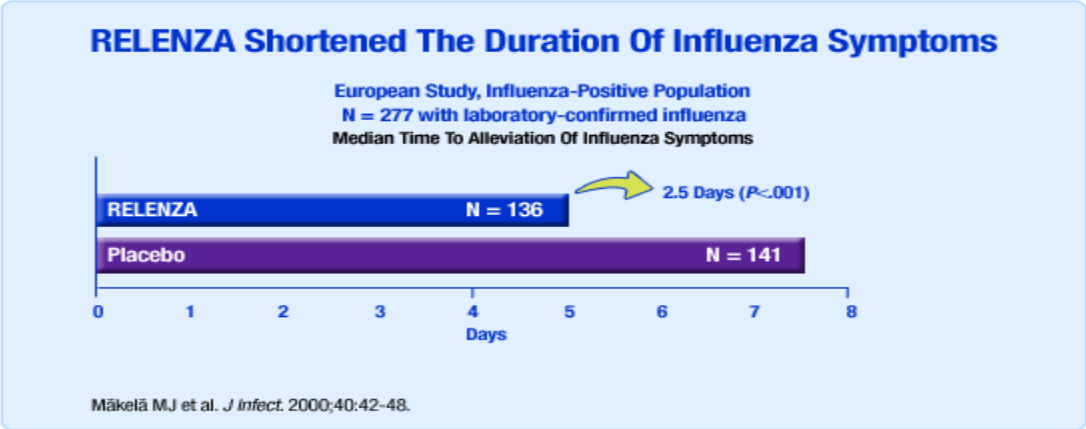
_____

_____

_____

2 marks

The graph below shows the response to *Relenza* in a trial program of 277 people who tested positive for the Influenza virus. A group comprising 136 subjects was given the drug while another group comprising 141 subjects was given a placebo.



(d) What was the purpose of giving one group a placebo?

_____

_____

1 mark

(e) Explain the effect of *Relenza* on influenza symptoms in this particular study.

_____

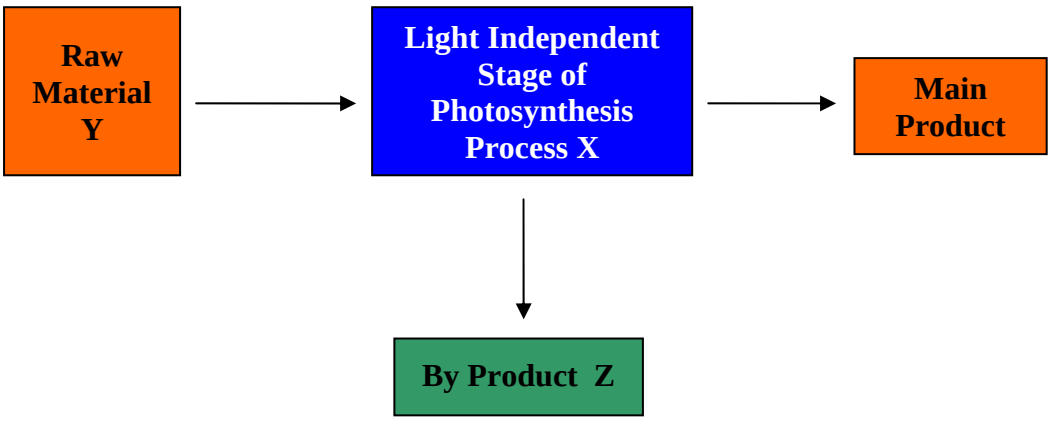
_____

1 mark

Total: 8 marks

QUESTION 5

The following diagram shows a simplified representation of the second stage of photosynthesis:



(a) Name process X.

_____

1 mark

(b) Within a cell, where does process X occur?

_____

1 mark

(c) Name byproduct Z.

_____

1 mark

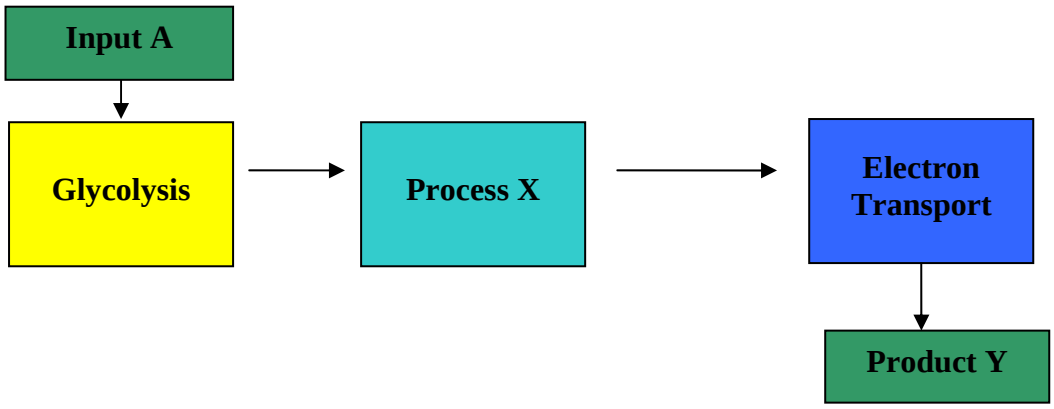
(d) Name the source of raw material Y.

_____

_____

1 mark

The breakdown of glucose during aerobic respiration can be represented as occurring in three main stages as indicated below.



(e) Describe what happens during Process X of aerobic respiration.

_____

_____

_____

_____

_____

_____

2 marks

(f) Name Input A.

_____

1 mark

Total: 7 marks

QUESTION 6

Using an example of a hormone you have studied, describe what a ***signal transduction pathway*** involves (Include a labelled diagram).

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

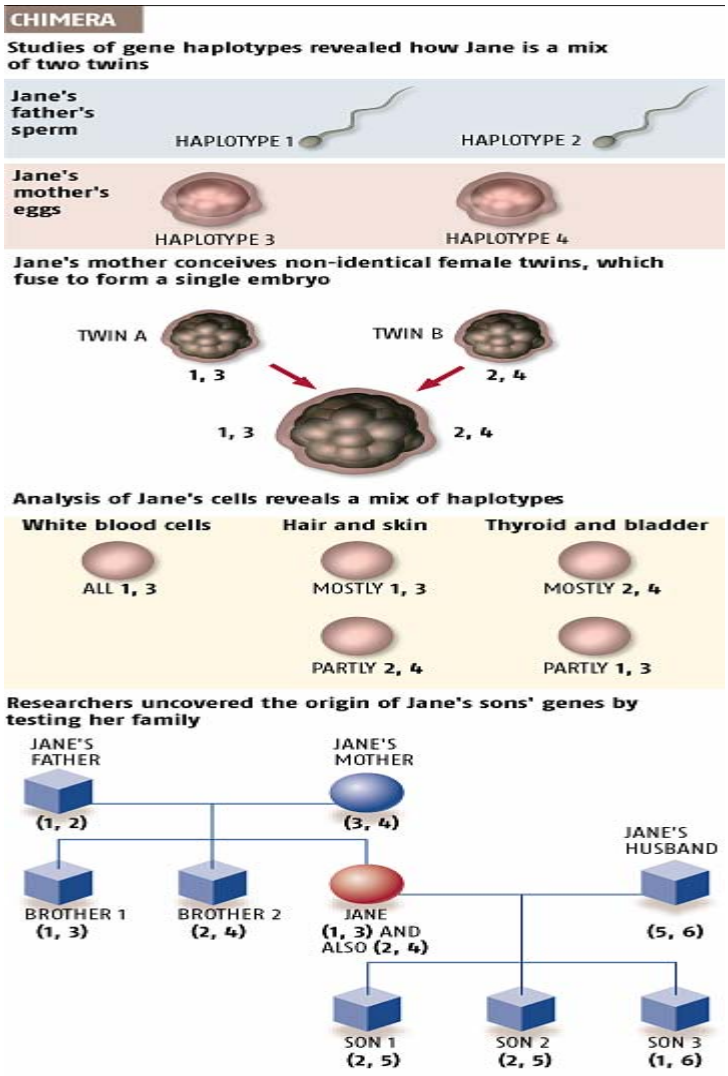
2 marks

QUESTION 7
Jane was a patient in need of a kidney transplant, so her family underwent blood tests to see if any of them would make a suitable kidney donor.

Data was obtained from tests which involved "tissue-typing" Jane and her children. The tests were based on a set of genes called the HLA complex, which encode many different immune proteins, including cell surface proteins that immune cells use to distinguish the body's own tissues from foreign material. There are hundreds of different versions of each HLA gene, and because of this, almost every individual's set of genes is unique. The genes tend to be inherited together in a block known as a haplotype. Everyone inherits two HLA haplotypes, one from each parent.

Tests revealed that some of Jane's tissues carried haplotypes 1 and 3, while others contained haplotypes 2 and 4. Jane's body was made up of two genetically distinct types of cells. There was only one conclusion: Jane was a mixture of two different people.

It was determined that Jane is a chimera, a mixture of two individuals - non-identical twin sisters - who fused in the womb and grew into a single body. Some parts of her are derived from one twin, and other parts from the other twin.



(a) Based on this information, how do you think Jane's prospects of matching with a suitable donor compare with a normal person who is not a chimera?

_____

_____

1 mark

(b) Explain why the closer the match between two people's HLA haplotypes, the lower the risk of transplant between them being rejected.

_____

_____

1 mark

(c) If son 1 required a kidney transplant, based on the haplotypes in the pedigree, who would be the most suitable donor?

_____

_____

1 mark

(d) Following a transplant, describe the process of tissue rejection that may occur in Jane after recognition of non-self cells has occurred.

_____

_____

_____

_____

_____

_____

_____

_____

3 marks

Total: 6 marks