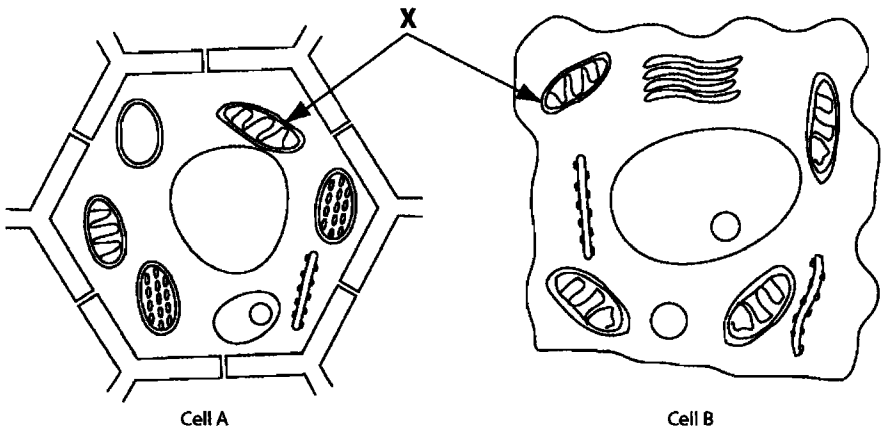
SECTION A / MULTIPLE-CHOICE QUESTIONS

INSTRUCTIONS FOR SECTION A

Section A consists of 25 multiple-choice questions, each worth one mark.
You should spend approximately 30 minutes answering this section of the paper.
Choose the response that is correct or best answers the question.
A correct answer scores 1 mark and an incorrect answer scores 0 marks.
Marks are not deducted for incorrect answers.
No marks will be awarded if more than one response is completed for any question.



Structure of cells

Question 1
Identify Cell A and Cell B.

A. Cell A is an animal cell and cell B is a plant cell.
B. Cell A is a plant cell and Cell B is an animal cell.
C. Cell A is an eukaryotic cell and Cell B is a prokaryotic cell.
D. Cell A is an eukaryotic cell and Cell B is a prokaryotic cell.

Question 2
Which of the following processes take place in cell organelle labelled X?

A. photosynthesis
B. aerobic respiration
C. anaerobic respiration
D. fermentation

Question 3
Programmed cell death is also known as

A. mitosis.
B. meiosis.
C. cytokinesis.
D. apoptosis.

Question 4

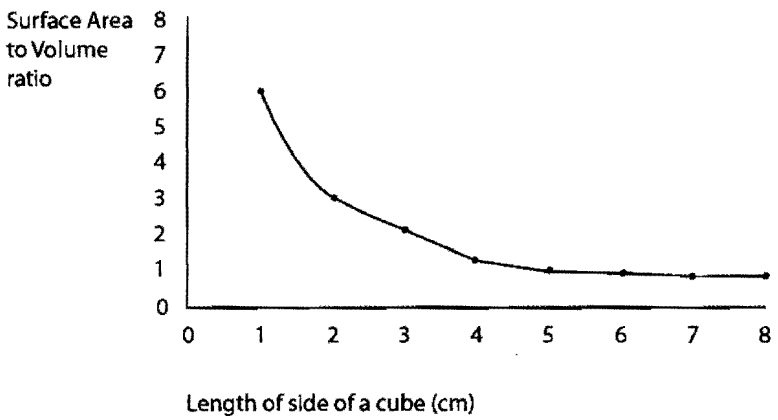
Viruses can be seen only with

A. an electron microscope.
B. a light microscope.
C. a stereo microscope.
D. the naked eye.

Question 5

Movement of water from a dilute solution to a concentrated solution through a semi-permeable membrane is also known as

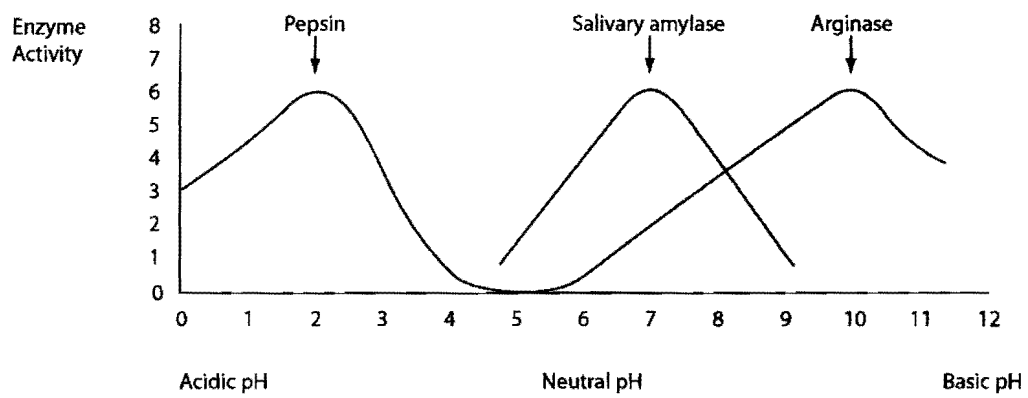
A. diffusion.
B. osmosis.
C. active transport.
D. pinocytosis.



Question 6

As the length of the side of a cube increases, its surface area to volume ratio

A. increases.
B. does not change.
C. shows many changes.
D. decreases.

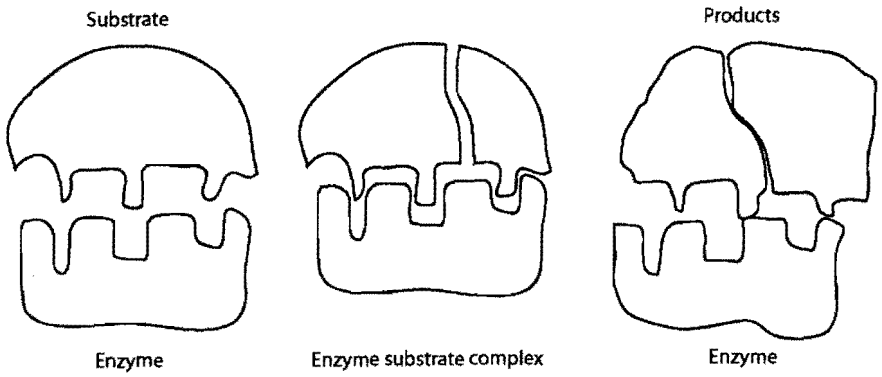


Question 7

The optimum pH for activity of the enzymes pepsin, salivary amylase and arginase are

A. 10, 7 and 2.
B. 7, 2 and 10.
C. 2, 7 and 10.
D. 10, 2 and 7.

The following diagrams shows a decomposition reaction due to the action of catalase enzyme with hydrogen peroxide to form water and oxygen.

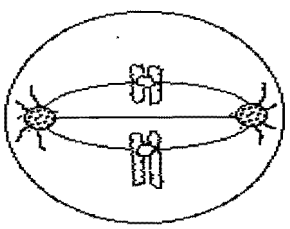


Question 8

In the reaction shown, the substrate and product(s) are:

	Substrate	Products
A.	catalase	water and oxygen
B.	oxygen and water	hydrogen peroxide
C.	oxygen and water	catalase
D.	hydrogen peroxide	oxygen and water

The following diagrams shows a stage in mitosis



Question 9

The stage of mitosis shown above is

A. prophase.
B. anaphase.
C. metaphase.
D. interphase.

Question 10

Our body temperature is controlled by the

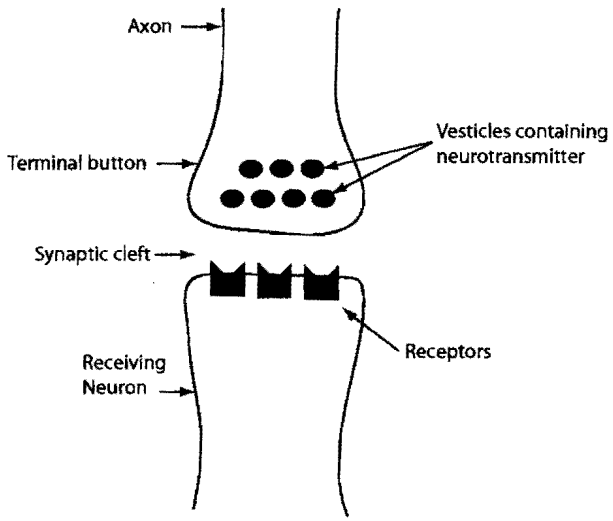
A. thalamus.
B. hypothalamus.
C. pituitary gland.
D. pineal gland.

Question 11

Which hormone is secreted by the pancreas, when the blood glucose level increases, to convert glucose to glycogen for storage in the liver and muscles?

A. glucagon
B. insulin
C. thyroxin
D. adrenalin

The following diagram shows a synaptic cleft between two neurons.



Question 12

Which chemical is released into the synaptic cleft by the vesicles in the terminal buttons of the axon of a neuron?

A. enzyme
B. acetic acid
C. hormone
D. neurotransmitter

Question 13

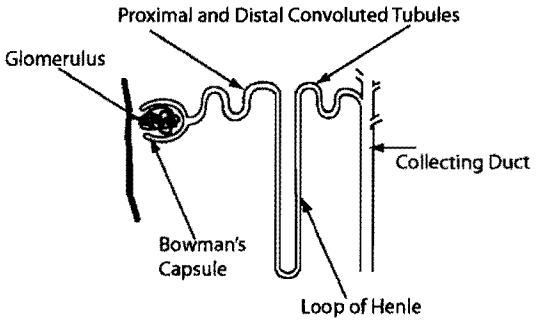
Organisms that regulate their own body temperature internally are known as

A. poikilotherms.
B. homeotherms.
C. ectotherms.
D. hemitherms.

Question 14

Plants that require 16 hours of light and 8 hours of darkness are called

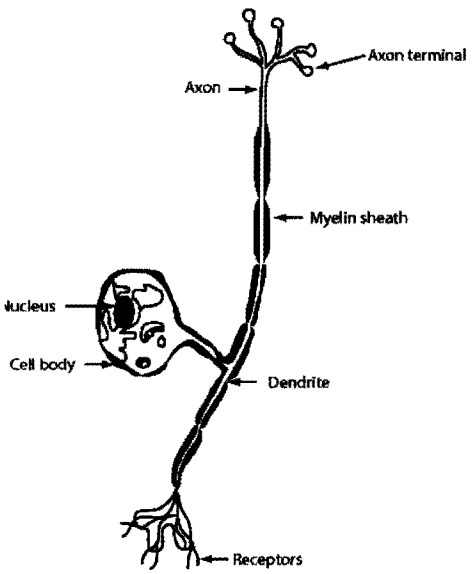
A. long day plants.
B. short day plants.
C. day neutral plants.
D. tundra plants.



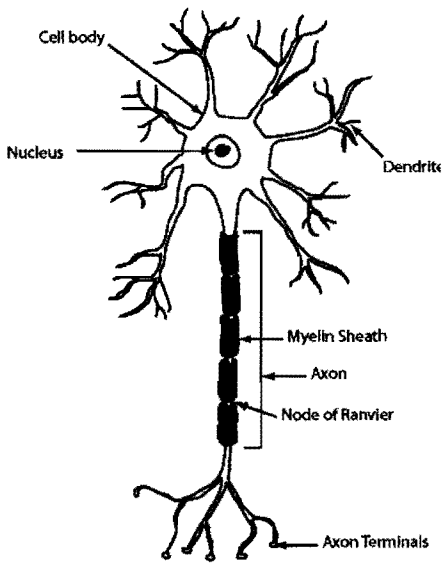
Question 15

In which part of the nephron is blood filtered?

A. glomerulus
B. Loop of Henle
C. collecting duct
D. distal convoluted tubule



Neuron A



Neuron B

Question 16

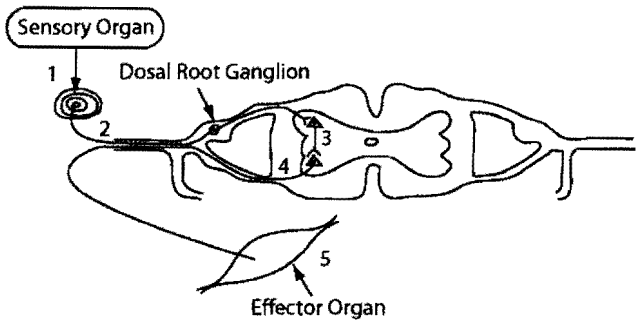
Identify Neuron A and Neuron B in the diagram above.

A. A is a motor neuron and B is a sensory neuron.
B. A is s sensory neuron and B is a motor neuron.
C. A is an interneuron and B is a motor neuron.
D. B is an interneuron and A is a sensory neuron.

Question 17

A knee jerk reflex action is controlled by the

A. central nervous system.
B. peripheral nervous system.
C. autonomic nervous system.
D. sympathetic nervous system.



Question 18
The part of somatic reflex arc labelled **3** is

A. a sensory neuron.
B. a motor neuron.
C. an interneuron.
D. a ganglion.

Question 19
The sensory neuron labelled **2** carries the message from

A. the sense organ to the central nervous system.
B. the central nervous system to the effector.
C. the central nervous system to the sense organ.
D. the effector to the central nervous system.

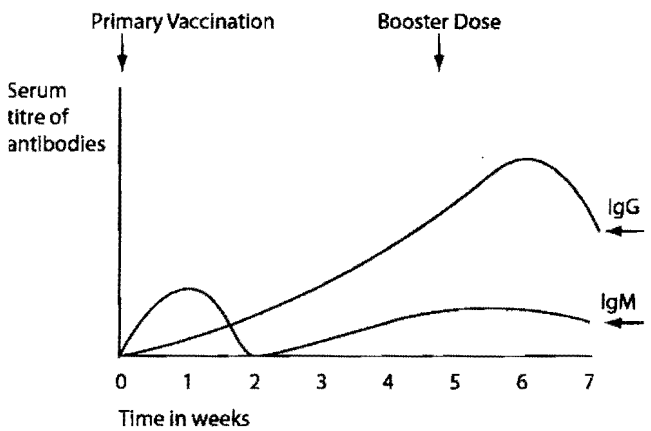
Question 20
The term used to describe white blood cells engulfing bacteria is

A. phagocytosis.
B. pinocytosis.
C. endocytosis.
D. exocytosis.

Question 21
The immune cell responsible for releasing histamine and causing the red itchy welts associated with allergies is called a

A. B cell.
B. T cell.
C. mast cell.
D. white blood cell.

The following diagram shows antibodies produced after a booster dose.



Question 22

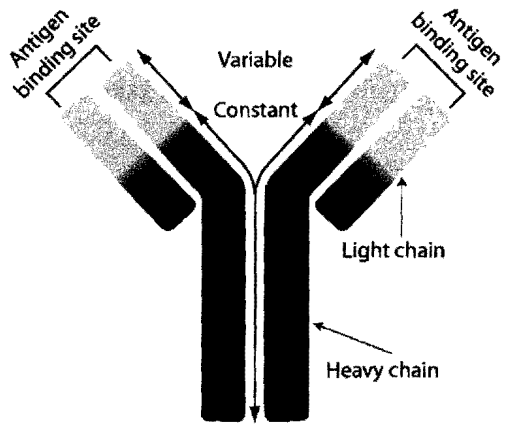
Which immunoglobulins (antibodies) show the greatest increase after a person is given a booster dose of a vaccine?

A. IgG
B. IgM
C. IgD
D. IgA

Question 23

Lymphocytes, also called B cells, are produced in the

A. bone marrow.
B. thymus gland.
C. lymph gland.
D. thyroid gland.



Question 24

An antibody consists of

A. two heavy chains and one light chain.
B. one heavy chain and one light chain.
C. two heavy chains and two light chains.
D. one heavy chain and two light chains.

Question 25

When a patient is exposed to an antiserum containing antibodies they develop

A. active immunity.
B. passive immunity.
C. natural immunity.
D. nonspecific immunity.

SECTION B / SHORT-ANSWER QUESTIONS

INSTRUCTIONS FOR SECTION B

Section B consists of 8 questions. You should attempt all questions.
The marks allotted to each question are shown at the end of the question.
You should spend approximately 60 minutes answering this section of the paper.
Answer all questions in the spaces provided using a pen.

Question 1

1a. In which type of cells are chloroplasts found?

1 MARK

1b. Explain with the help of equations what happens during light-dependent and light-independent reactions of photosynthesis?

Light-dependent reaction

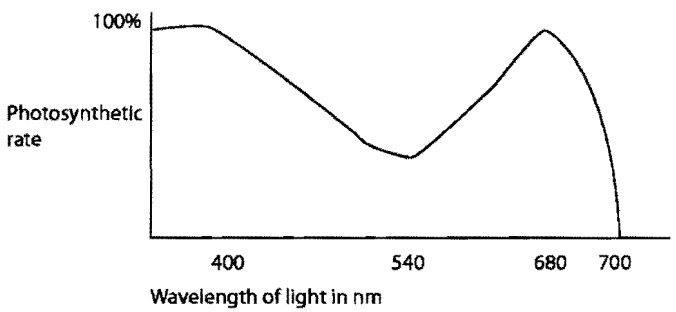
Light-independent reaction

2 MARKS

1c. Explain whether photosynthesis is an endergonic or exergonic reaction?

1 MARK

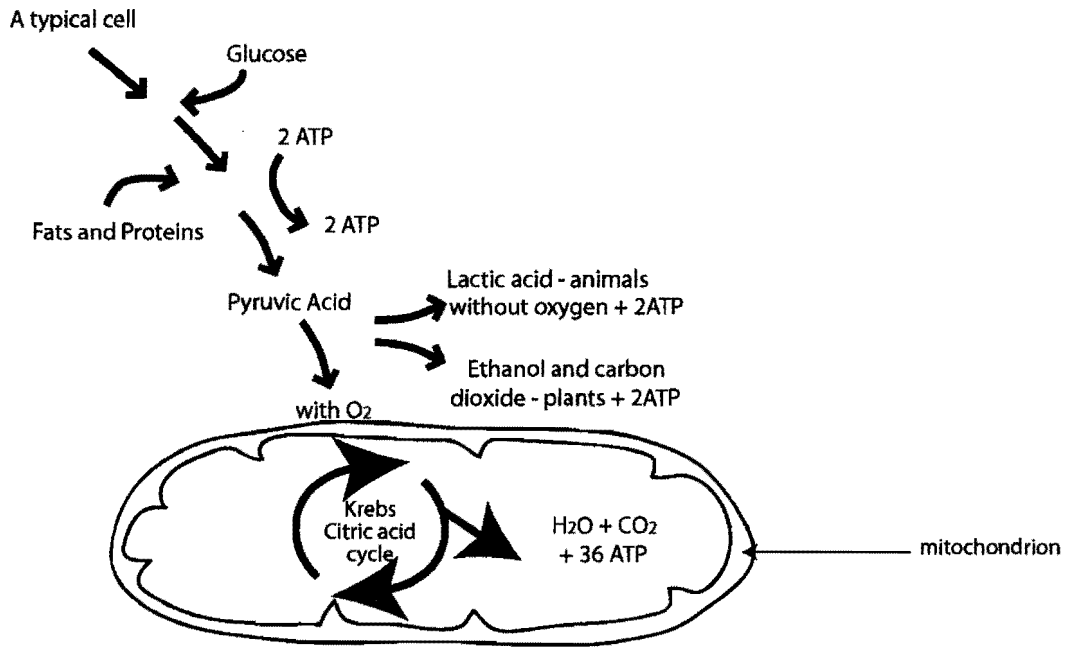
The graph given below indicates how different wavelengths of light affect the rate of photosynthesis.



1d. At which wavelengths of light is the rate of photosynthesis greatest?

1 MARK

The following diagram shows the different stages of aerobic and anaerobic respiration in animals and plants:



1e. State the differences between aerobic respiration and anaerobic respiration in plant cells and animal cells.

2 MARKS

1f. Define the term glycolysis. What products are formed during glycolysis?

1 MARK

TOTAL 8 MARKS

Question 2

2a. Describe the structure of the plasma membrane according to the fluid mosaic model.

2 MARKS

A student fills three petri dishes with distilled water, alcohol and concentrated detergent solution respectively. He/she then places four pieces of beetroot in each petri dish. After 10 minutes the student notices that the colour of the solutions surrounding the beetroot pieces have turned bright pink in both dish 2 containing alcohol and in dish 3 containing concentrated detergent solution.

2b i. Explain why the colour of solutions in dish 1 and dish 2 changed. Which part of the cell membrane was damaged by these two solutions?

2 MARKS

2b ii. By what specific type of transport did water enter the beetroot cells?

1 MARK

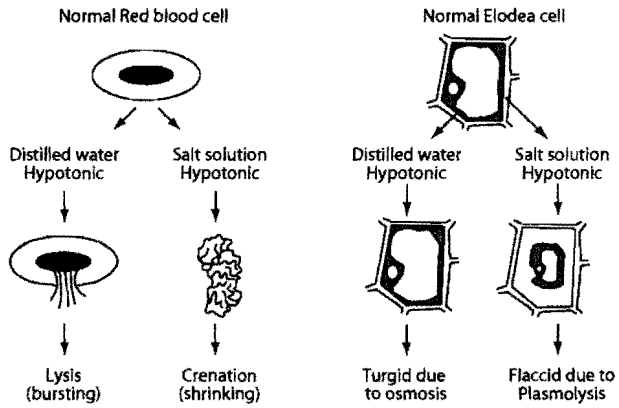
2b iii. Explain how active transport is different from simple diffusion.

2 MARKS

TOTAL 7 MARKS

Question 3

Red blood cells and elodea cells were placed in two types of solutions. Dish 1 contained distilled water, which was hypotonic. Dish 2 contained salt solution, which was hypertonic. The following diagrams show what happened when red blood cells and plant cells were placed in hypotonic and hypertonic solutions:



3a. What is meant by the terms hypotonic and hypertonic solutions?

2 MARKS

3b. Explain why lysis occurred in red blood cells but the elodea cells became turgid when they were each placed in the hypotonic solution (distilled water)?

1 MARK

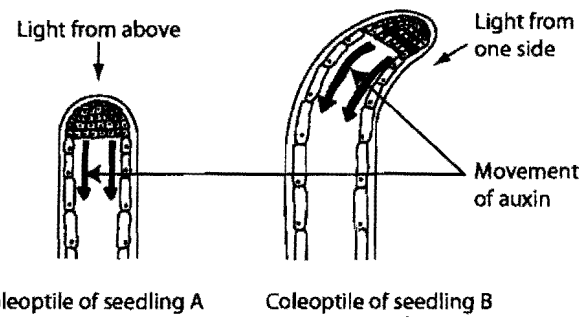
3c. Explain why plasmolysis occurred in elodea cells but crenation occurred in red blood cells when they were each placed in hypertonic salt solution?

1 MARK

TOTAL 4 MARKS

Question 4

The following diagram shows Coleoptiles of seedlings exposed to light coming from different directions.

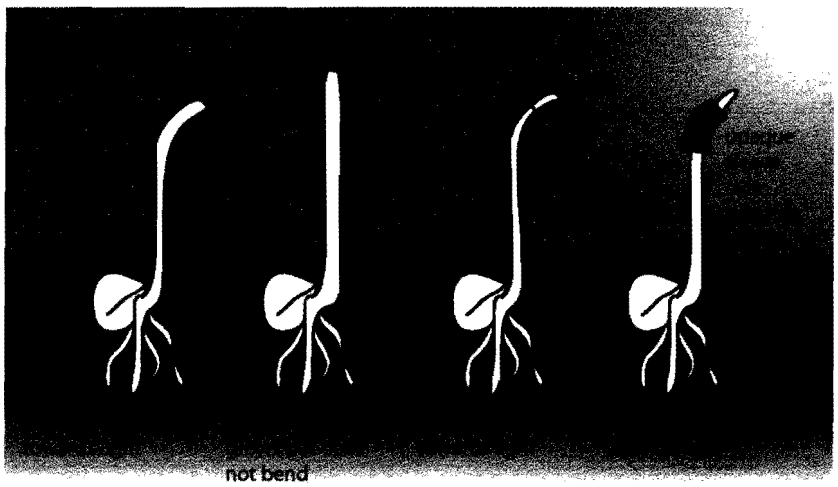


4a. What is meant by the terms 'positive phototropism' and 'negative phototropism'?

1 MARK

4b. Explain why the tip of the shoot is growing straight in seedling A but is bending towards the light in seedling B.

2 MARKS



4c. In one experiment, a student modified four root tips according to the following diagram. Explain why shoots in set-up (a), (c) and (d) bend towards the light but in set up (b) the shoot grows straight.

Set-up a

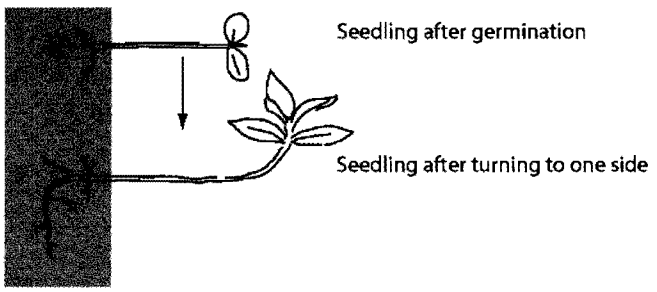
Set-up b

Set-up c

Set-up d

2 MARKS

4d. The experiment below shows the effect of gravity on the growth of a seedling. After germinating, the young seedling was turned on its side. Several days later its roots turned downwards and its shoot turned upwards in response to gravity.



4d i. What is the name of tropism exhibited by the roots growing downwards? What is the advantage of this type of tropism?

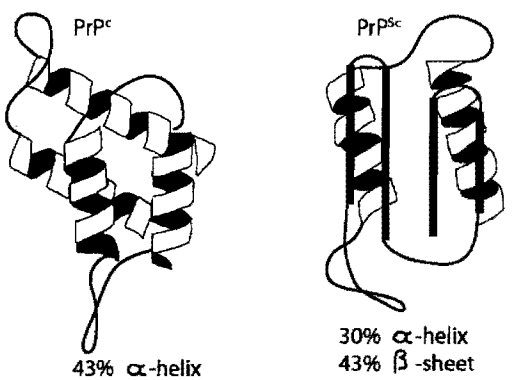
4d ii. Explain how auxin causes the roots to grow downwards and shoots to grow towards light?

2 + 2 = 4 MARKS

TOTAL 9 MARKS

Question 5

The following diagram shows the structure of PrP^c and PrP^{sc}.



5a. Define the term, 'prion' and state which type of prion is found in normal brain cells.

1 MARK

5b. Explain how PrP^{c} is different from PrP^{sc}.

2 MARKS

5c. Explain how people are infected with prions.

1 MARK

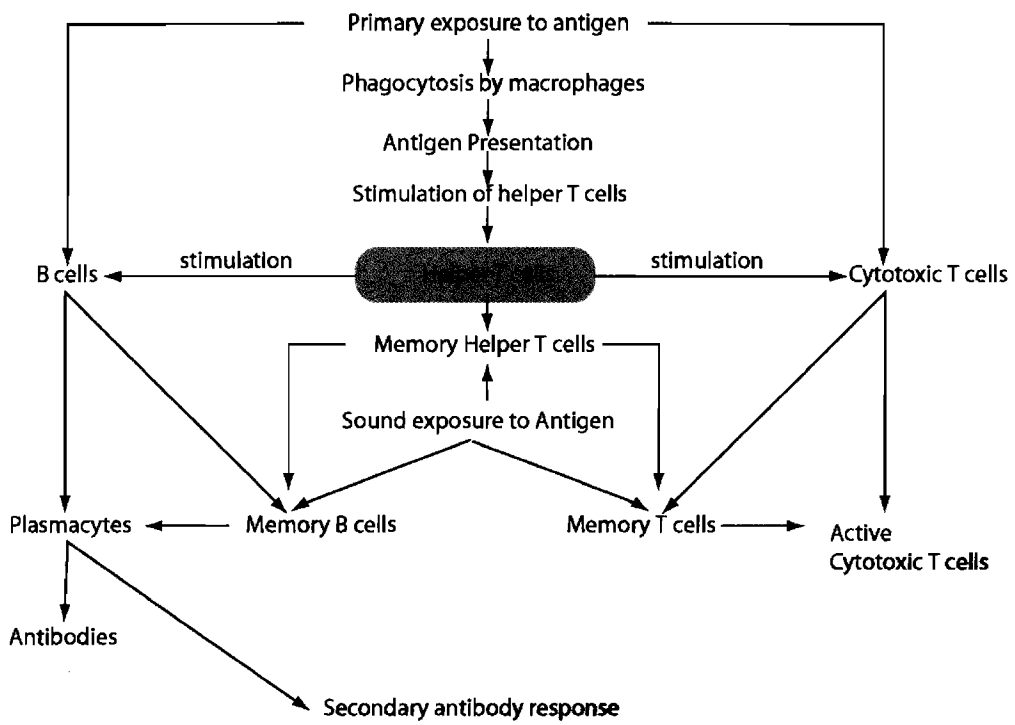
5d. Name two diseases caused by prions in humans and cattle.

1 MARK

TOTAL 5 MARKS

Question 6

The following diagram shows the humoral and cellular immune responses after exposure to a pathogen.



6a. Define the term 'antigen'. State two examples of antigens.

1 MARK

6b. Describe what macrophages do when they detect antigens in the body.

1 MARK

6c. Which cells are stimulated by helper T cells?

1 MARK

6d. Describe how antibodies are produced.

1 MARK

6e. Which cells are stimulated after a second exposure to the same antigen?

1 MARK

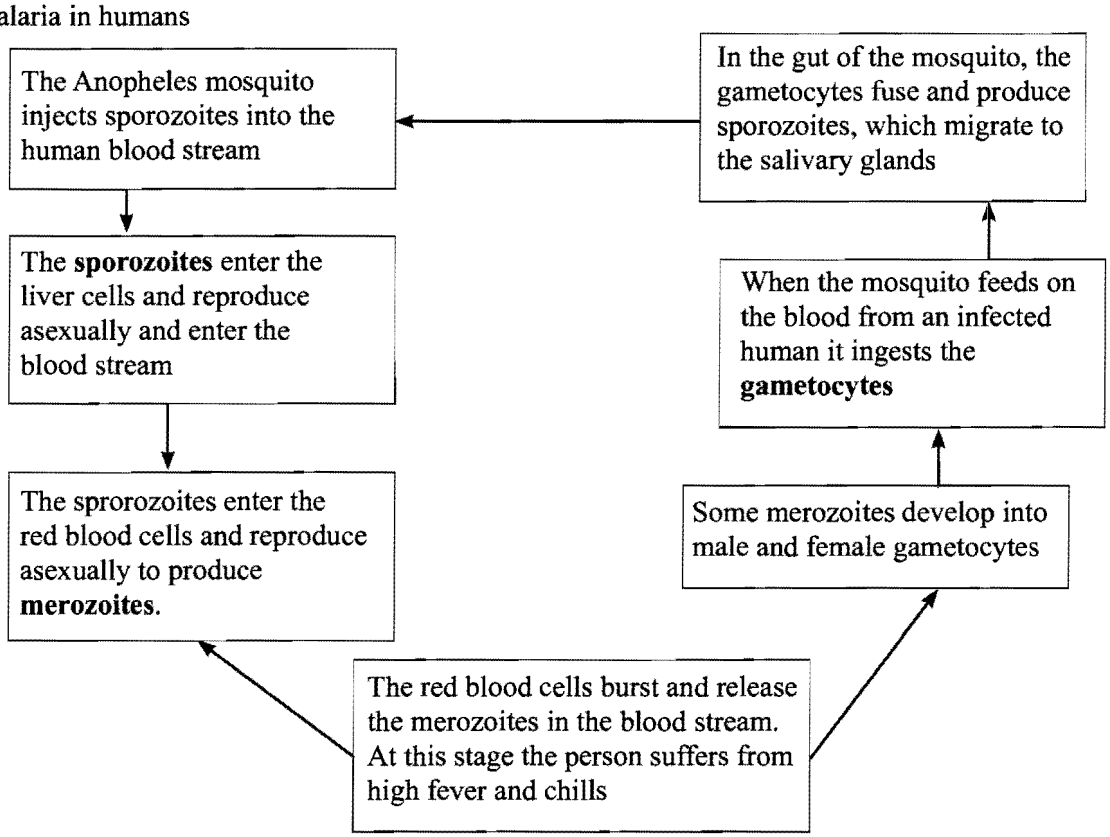
6f. Outline in detail the differences between humoral immunity and cell-mediated immunity.

2 MARKS

TOTAL 7 MARKS

Question 7

The following diagram shows the life cycle of malarial parasite, plasmodium, that causes malaria in humans



7a. Which species of mosquito acts as a vector for plasmodium?

1 MARK

7b. Describe how the parasite enters the human body?

1 MARK

7c. Where do the parasites reproduce asexually?

1 MARK

7d. Identify the stage in the plasmodium life cycle when an infected person suffers from high fever and chills.

1 MARK

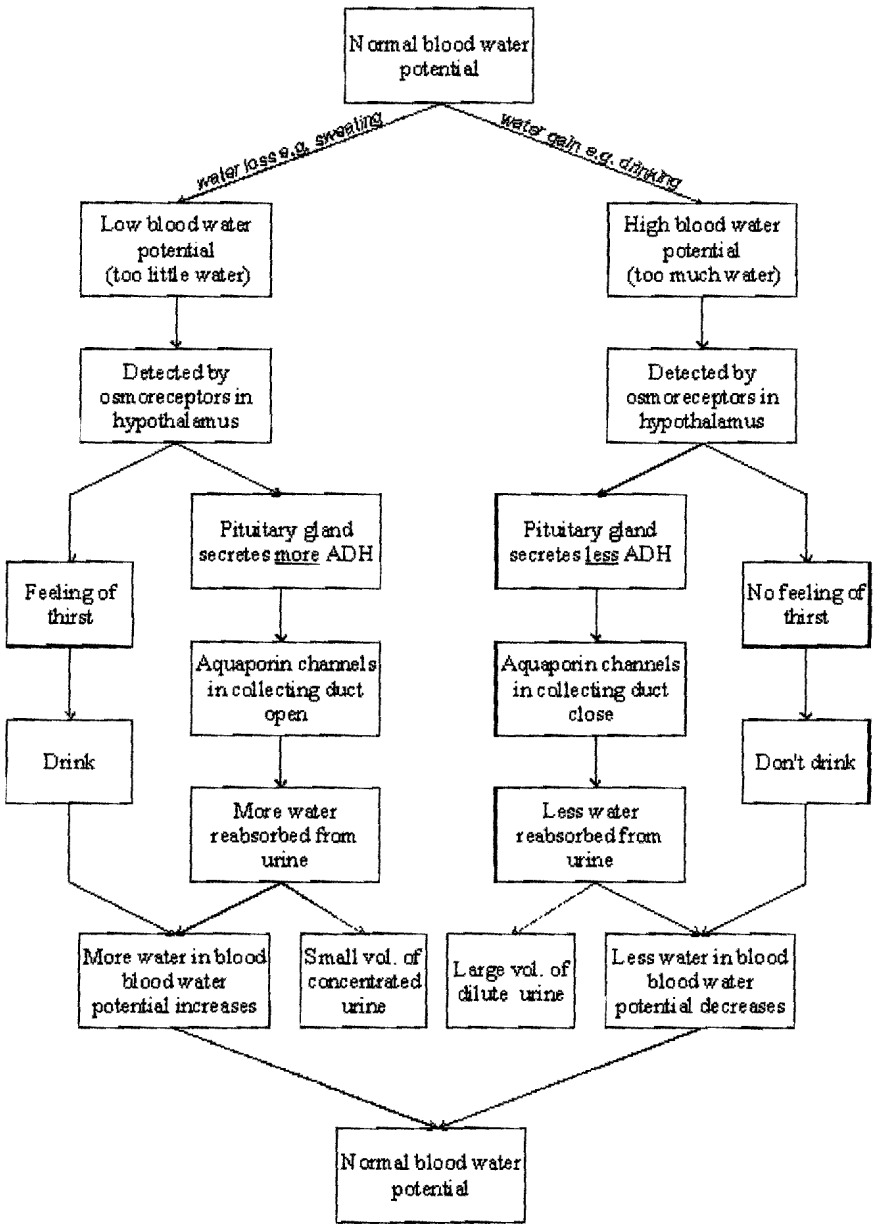
7e. Describe one adaptation of the plasmodium which enables it to survive in its primary and secondary hosts.

1 MARK

TOTAL 5 MARKS

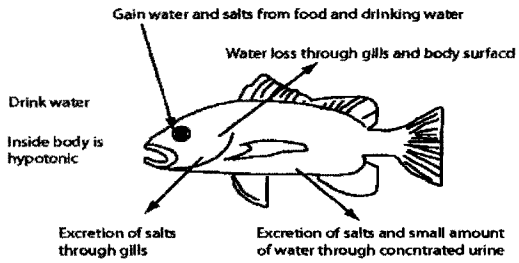
Question 8

The following diagrams shows the negative feedback mechanism involved in osmoregulation.

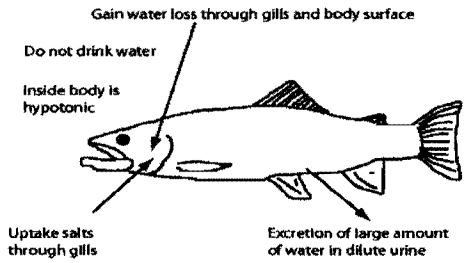


8a. When people eat food containing a large amount of salt, they feel thirsty and drink plenty of water. Explain how the negative feedback system works in controlling osmo-regulation.

2 MARKS



Osmoregulation in Saltwater Fish



Osmoregulation in Freshwater Fish

8b. How do saltwater fish and freshwater fish maintain osmo-regulation?

2 MARKS

8c. What would happen if a freshwater fish is placed in salt water?

1 MARK

TOTAL 5 MARKS

TOTAL SECTION B 50 MARKS

GRAND TOTAL 75 MARKS

END OF PRACTICE EXAM 4

PRACTICE EXAM 1 / SECTION A MULTIPLE-CHOICE QUESTIONS

Question 1: D

- **D is correct** – the side chain is different in all amino acids, it is also known as the variable group.
- A is incorrect – the carboxyl group is the same in all amino acids, hence chemical properties are the same.
- B is incorrect – the amine group is the same in all amino acids, hence chemical properties are the same.
- C is incorrect – the hydrogen group is the same in all amino acids, hence chemical properties are the same.

Question 2: A

- **A is correct** – when two amino acids join to form a dipeptide, water is released (condensation).
- B is incorrect – when two amino acids join to form a dipeptide, hydrogen is not released.
- C is incorrect – hydrolysis refers to the splitting of a water molecule and is the process involved in the reforming of two amino acids from a dipeptide.
- D is incorrect – hydrogen is not produced when two amino acids form a dipeptide and hydrolysis refers to the splitting of a water molecule and is the process involved in the reforming of two amino acids from a dipeptide.

Question 3: C

- A is incorrect – globular proteins have disulfide bridges and a transport not a structural role.
- B is incorrect – globular proteins have disulfide bridges and a transport not a contractile role.
- D is incorrect – globular proteins have a transport not a structural role.

Question 4: B

- A is incorrect – chlorophyll is a pigment and not an organelle.
- C is incorrect – thylakoid membrane is not the actual organelle, it is found within the chloroplast.
- D is incorrect – a granum (not an organelle) is a stack of thylakoid membranes, in the chloroplast.

Question 5: A

- B is incorrect – the light independent phase 'unloads' NADPH molecules, it doesn't produce them.
- C is incorrect – the light independent phase uses ATP and produces ADP.
- D is incorrect – the light independent phase requires CO_2 and produces O_2.

Question 6: C

- **C is correct** – cellulose IS an example of a polysaccharide.
- A is incorrect – deoxyribose is a monosaccharide, not a polysaccharide.
- B is incorrect – sucrose is a disaccharide, not a polysaccharide.
- D is incorrect – maltose is a disaccharide, not a polysaccharide.

Question 7: D

- **D is correct** – acetyl CoA does not have any nucleotides.
- A is incorrect – adenine (A) is found in the molecule adenosine triphosphate.
- B is incorrect – RNA contains the nucleotides ade-nine (A), cytosine (C), guanine (G) and uracil (U).
- C is incorrect – FAD (flavine adenine dinucleotide) contains the nucleotide adenine (A).

Question 8: C

- A is incorrect – cytosine has been shown as a purine and guanine as a pyrimidine.
- B is incorrect – thymine has been shown as a purine and adenine as a pyrimidine.
- D is incorrect – adenine and thymine share a double hydrogen bond, not a triple bond.

Question 9: A

- B is incorrect – enzymes lower the activation energy required to catalyse a metabolic reaction.
- C is incorrect – enzymes can bind more than one substrate molecule in the active site.
- D is incorrect – enzymes may alter their structure during catalysis but remain unaffected in terms of structure after participating in a metabolic reaction.

Question 10: B

- **B is correct** – chemical digestion, also called enzyme-catalysed hydrolysis is associated with the release of energy (exergonic) and involves the metabolic breakdown of larger molecules into smaller ones (catabolic).
- A is incorrect – cellular respiration is associated with the release of energy (exergonic); not endergonic.
- C is incorrect – photosynthesis requires energy (endergonic); not exergonic.
- D is incorrect – protein synthesis involves building of molecules and requires energy (endergonic); not exergonic.

Question 11: D

- A is incorrect – proteins must be synthesised by ribosomes, smooth ER has no associated ribosomes.
- B is incorrect – Golgi apparatus is responsible for storing and dispatching transport vesicles of packaged protein, but the polypeptide needs to be synthesised by ribosomes first.
- C is incorrect – free ribosomes are associated with the formation of polypeptides that will remain dissolved in the cytosol, not proteins for transport.

Question 12: C

- A is incorrect – the genome is subject to change independent of changes in the environment, such as spontaneous mutations arising during DNA replication.
- B is incorrect – proteins are not necessarily smaller molecules than genes.
- D is incorrect – much is known about the genomes of some organisms however not everything has been discovered.

Question 13: A

- B is incorrect – gel electrophoresis does not identify the length of a protein.
- C is incorrect – gel electrophoresis does not identify the 3D structure of a protein.
- D is incorrect – gel electrophoresis does not identify the amounts of amino acid in a protein.

Question 14: C

- **C is the best response** – although clinical trials are an important part of the drug development process, the focus of rational drug design is the targeted development of a chemical treatment using molecular knowledge and the specific chemical responses of target organisms, rather than relying on trial and error.
- A is incorrect – determining the activity of a drug at its binding site uses molecular knowledge.
- B is incorrect – the use of three-dimensional information about biomacromolecules is an example of rational drug design.
- D is incorrect – preventing the function of a key molecule and interrupting a metabolic pathway uses molecular knowledge.

Question 15: A

- **A is correct** – glucagon is a hormone associated with regulation of blood glucose levels.
- B is incorrect – glycerol can be metabolised to release energy that can bind ADP + Pi to produce ATP.
- C is incorrect – glycogen is metabolised to release energy that can bind ADP + Pi to produce ATP.
- D is incorrect – glucose is metabolised to release energy that can bind ADP + Pi to produce ATP.

Question 16: B

- A is incorrect – receptors for steroid (not peptide) hormones are found in the cytosol of target cells.
- C is incorrect – receptors for peptide hormones are found in the plasma (not nuclear) membrane of target cells.
- D is incorrect – receptors for peptide hormones are found in the plasma membrane, not within the nucleus of target cells.

Question 17: B

- **B is correct** – action potentials are NOT generated from the cell body of an axon, they are generated at the beginning of an axon.
- A is incorrect – the frequency of impulses in a receptor cell IS directly proportional to the strength of the stimulus.
- C is incorrect – sensory cells DO demonstrate sensory adaptation and WILL eventually stop responding to a stimulus.
- D is incorrect – receptor cell response DOES have the capacity to change energy from one form to another.

Question 18: D

- A is incorrect – pheromones are released into the external environment, not into the bloodstream.
- B is incorrect – pheromones act intraspecifically, not interspecifically.
- C is incorrect – pheromones are small, volatile and water-soluble molecules.

Question 19: A

- B is incorrect – this is an example of a chemical barrier which is a passive defence strategy.
- C is incorrect – this is an example of a physical barrier which is a passive defence strategy.
- D is incorrect – this is an example of a physical barrier which is a passive defence strategy.

Question 20: C

- A is incorrect – protection from parasitic protozoans, fungi and worms is primarily cell-mediated.
- B is incorrect – protection from viruses and bacteria found within cells is cell-mediated.
- D is incorrect – protection from the development of tumours that cause cancer is primarily cell-mediated.

Question 21: D

- **D is correct** – fever and shivering WILL NOT be associated with vasoconstriction, rather vasodilation.
- A is incorrect – fever DOES speed up metabolism to assist in the repair of body tissues.
- B is incorrect – fever DOES increase heart rate to enable more efficient supply of white blood cells to sites of infection.
- C is incorrect – fever CAN BE due to the release of pyrogens which set the body's thermostat at a higher temperature.

Question 22: C

- A is incorrect – positive feedback mechanisms trigger a response which amplifies the original stimulus.
- B is incorrect – positive feedback mechanisms are not always harmful e.g. childbirth, lactation or bloodclotting.
- D is incorrect – positive feedback mechanisms can be harmful e.g. escalating body temperature.

Question 23: B

- A is incorrect – Cell A does not have any of the specified non-self antigens as Cell B, therefore induces a lesser response from the immune cell.
- C is incorrect – Cell C does not have as many non-self antigens as Cell B, therefore a lesser response.
- D is incorrect – Cell D does not have any of the specified non-self antigens that Cell B does, therefore a lesser response.

Question 24: D

- A is incorrect – not natural (exposure is induced) or passive (antibodies have been actively made).
- B is incorrect – not natural (exposure is induced).
- C is incorrect – not passive (antibodies have been actively made).

Question 25: B

- A is incorrect – toxoids are not reabsorbed from the bloodstream.
- C is incorrect – the immune system produces antibodies after the first injection however it takes time to build up immunity.
- D is incorrect – there are no antibodies provided in the vaccination, only toxoids.

PRACTICE EXAM 1 / SECTION B
SHORT-ANSWER QUESTIONS

Question 1: 1 mark

Protein

- Carbonic anhydrase is an enzyme. Enzymes are a class of proteins which act as biological catalysts. Enzymes increase the rate of the reaction without being consumed by the reaction.
- It is likely that bicarbonate ions cross cell membranes by diffusing through transmembrane channels in the plasma membrane.

Question 1b i: 1 mark

A pore in the phospholipid bilayer of a plasma membrane, through which ions and some small hydrophilic molecules can pass.

Question 1b ii: 1 mark

The lipid bilayer is not permeable to charged chemical substances (ions) and bicarbonate is an ion therefore must leave via the transmembrane channels.

- Some ions and hydrophilic molecules are insoluble in the plasma membrane and cannot diffuse across. The water filled transmembrane pore is found in the phospholipid bilayer of a plasma membrane and ions and some small hydrophilic molecules can pass through it passively via the process of facilitated diffusion.

Question 1c i: 1 mark

The matrix of the mitochondria

Question 1c ii: 1 mark

Pyruvate

Question 1c iii: 1 mark

Oxidation

Question 1d: 1 mark

Fermentation NOT anaerobic respiration

- Even though fermentation and anaerobic respiration are terms that are often used interchangeably they are different. Anaerobic respiration involves hydrogen ions passing down a chain of carriers to a terminal acceptor and this does not occur in fermentation.

Question 1e: 1 mark

The accumulation of toxic products (in this case ethanol) inhibits any further metabolic activity.

Question 1f: 1 mark

Not a very efficient process as it only yields 2 ATP in comparison with the 36(38) ATP from aerobic respiration.

Question 2a: 1 mark

That pupation is under the control of a hormone produced in the head/anterior end of the larva.

- Information is given in the stem which indicates that pupation is under the control of hormones. All that is required is to observe the diagram(s) and notice that the larva has been tied off at the anterior end, thus investigating whether the hormone originates in this area of the body.

Question 2b: 1 mark

Yes, the results support the hypothesis. Diagram shows that the anterior region of each larva has darkened due to the effect of the hormone produced in the head.

- In experimental larvae, the anterior region of each larva has darkened due to the effect of the hormone produced in the head. The larvae do not show darkened bodies below the tied cotton thread suggesting that the hormone, constrained by the thread, has not moved beyond the anterior section.

Question 2c: 3 marks

Experimental design needs to show controlled variables (such as genetic stock, temperature of environment, humidity, food source) except the one being investigated (experimental variable). The experimental variable is the time during the larval stage at which the cotton is tied around the head of the larvae. Experiment must show an adequate number of replicates (more than 5 in each treatment).

Question 3a i: 1 mark

Hormone OR growth factor.

- The stem provides information which relates to cell growth (cell growth can be controlled depending on the regulatory signalling pathway) and the diagram illustrates the signalling pathway that regulates cell growth. It can be reasonably concluded that substance A is a hormone or a growth factor.

Question 3a ii: 2 marks

Growth factor (or hormone) is binding to the receptor. This is an essential process in the signalling pathway because if growth factor does not bind to the receptor, signal transduction cannot occur.

Question 3b i: 1 mark

G protein OR second messenger

- G proteins (second messengers) are essential signal transducing molecules which are involved in second messenger cascades in cells. The term G protein is short for guanine nucleotide-binding proteins.

Question 3b ii: 1 mark

Signal transduction

- Signal transduction is a process in which a cell converts a signal or stimulus into another. Generally, signal transduction involves ordered sequences of biochemical reactions inside a cell, which are enabled by enzymes, activated by second messengers, and ultimately culminate in a signal transduction pathway.

Question 3c i: 1 mark

Gene expression/transcription

Question 3c ii: 1 mark

Substance E is most likely a protein which will be involved in the initiation of the cell cycle to stimulate cell growth.

- At the end of the signal transduction pathway, a transcription factor (activator) enters the nucleus of the cell and turns on a gene (or genes) which will produce one or more proteins that stimulate the cell cycle, resulting in cell growth.

Question 4a i: 1 mark

11 amino acids

Question 4a ii: 1 mark

Normal	Mutant
AAC	TAC
TTG	**ATG**

- In a sequence of DNA, each triplet (group of 3 nucleotides) codes for 1 amino acid. There are 33 nucleotides present in the normal E1α Exon 9 sequence and therefore the sequence codes

for 11 amino acids. According to the rule of base pairing (A pairs with T, C pairs with G), the complementary base sequences of DNA for the normal and the mutant triplets are TTG (normal) and ATG (mutant).

Question 4b i: 1 mark

A – adenine

Question 4b ii: 1 mark

Different DNA triplets can code for the same amino acid.

- The genetic code demonstrates a built in redundancy which means that different DNA triplets can code for the same amino acid e.g. AAC and GAC both code for *leucine* and TAA and TAG both code for *isoleucine*.
- It is possible, using DNA diagnostic methods, to identify individuals who have the A→ T mutation at position 438 and who are at risk of developing MSUD.

Question 4c: 1 mark

Development of MSUD can be averted with modification of diet e.g. restriction of leucine, isoleucine, valine through a modified protein diet.

Question 4d: 2 marks

Taqman Assay enables more rapid diagnosis of infants with MSUD prior to clinical disease and because of its rapid screening time (and increased sensitivity and validity in terms of a lower % of samples requiring repeat testing) it is likely to be of economic advantage.

- When considering suitability for commercial application it is necessary to consider the most efficient, effective and inexpensive method of testing. As demonstrated by the comparative study, it is the Taqman Assay.

Mark allocation: 4d.
1 mark – Taqman Assay
1 mark – rapid screening time (and increased sensitivity as well as validity) lends it to commercial application

Question 5a: 1 mark

Food OR water OR air OR through bites from a vector (e.g. mosquito, tick, flea)

- Parasites can enter a host in a variety of ways, depending on their type. Generally, the most common strategies for entry include through food and/or water, air and through bites from a vector (e.g. mosquito, tick, flea).

Question 5b: 2 marks

Presence would induce the production of antibodies assisted by macrophages and eosinophils.

- Flatworms present a size problem to the immune system as they are too big to phagocytose. They present as 'non-self' to the host immune system, which is detected by macrophages which present 'non-self' antigens (from flatworms) to helper T cells. When helper T cells are activated they respond in 2 ways. They produce cloned activated helper T cells (which can produce B cells and antibodies) and memory helper T cells. In addition, eosinophils align themselves against the external wall of the flatworm and release destructive enzymes from cytoplasmic granules.

Question 5c: 1 mark

The host is protected from infection by any future invasions of that particular flatworm.

- Whilst the antibodies generated by B cells do not provide protection from the resident flatworm, their sheer numbers (due to recognition by the memory cells and rapid proliferation of more antibodies) ensure protection from new invasions.

Question 5d i: 1 mark

'Self' describes all the components (receptors and antigens) that are recognised by the immune system of an organism as being part of that particular organism.

Question 5d ii: 1 mark

Flatworms could coat themselves with host antigens (e.g. ABO blood group antigens OR histocompatability molecules).

- If a parasite is able to remain undetected by the immune system of its host it will maximise its chance of survival. If the flatworm is capable of incorporating the antigens of its host into its exterior surfaces, then it will appear as 'self' and be protected from attack by the immune system. The exact mechanism by which a flatworm does this is not yet fully understood.

Mark allocation: 5b.
1 mark – resident flatworm induces production of antibodies
1 mark – production of antibodies is assisted by macrophages and eosinophils

Question 6a: 1 mark

The overstimulation of sweat glands is likely to be due to the autonomic nervous system because it is this system that is responsible for transmitting messages to glands (and smooth muscle and heart muscle).

Question 6b i: 1 mark

Acetylcholine or any suitable neurotransmitter.

Question 6b ii: 1 mark

Acetylcholine changes the permeability of postsynaptic membranes to specific ions thereby enabling transfer of nerve impulse which results in contraction of sweat gland and release of sweat.

- Acetylcholine is one of the most common neurotransmitters and functions by binding to receptors on post synaptic membranes, thus altering their permeability to specific ions.

Question 6c: 1 mark

Cutting segments of the sympathetic nerve impedes the normal transmission of nerve signals and thus reduces sweating.

- Nerve signals require a medium along which the electrical impulse can pass. If there is a gap in the neuron the nerve impulse will terminate at the break. This occurs naturally at the end of an axon however release of neurotransmitters ensures the impulse continues toward its destination. When cuts are made in the neuron, there is no way for the impulse to continue.

Question 7a: 1 mark

Myelin forms an insulating coat around processes of nerve cells and speeds the transmission of nerve impulses.

- Myelin is fatty connective tissue (white matter) which forms an insulating coat around processes of nerve cells. Myelin speeds transmission of nerve impulses by electrically insulating nerves from the surrounding environment. Myelin is produced by cells known as oligodendrocytes.

Question 7b i: 1 mark

A disorder in which the body's immune cells fail to distinguish between self and non-self and begin to attack its own tissues.

Question 7b ii: 1 mark

T-lymphocytes OR T-cells

There are many diseases (multiple sclerosis, rheumatoid arthritis, diabetes mellitus) which are caused by the reaction of an individual's immune system against 'self'. In normal circumstances, there are lymphocytes (T-lymphocytes or T-cells) which are capable of reacting against self (e.g. in apoptosis) however these are suppressed unless required. When lymphocytes manage to avoid suppression or when a body tissue becomes altered so that it is no longer recognised as self, an autoimmune condition occurs. The triggers of autoimmune conditions are not well understood but are thought to be associated with interaction with environmental factors such as pathogens or drugs.

Question 7c: 2 marks

There is a similarity between the surface antigens (proteins) expressed by cells in the myelin (oligodendrocytes) and the proteins expressed by viral pathogens. The immune system directs an attack on both the viral proteins (appropriately) and the myelin proteins (inappropriately) leading to an autoimmune response.

Mark allocation: 7c.
1 mark – Why? Similarity exists between surface proteins of myelin and viral pathogens
1 mark – How? Immune system attacks both types of protein (viral and self) leading to autoimmune response

Question 8a i: 1 mark

A pathogen is a cellular agent/organism capable of causing an infectious disease in a host.

Question 8a ii: 2 marks

Two of: a cell wall, a single major chromosome, nucleus not membrane bound, organelles not membrane bound

- Disease in hosts can be caused by non-cellular and cellular agents. Non-cellular agents are generally classified as non-living and include prions and viruses. Cellular agents are living organisms and include micro-organisms (bacteria and fungi) and multicellular organisms (worms). Bacteria are pathogens found everywhere. They have varied characteristics and requirements however they all have the following characteristics: a cell wall, a single major chromosome, nucleus not membrane bound, organelles not membrane bound.

Question 8b: 1 mark

Methicillin resistant means that the bacteria is not susceptible to methicillin antibiotic treatment (methicillin cannot be used to control or kill this strain of Staphylococcus aureus).

Despite the vigilance in observing strict hand hygiene, repeated outbreaks of deadly illnesses continue to occur in hospitals.

Question 8c i: 1 mark

Staphylococcus aureus is not only carried on the hands of staff, sources can also include lanyards and plastic name badges OR Staphylococcus aureus can be carried into hospitals by visiting friends and family who do not necessarily observe strict handwashing requirements.

Question 8c ii: 1 mark

Staff lanyards and name tags to be thoroughly washed/ sterilised. Visiting family/friends to observe strict handwashing techniques during all visits.

Mark allocation: 8a ii.
1 mark for correct shared characteristic 1
1 mark for correct shared characteristic 2

PRACTICE EXAM 2 / SECTION A MULTIPLE-CHOICE QUESTIONS

Question 1: D

- A is incorrect because fats and waxes are usually solids at room temperature.
- B is incorrect because fats are composed only of carbon, hydrogen and oxygen.
- C is incorrect because a fat is made of a single glycerol molecule (glyceride) to which three fatty acids are attached.

Question 2: A

- **A is correct** since the compound follows the general formula of a polysaccharide $(C_6H_{10}O_5)n$.
- B is incorrect because it contains N (nitrogen) and S (sulfur), two elements which are not contained in polysaccharides (carbohydrates).
- C is incorrect because it is the formula for glucose, which is a monosaccharide.
- D is incorrect because it is the formula for palmitin, which is a lipid.

Question 3: C

- A is incorrect because quaternary structure can be achieved without β-pleated sheets.
- B is incorrect because quaternary structure is not determined by the number of amino acids in a protein.
- D is incorrect because myoglobin is a protein and must have peptide bonds linking its amino acids.

Question 4: B

- A is incorrect because apoptosis occurs in both damaged and healthy cells.
- C is incorrect because apoptosis occurs via the mitochondrial and death receptor pathway. There is no ribosomal pathway associated with apoptosis.
- D is incorrect because apoptosis occurs both in embryos and developed organisms.

Question 5: D

- A is incorrect because bulk transport involves movement of large quantities of material in vesicles (made from a phospholipid membrane) which are formed at the cell membrane.
- B is incorrect because endocytosis is a form of bulk transport and bulk transport is not the likely process.
- C is incorrect because exocytosis is a form of bulk transport and bulk transport is not the likely process.

Question 6: B

- A is incorrect because proteins are water soluble (not lipid soluble), sugar is water soluble (not a small uncharged molecule) and chloroform is lipid soluble (not water soluble).
- C is incorrect because ions are water-soluble molecules (not lipid soluble) and carbon dioxide is a small uncharged molecule (not water soluble).
- D is incorrect because sugars are water soluble (not lipid soluble) and alcohol is lipid soluble (not a small uncharged molecule).

Question 7: D

- A is incorrect because cholesterol molecules are usually found embedded in the fatty acid tails.
- B is incorrect because phospholipids are represented by a round phosphate head with two fatty acid tails; structure D does not have this appearance.
- C is incorrect because structure D does not cross both phospholipid layers of the membrane (a protein channel does) and E is not a cholesterol molecule for the reason that A is incorrect.

Question 8: A

- B is incorrect because genes are not proteins (they can produce proteins).
- C is incorrect because polysaccharides are not proteins.
- D is incorrect, even though glycoproteins are made from proteins, because glycoproteins are not all the proteins produced by a single cell or an organism in a particular environment.

Question 9: C

- A is incorrect because even though there are many proteins in the proteome and research funding is limited, this is not the main reason for developing the field of proteomics.
- B is incorrect because protein structure is not an obstacle to studying them in isolation.
- D is incorrect because there are actually many proteins in the proteome.

Question 10: C

- A is incorrect because the Golgi apparatus is associated with transportation of proteins into and out of cells, not protein building.
- B is incorrect because lysosomes are involved with the destruction of unwanted or damaged cell parts and molecules, not protein building.
- D is incorrect because the nucleus does not have a direct role in protein building; it merely contains the DNA with the instructions for protein building.

Question 11: B

- A is incorrect because photosynthesis is an endergonic or anabolic (energy requiring) process.
- C is incorrect because reduction reactions are endergonic or anabolic (energy requiring) processes.
- D is incorrect because anabolism is an endergonic (energy requiring) process.

Question 12: A

- B is incorrect because exergonic reactions release ATP and when ATP is catabolised, ADP + P_i is released, not just ADP_i.
- C is incorrect because exergonic reactions release ATP, not ADP + P_i.
- D is incorrect because exergonic reactions release ATP, not ADP_i.

Question 13: C

- **C is correct** because enzymes can contain metallic ions as part of their structure.
- A is incorrect because these *are* the two theories of enzyme action.
- B is incorrect because enzyme activity *is* affected by the stated factors.
- D is incorrect because enzyme inhibition *can* occur if a compound binds competitively with the active site of an enzyme.

Question 14: D

- A is incorrect because **B** is the active site, not the substrate and **C** is the product, not the active site.
- B is incorrect because **D** is the enzyme-substrate complex, not the products and **E** is the products, not the enzyme-substrate complex.
- C is incorrect because **C** is the substrate, not the enzyme-substrate complex and **D** is the enzyme-substrate complex, not the substrate.

Question 15: B

- A is incorrect because the light-dependent reaction occurs within the grana of the chloroplasts on the thylakoid membranes.
- C is incorrect because it is a light-dependent reaction (not independent) and occurs within the grana of the chloroplasts on the thylakoid membranes.
- D is incorrect because it is a light-dependent reaction (not independent).

Question 16: A

Answer is A

- B is incorrect because CO_2 is not an output from the conversion of radiant energy to chemical energy.
- C is incorrect because $NADP^+$ is an input to the light-dependent stage of photosynthesis and CO_2 is not an output from the conversion of radiant energy to chemical energy.
- D is incorrect because $NADP^+$ and ADP + P_i are both inputs to the light-dependent stage of photosynthesis, not outputs.

Question 17: B

- A is incorrect because negative feedback mechanisms *do* act to restore the original homeostatic state of an organism.
- C is incorrect because most negative feedback systems *do* operate as proportional control systems.
- D is incorrect because some negative feedback systems *do* operate as on-off control systems.

Question 18: C

- A is incorrect because an overactive pituitary results in an increase in metabolic rate.
- B is incorrect because an underactive thyroid gland results in the underproduction of thyroxine.

- D is incorrect because an overactive parathyroid gland increases the level of calcium in the blood.

Question 19: A

- B is incorrect because amino acid derivatives are synthesised in advance (not on demand) and have a short life span (not long) AND steroid hormones are synthesised on demand (not in advance) and have a long life span (not short) AND peptide hormones are synthesised in advance (not in demand) and have a short life span (not long).
- C is incorrect because steroid hormones are synthesised on demand (not in advance) and have a long life span (not short) AND peptide hormones are synthesised in advance (not in demand) and have a short life span (not long).
- D is incorrect because amino acid derivatives are synthesised in advance (not on demand) and have a short life span (not long) AND peptide hormones are synthesised in advance (not on demand) and have a short life span (not long).

Question 20: C

- A is incorrect because amino acid derived hormones are water soluble; Pathway **B** is taken by lipid-soluble hormones.
- B is incorrect because protein hormones are water soluble; Pathway **B** is taken by lipid-soluble hormones.
- D is incorrect because peptide hormones are water soluble; Pathway **B** is taken by lipid-soluble hormones.

Question 21: B

- A is incorrect because relay molecules are responsible for progressing signal transduction, not initiating it.
- C is incorrect because transduction molecule is an alternative name for relay molecule.
- D is incorrect because secondary messengers are the initiators of signal transduction.

Question 22: C

- A is incorrect because transmitter substance has to be secreted before it can bind to a receptor molecule on the muscle cell membrane.
- B is incorrect because transmitter substance has to be secreted and bind to a receptor molecule on the muscle cell membrane before it becomes inactivated by an enzyme.
- D is incorrect because transmitter substance has to be secreted, bind to a receptor molecule on the muscle cell membrane and become inactivated by an enzyme before the muscle cell contracts.

Question 23: B

- A is incorrect because the venom contains antigens (not antibodies) and antibodies are required to form an antigen–antibody complex.
- C is incorrect because toxoids are produced by treating toxins to produce substances that act as antigens but are unable to cause disease. In addition, toxoids are usually derived from toxins produced by micro-organisms, not from toxins found in venom.
- D is incorrect because even though plasma cells are capable of producing antibodies (which are essential for disabling venom) they would not be able to differentiate rapidly enough to produce a sufficient quantity of antibodies to prevent the action of the venom.

Question 24: A

- B is incorrect because whilst MHC markers are proteins, they are associated with specific immunity.
- C is incorrect because whilst antibodies are proteins, they are associated with specific immunity.
- D is incorrect because whilst immunoglobulins are proteins, they are associated with specific immunity.

Question 25: C

- A is incorrect because natural passive immunity occurs when a foetus receives maternal antibodies across the placenta. This may occur inadvertently; however, this is not the focus of the question.
- B is incorrect because whilst the woman may begin to develop a primary response to the virus, the question is asking what form of immunity the woman will be provided with as a result of the treatment.
- D is incorrect because the treatment is providing the woman with VZIG immunoglobulins which are not an attenuated form of the virus.

PRACTICE EXAM 2 / SECTION B SHORT-ANSWER QUESTIONS

Question 1a: 2 marks

Biological Function	Biological Molecule
solvent, support, turgor, site for metabolic reactions	**water**
insulation, source of energy, structural	**lipid**
provide information about construction and function	**nucleic acid**
structural, energy storage, cellular recognition	**carbohydrate**

Mark allocation
2 marks if all answers are correct.
1 mark if 2 or 3 answers are correct.
0 marks if 0 or 1 answer is correct.

- Proteins are three-dimensional biological molecules which are classified on the basis of their shape and form as primary, secondary, tertiary and quaternary. The tertiary structure is a precise folded configuration of the secondary structure.

Question 1b: 1 mark

Disulfide bridges OR hydrophobic interactions OR hydrogen bonds OR ionic/salt bridges

- The protein folds because various points on the secondary structure are attracted to each other, the strongest attraction being between cysteine amino acids, which form disulfide bonds. Weak bonding interactions may include ionic (between positively and negatively charged side chains), hydrogen bonds (between polar side chains) and hydrophobic interactions (amino acids with hydrophobic side chains cluster out of contact with water).

TIPS
It is a good idea to be generally familiar with the types of bonding associated with each of the protein structures.

Question 1c i: 1 mark

A protein with a carbohydrate molecule attached to it

Question 1c ii: 1 mark

Glycoproteins are important recognition markers on cell membrane surfaces.

OR

Glycoproteins are secretory proteins.

- Glycoproteins form when protein molecules bond covalently with carbohydrate molecules. This occurs in the interior of the rough endoplasmic reticulum. Once formed, the carbohydrate group can act as a marker which can determine the destination of a glycoprotein (whether it remains in the cell or becomes exported). The carbohydrate group can help orientate and maintain the position of the glycoprotein in the cell membrane and may perform a function in recognition between cells (tissue formation and immune response). Some glycoproteins become incorporated within transport vesicles and move toward the Golgi apparatus.

TIP

Be able to transfer basic structural knowledge about proteins (and all biological molecules) and apply it to the function of the molecule within a cell or living organism.

Question 1d i: 1 mark

Denaturation

Question 1d ii: 1 mark

Concentrated acids (must say concentrated) OR concentrated alkalis (must say concentrated) OR heavy metals OR heat OR radiation OR detergents OR organic solvents

- Denaturation occurs when the bonds that support the secondary and tertiary structure of the protein are altered or broken.

Total 7 marks

Question 2a: 1 mark

The cells in the surrounding tissue switch from performing aerobic cellular respiration to anaerobic cellular respiration.

- Living tissue requires a constant supply of oxygen to perform cellular respiration. In circumstances where oxygen is readily available, living tissue will perform aerobic cellular respiration. When oxygen is in short supply (or becomes absent – as in the case with interrupted blood flow) cells in living tissue will switch to anaerobic cellular respiration which does not require oxygen to continue. However, it can only be sustained for a short time due to the increasing build-up of lactic acid which is toxic to living tissue.

Question 2b i: 1 mark

Rational drug design

Question 2b ii: 1 mark

Rational drug design is of no use when nothing is known about the molecular mechanism of the disease.

- Flavonoids are compounds metabolised in plants and are found in fruits, vegetables, tea and red wine. Studies of human populations have shown that those with diets rich in fresh fruit and vegetables and/or regular moderate wine consumption have low incidence of CVD (even when their diet is high in dairy fat – a contributor to CVD).
- Proteins often interact and so the targeting of only one aspect of cellular function with a single drug may not account for this.

Question 2c: 1 mark

They are able to react chemically or preferentially bind with the reactive oxygen species (radicals) which stabilises them and prevents any tissue damage.

Total 4 marks

Question 3a i: 1 mark

Proteins

- All proteins are formed primarily from essential amino acids – of which there are 20 known in humans. Phenylalanine is an essential amino acid and is fundamental in the formation of some proteins.

Question 3a ii: 1 mark

An enzyme

- The presence of phenylalanine hydroxylase results in the production of tyrosine. The compound also ends with the suffix *-ase* indicating that it is an enzyme.

Question 3b: 2 marks

Phenylpyruvic acid does not accumulate in the foetus because the mother's body produces phenylalanine hydroxylase which breaks down phenylalanine and then supplies the metabolites to the developing foetus.

Mark allocation
1 mark – that phenylpyruvic acid does not accumulate in the foetus.
1 mark – because that the mother's body produces phenylalanine hydroxylase to break down phenylalanine.

- The disorder occurs when a person does not produce the enzyme phenylalanine hydroxylase to break down phenylalanine. Whilst the foetus is *in utero*, the mother will be producing phenylalanine hydroxylase and breaking down the phenylalanine. After birth the infant needs to produce phenylalanine hydroxylase but is unable to do so. This leads to an accumulation of phenylalanine which is metabolised to phenylpyruvic acid and causes damage to brain tissue.

Question 3c i: 2 marks

The discs in Row A function as a control and each will contain a known concentration of phenylalanine.

Mark allocation
1 mark – discs in Row A function as a control
1 mark – contain a known concentration of phenylalanine

- The discs in Row A all show a distinct band of growth around them.

Question 3c ii: 1 mark

Samples 10, 12 and 24 indicate that the babies from whom these blood samples were taken have PKU.

- Samples **10**, **12** and **24** have a concentration of phenylalanine that is high enough to enable bacterial growth therefore the babies from whom these blood samples were taken have PKU.

Question 3d: 1 mark

Introducing a low protein diet that incorporates foods that are low in phenylalanine and include drinks which supply other essential amino acids, vitamins and minerals

- It is essential to minimise the amount of phenylalanine in the diet. The effects of PKU can be avoided by reducing the amount of protein which contains phenylalanine (most protein) and supplementing the diet with a supply of phenylalanine-free

amino acids OR by administering regular/controlled injections of stabilised phenylalanine hydroxylase.

Total 8 marks

Question 4a: 2 marks

Overall, the fruit in Group A demonstrate a peak in the rate of oxygen consumption at some stage of their ripening whereas overall the fruit in Group B demonstrate a gradual decline in their rate of oxygen consumption during their ripening process.

Mark allocation
1 mark for fruit in Group A demonstrate a peak in the rate of oxygen consumption
1 mark for fruit in Group B demonstrate a gradual decline in their rate of oxygen consumption

Question 4b i: 1 mark

Cellular respiration

Question 4b ii: 2 marks

$C_6H_{12}O6 + 6O_2 \rightarrow 6CO_2 + 6H_2O + 36ATP$ **(sometimes 38 ATP)**

Mark allocation
1 mark if all reactants and products are correct
1 mark for correct molecular ratios

Question 4c: 2 marks

Oxygen is the final electron acceptor in the electron transport chain and is reduced to water.

Mark allocation
1 mark for oxygen is the final electron acceptor in the electron transport chain
1 mark for oxygen is reduced to water

Total 7 marks

Question 5a: 1 mark

Hormones

Question 5b i: 1 mark

A weedkiller that kills some plants but not others

Question 5b ii: 1 mark

2,4-D is an auxin and disrupts normal growth of dicotyledons by inhibiting the growth of coleoptiles (shoot tips).

- It is thought that 2,4-D operates due to toxic accumulation within plant cells. Indoleacetic acid (IAA) enters and leaves cells by two different transmembrane transporters. Suggestions have been made that the transmembrane importer brings 2,4-D successfully into cells; however, the transmembrane exported is unable to remove the 2,4-D from the cell and it is this accumulation that becomes toxic to the cell, thus inhibiting function and growth.

Question 5c i: 1 mark

Weeds may have several strains. Some strains have a naturally occurring resistance to the herbicide and can withstand the effects of the 2,4-D.

Question 5c ii: 1 mark

They may wish to investigate the possible effects of long-term exposure (for humans and other animals) to the herbicide 2,4-D.

OR

They may wish to study the mechanisms of resistance development and its transfer to other species.

Total 5 marks

Question 6a: 4 marks

sensory nervous system	**somatic sensory neurons**	conveys information to CNS from the external environment
	visceral sensory neurons	**conveys information to CNS from the internal environment**
motor nervous system	somatic nervous system	**conveys signals to skeletal muscles**
	autonomic nervous system	conveys signals that regulate internal environment

Mark allocation
1 mark each correct response

Question 6b i: 1 mark

If a nerve cell is polarised, a potential difference in charge exists between the inside and outside of the cell.

Question 6b ii: 1 mark

Sodium–potassium pumps in the cell membrane actively pump sodium ions out of and potassium ions into the nerve cell.

- Sodium–potassium pumps in the cell membrane actively pump sodium ions out of and potassium ions into the nerve cell. As a result an excess of sodium ions accumulate outside the cell and potassium inside. Even though both ions are positively charged, the overall difference in accumulation leads to a relatively negative interior and relatively positive exterior.

Total 6 marks

Question 7a i: 1 mark

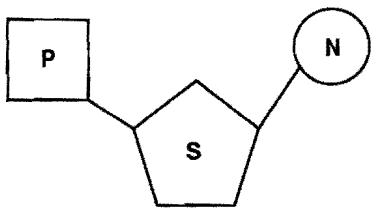
Deoxyribonucleic acid (DNA) and ribonucleic acid (RNA).

Mark allocation
1 mark – both identified correctly (either full name or acronym)
0 marks if only one identified correctly

- Essentially the two basic forms of nucleic acid are DNA and RNA. Even though pathogens may contain mitochondrial DNA and/or messenger, ribosomal or transfer RNA, the question asks for the *basic* forms of nucleic acid.

Question 7a ii. 3 marks

Monomer of DNA (or RNA)



P – phosphate

S – sugar

N – nitrogen base

Mark allocation
1 mark for title indicating whether monomer is DNA or RNA
1 mark for presenting correct molecules (named, i.e. phosphate, sugar, nitrogen base)
1 mark for correct positions and links between molecules

Question 7b: 1 mark

Prions

Total 5 marks

Question 8a: 1 mark

Regulator proteins

Question 8b: 1 mark

To vaccinate the rat through the induction of an immune response due to presence of tumour antigens

Question 8c: 2 marks

Antigens on tumour cells are recognised by the immune system. The rat's immune system becomes competent following the production of antibodies which serve to prime the rat in the event of potential further infection.

Mark allocation
1 mark for antigens on tumour cells are recognised by the immune system which promotes production of antibodies
1 mark for rat immune system becomes competent, priming the rat against potential further infection

- Some dead tumour cells will activate B cells, which will differentiate into plasma cells (which generate antibodies) and memory B cells. The production of tumour antibodies will continue in the long term (possibly for life) providing immunity to the rat.
- Some dead tumour cells are engulfed by macrophages which stimulate helper T cells (some of which will become memory helper T cells).

Question 8d: 2 marks

Rat 1 is exposed to tumour cells and consequently its immune system has had a chance to make antibodies in response to the tumour cell membrane surface antigens. At the same time, the tumour has been removed and so causes no more damage. When live tumour cells are introduced, antibodies are present and form antibody–antigen complex with tumour antigens. Rat 3 has not had prior opportunity to form antibodies against tumour antigens and therefore is unable to respond rapidly to the presence of the tumour which grows unchecked and out of control.

Mark allocation
1 mark for Rat 1 is exposed to tumour cells and immune system makes antibodies in response to the tumour cell membrane surface antigens
1 mark for tumour has been removed and causes no more damage

Question 8e: 2 marks

If experimental results are to be published, it is essential to replicate using genetically identical rats within each treatment. Each of the treatments had only one replicate (one rat each) which does not provide enough data to substantiate results. There should be at least five per treatment group, otherwise results are not robust and reliable enough.

Mark allocation
1 mark for experimental results to be published the experiments must be replicated using genetically identical rats
1 mark for there should be at least 5 per treatment group, otherwise results are not robust, reliable enough

Total 8 marks

PRACTICE EXAM 3 / SECTION A MULTIPLE-CHOICE QUESTIONS

Question 1: B

- **B is correct** because it identifies the four classes of biomacromolecules.
- A and D do not identify proteins.
- C does not identify nucleic acids.

Question 2: C

- A and D are incorrect. Exposure to low temperatures is least likely to result in a permanent change to the functional shape of a protein. Unlike high temperatures, low temperatures do not provide enough energy to alter or break the chemical bonds in the complex structure of the protein molecule. Due to their chemical properties and resultant interaction with proteins, strong salty solutions and/or highly acidic or alkaline solutions can lead to changes in bonding arrangements which are then likely to result in changes in functional shape.
- B is incorrect. High temperatures can alter or break chemical bonds in the protein molecule thereby changing the functional shape.

Question 3: D

Question 4: B

- Typical prokaryotes have plasmids.
- A is incorrect. They do not have membrane-bound nuclei.
- C is incorrect. They have a single, **double**-stranded DNA molecule.
- D is incorrect. They do not have membrane-bound organelles.

Question 5: A

- The water will diffuse from the hypotonic solution to the hypertonic solution through the porous membrane. The porous membrane prevents the solute (sugar) from diffusing down the concentration gradient (from a region of relatively high solute concentration to one of relatively low solute concentration). Only the water molecules can diffuse from a region of relatively high solvent (water) concentration to one of relatively low solvent concentration.

Question 6: C

- A, B and D are incorrect. The process of exocytosis involves the secretion or expulsion of material from within a cell. In order to cross the plasma membrane, the material is packaged in a vesicle which fuses with the membrane so its contents can be exported. Endocytosis, pinocytosis and phagocytosis are all forms of bulk transport of material into a cell. There is no fusion of vesicles to plasma membranes associated with these three processes.

Question 7: B

- The only correct combination is B. Photosynthesis **is a chemical** process which requires energy (endergonic) **and constructs** complex molecules, i.e. carbohydrates **from more simple ones** (anabolic). It does not release energy **(exergonic) nor does it** break down complex molecules **to simple ones (catabolic).**

Question 8: A

- B, C and D are incorrect. Harnessing heat as a source of energy would be detrimental to the cell. Heat has the effect of denaturing enzymes, which are proteins, because it changes the functional shape of the molecule. If cells produce heat, it is harnessed in a form of energy in chemical bonds.

Question 9: B

- A is incorrect. The bacteria can remain metabolically active because their enzymes have high optimal temperatures relative to human enzymes. The optimal temperature and pH ranges for enzymes vary between species. Enzymes are always sensitive to temperature.
- C is incorrect. Active metabolism will not be facilitated if the temperature denatures the enzymes in the organism.
- D is incorrect. Cells use enzymes (proteins) as biological or organic catalysts. They do not and cannot use any other molecules for this purpose.

Question 10: D

- A is not the best answer, because although pyruvate is produced by anaerobic cellular respiration, it is then converted to other compounds in the process. Pyruvate is not an end-product of anaerobic cellular respiration.
- B is incorrect. Products of fermentation are found in the cytosol, not the mitochondria.
- C is incorrect. The first stage of both aerobic and anaerobic cellular respiration results in the production of pyruvate by oxidising glucose (and sometimes other organic fuels such as glycerol or amino acids) in a process known as glycolysis. Aerobic cellular respiration produces a net yield of 36 (38) mole ATP per mole of glucose used whereas anaerobic cellular respiration produces a net yield of 2 mole ATP per mole of glucose used.

Question 11: B

- A is incorrect. Krebs cycle produces NADH, $FADH_2$, ATP and CO_2. O_2 is not released.
- C is incorrect. NAD becomes a 'loaded' acceptor molecule.
- D is incorrect. FAD becomes a 'loaded' acceptor molecule in this stage of aerobic cellular respiration.

Question 12: D

- A, B and C are all true of homeostasis. Homeostasis 'fails' when certain factors produce effects beyond the range of the normal homeostatic response to change.

Question 13: B

- A and C are incorrect. In the diagram, X represents negative feedback and Y represents positive feedback. X cannot represent positive feedback because a corrective response returns the system to its 'normal (set point)' after the 'increase' in the 'normal (set point)' which indicates a negative feedback response.
- D is incorrect. Y cannot represent negative feedback because there is no corrective response to return the system to its 'normal (set point)' after the 'increase' in the 'normal (set point)'. There is, in fact, a continued increase which indicates a positive feedback mechanism in place.

Question 14: D

- The most likely homeostatic response at Z if a deficiency of blood glucose is detected would be a decrease in the secretion of insulin from the beta cells (in the islets of Langerhans) in the pancreas. This would inhibit the conversion of glucose to glycogen and fat, thus restoring levels of glucose in the blood to within the normal range. (B is therefore incorrect – it does not enhance conversion.) The pancreas would not secrete more insulin as this would lead to increased uptake of blood glucose into cells and a further drop in blood glucose (A and C are incorrect).

Question 15: A

- B and C are incorrect. The corrective response at Z would lead to a rise in blood glucose level because in addition to the decrease in insulin production (which inhibits conversion of glucose to glycogen and fat) there is also an increase in the release of glucagon (a hormone released from the alpha cells in the islets of Langerhans) in the pancreas.
- D is incorrect. Glucagon triggers the conversion of stored glycogen and fats to glucose, thus the level of glycogen would **decrease**.

Question 16: B

- A is incorrect. There are no electrical impulses associated with this mechanism.
- C is incorrect. Control of blood glucose is principally maintained by the endocrine system in an individual who is free of diabetes.
- D is incorrect. The hypothalamus and pituitary gland are involved in many homeostatic mechanisms, but not, however, in the control of blood glucose. Control of blood glucose is principally maintained by cells in the pancreas.

Question 17: A

- B, C and D are incorrect. In normal circumstances (absence of autoimmune disease), an antibody would not normally stimulate an immune response from a B-cell or T-cell in an organism because it is recognised as 'self'. Antigens, pollen and viruses are all recognised as 'non-self' due to their antigenic state and would therefore stimulate an immune response.

Question 18: D

- A is incorrect – not specific enough. The structure of an antibody is such that the epitope binding site is comprised of the variable regions of the combined light chain and heavy chain.
- B and C are incorrect. It is not physically possible to bind with only the light chain regions or only the heavy chain regions of an antibody.

Question 19: D

- **D is correct** because second-line defence in plants involves the use of chemicals. Phytoalexins are plant chemicals that act in a similar way to antibiotics to protect a plant against pathogens. The first line of defence in plants is associated with a physical barrier against pathogens.
- A, B and C are incorrect. They all provide a structural (physical) barrier and therefore provide **first-line** defence, not second-line defence.

Question 20: B

- Prions are infectious proteins which are resistant to high temperatures, some enzymes and ultraviolet radiation.

- A is incorrect. They do not possess any genetic material.
- C is incorrect. They **do** cause BSE, CJD but **not** SARS, which is viral.
- D is incorrect. They do not just infect humans and cattle; they can infect sheep and cats too.

Question 21: D

- White blood cells are capable of producing antibodies.
- A is incorrect. They do not include erythrocytes – red blood cells.
- B is incorrect. They are associated with the second and third lines of defence.
- C is incorrect. They are found in the blood, lymph and tissue fluid.

Question 22: A

- **The only correct answer is A.** Antibodies are proteins with a Y-shaped structure that bind specifically with antigens. The antigen-binding sites are located on the arms of the Y. The antigen-binding sites on an antibody are identical.
- B, C and D do not depict antibodies with identical antigen-binding sites.

Question 23: D

- Following an encounter with a specific antigen, B-memory cells (and B-plasma cells) have been produced through the process of clonal selection. After some time the B-memory cells migrate to the lymph nodes where they remain until activated by antigens. The B-plasma cells produce large amounts of antibodies which circulate in the body for only around a month.
- A is incorrect. Antibodies could not survive for the length of time (months) suggested.
- B is incorrect. A low concentration of B-plasma cells is more likely to produce an effect similar to the primary response and the immune system will need to undergo clonal selection to produce antibodies and B-memory cells. It cannot produce a secondary response such as that depicted.
- C is incorrect. The concentration of B-plasma cells at the time of the secondary response is very unlikely to be high given the time elapsed since the primary antibody response, as they only survive for a few days.

Question 24: A

- **A is correct.** Acquired active immunity involves introducing a dead or attenuated form of a pathogen (through a vaccine) to an organism to stimulate the immune system to make memory cells so that it is ready for rapid activation in the event of an infection of that same (or closely related) pathogen.
- **B is** incorrect. Immunity can also be acquired passively through inoculation with antibodies produced by other organisms.
- **C and D are** incorrect. Immunity can also be developed naturally either when antibodies pass from mother to foetus through the placenta (D) or when an individual naturally comes into direct contact with a live form of the pathogen (not through a vaccine) and the immune system produces antibodies and continues to do so (C).

Question 25: B

- **A and** C are incorrect – not specific enough. Cells most directly associated with an allergic response are mast cells and basophils. Both cell types are associated with the response – not one or the other.
- D is incorrect. Lysosomes are associated with the breakdown and recycling of molecules within cells, not immunity.

PRACTICE EXAM 3 / SECTION B SHORT-ANSWER QUESTIONS

Question 1a: 1 mark

Carbon, hydrogen, oxygen, nitrogen and sulphur

- All five elements must be given in the answer to be awarded 1 mark for this question.

Question 1b i: 1 mark

Sample C

Question 1b ii: 1 mark

Nucleic acid is composed of carbon, hydrogen, oxygen phosphorus and nitrogen. Each of these elements (and no others) is present in Sample C.

Question 1c: 1 mark

The existence of a ribose sugar in RNA (ribonucleic acid) and a deoxyribose sugar in DNA. The deoxyribose sugar lacks an oxygen atom on its carbon.

Question 1d i: 1 mark

A single subunit/building block of a polymer

Question d ii: 1 mark

Polymerisation

Question 1d iii: 1 mark

Sample B

- Not Sample A (chitin, a carbohydrate like cellulose, does not contain sulphur) or Sample C (chitin, a carbohydrate like cellulose, does not contain phosphorus). Not Sample D because chitin contains nitrogen.

Question 2a: 4 marks

Cell type	Cellular structure	Function of structure
epithelial cell	microtubule	**maintaining cell shape OR enabling the elongation of cells OR facilitating movement of organelles and/or chromosomes OR involved in spindle formation during eukaryote cell division**
muscle cell	**mitochondrion**	site of ATP production
sperm cell OR unicellular eukaryote	flagellum	produces motion to allow transport
liver cell	endoplasmic reticulum	**transport channels for newly made proteins in cell, smooth ER OR site of protein synthesis, rough ER OR site of membrane production**

Question 2b i: 1 mark
Extracellular matrix (ECM)

Question 1b ii: 1 mark
Fibroblasts

Question 3a: 1 mark
Thylakoid membranes

Question 3b: 1 mark
Sugar
OR
Carbohydrate

Question 3c i: 1 mark
Cytosal

Question 3c ii: 1 mark
Inner mitochondrial membranes

Question 4a: 1 mark
Geotropism OR Gravitropism

Question 4b: 1 mark
To investigate the effect of rotation on geotropic responses

Question 4c Conclusion: 1 mark
That speed of rotation has an effect on the geotropic response of roots and shoots of bean seedlings.

Question 4c Explanation: 1 mark
Under normal conditions (Group 1 and Group 2) roots and shoots demonstrate positive and negative geotropism. In Group 3 the slow rotation results in a clearly observable response to gravity. In Group 4 the rotation is fast, preventing the plant from responding to the gravitational stimulus.

Question 4d: 1 mark
Auxin

Question 4e: 2 marks
Statoliths have an impact on the distribution of auxin. Auxins accumulate on the lower side of the roots and shoots (1 mark).

In the shoot, auxin enhances cell elongation on the lower side, leading to upward curvature. In the root, auxin inhibits cell growth on the lower side, leading to a downward curvature (1 mark).

Question 5a: 1 mark
Intermediate host

Question 5b: 2 marks
A scolex with suckers or a scolex with a ring of hooks (1 mark)

It maintains a strong attachment to the intestinal wall of the dog. (1 mark)

OR

The mature adult has a protective body coating (1 mark)

It makes it resistant to digestive enzymes found in the intestine of the dog (1 mark).

Question 5c: 1 mark
If the cyst ruptures during removal, the worms in the cyst may be spread further.

Question 5d: 1 mark
Worming tablets

Question 6a: 1 mark
Pheromone

Question 6b i: 1 mark
Mimicry

Question 6b ii: 1 mark
As a defence against a predator

Question 6c: 1 mark
Receptors

Question 7a: 1 mark
The immune system loses the ability to distinguish self cells from non-self cells. B-cells and T-cells then attack and destroy self cells.

Question 7b i: 1 mark
The fatty layer surrounding the axons of many neurons

Question 7b ii: 1 mark
It increases the speed at which electrical impulses travel along the nerve.

OR

It insulates nerve fibres from each other, enhancing the speed of impulse.

Question 7c: 1 mark
By electrical impulses

Question 7d i: 1 mark
Mitochondrion

ATP production

- No mark is awarded for 'mitochondria' – only one is indicated on the diagram, therefore the singular form is correct.

Question 7d ii: 1 mark
Secretory vesicle

Storage of chemical neurotransmitter

Question 7e 3 marks
The electrical impulse arrives at the end of the axon/synaptic knob which triggers secretory vesicles to migrate towards the pre-synaptic membrane (1 mark).

The vesicles fuse with the membrane and release neurotransmitter into the synaptic cleft (1 mark).

Neurotransmitter diffuses across synaptic cleft and binds with protein receptors on the post-synaptic membrane (1 mark).

- The maximum score for this question is 3 marks; all information presented must be correct to gain full marks.

Question 8a: 1 mark
An infection occurs when a pathogen enters an organism; a disease is the state which results due to the harmful effects of a pathogen in its host.

Question 8b: 1 mark
It moves from blood vessels to tissues engulfing and digesting bacteria and dead cells by phagocytosis.

Question 8c: 1 mark

By coating the surface of fungi or bacteria and signalling to phagocytes to engulf them

OR

By promoting inflammation and attracting phagocytes and other leucocytes

Question 8d: 1 mark

Arterioles in the injured area vasodilate, leading to an increased blood flow to the area.

Question 8e: 1 mark

Serotonin

OR

Histamine

Question 8f: 1 mark

Non-specific immunity

Question 8g: 1 mark

It can take an immature immune system longer to build up the necessary numbers of B-memory cells that recognise and destroy the *Clostridium tetani.*

PRACTICE EXAM 4 / SECTION A MULTIPLE-CHOICE QUESTIONS

Question 1: B

- **Answer B is correct** because Cell A is a plant cell since it has a cell wall, chloroplasts and a large vacuole and Cell B is an animal cell as it does not have a cell wall or chloroplasts and has a small vacuole.
- Answer A is incorrect because Cell A is not an animal cell and Cell B is not a plant cell.
- Answer C is incorrect because both cells A and B are eukaryotes as they possess membrane bound cell organelles.
- Answer D is incorrect because both cell A and cell B are not prokaryotes as they possess membrane bound cell organelles.

Question 2: B

- **Answer B is correct** because the cell organelle labelled X found in both plant and animal cells is a mitochondrion that carries out aerobic respiration.
- Answer A is incorrect because photosynthesis does not take place in mitochondria but takes place in chloroplasts, which are found only in Cell A.
- Answer C is incorrect because anaerobic respiration takes place in the cytosol of both Cells A and B.
- Answer D is incorrect because fermentation takes place in the cytosol of plant Cell A only.

Question 3: D

- **Answer D is correct** because apoptosis is the programmed cell death.
- Answer A is incorrect because mitosis is a cell division by which two identical daughter cells are produced.
- Answer B is incorrect because meiosis is the cell division by which four daughter cells (gametes) are produced.
- Answer C is incorrect because cytokinesis is the division of the cytoplasm which takes place after the nuclear division.

Question 4: A

- **Answer A is correct** because electron microscopes have the high magnifying power to view extremely small viruses.
- Answers B and C are incorrect because a light microscope and stereo-microscope do not have the magnifying power to view viruses.
- Answer D is incorrect because viruses cannot be seen with the naked eye.

Question 5: B

- **Answer B is correct** because osmosis is the movement of water from a region of low solute concentration through a semi-permeable membrane to a region of high solute concentration.
- Answer A is incorrect because diffusion is the movement of solutes from a region of higher solute concentration to a region of lower solute concentration through a semi-permeable membrane.
- Answer C is incorrect because active transport is the movement of solutes and ions from a region of lower concentration to a region of higher concentration by using specific transport proteins and energy from ATP molecules against concentration gradient.
- Answer D is incorrect because pinocytosis is the process by which some cells engulf and incorporate droplets of fluid.

Question 6: D

- **Answer D is correct** because as the size of the cube increases its surface area to volume ratio decreases because the volume of the cell increases more than its surface area.
- Answers to A, B and C are incorrect because as the size of the cube increases its surface area to volume ratio does not increase but decreases. This happens because the volume of the cell increases more than its surface area.

Question 7: C

- **Answer C is correct** because it can be interpreted from the graph that the optimum pH for enzymes pepsin, salivary amylase and arginase are 2, 7 and 10 respectively.
- Answers to A, B and D are incorrect because the pH values given in each case are incorrect.
- Note: It is best to use a ruler to get correct answers.

Question 8: D

- **Answer D is correct** because the diagram shows the decomposition reaction of enzyme catalase with its substrate hydrogen peroxide to produce oxygen and water as products.
- Answer A is incorrect because catalase is the enzyme, not the substrate
- Answer to B and C are incorrect because the enzyme catalase does not react with oxygen and water as they are the products of the reaction.

Question 9: C

- **Answer C is correct because during metaphase of mitosis the double stranded chromosomes line up at the equator of the cell.**
- **Answer A is incorrect because during prophase the chromosomes are just visible**

- Answer B is incorrect because during anaphase chromatids are pulled apart by the spindle fibres and they start to move to the opposite poles of the cell.
- Answer D is incorrect because during interphase chromosomes are not visible.

Question 10: B

- **Answer B is correct** because the thermoregulatory centre in the hypothalamus controls our body temperature.
- Answer A is incorrect because the thalamus does not control our body temperature.
- Answer C is incorrect because the pituitary gland is the master gland which controls the secretions of all the other endocrine glands.
- Answer D is incorrect because the pineal gland controls our sleep cycle.

Question 11: B

- **Answer B is correct** because insulin is secreted by the pancreas when the blood glucose level rises to convert glucose to glycogen for storage in the liver and muscles.
- Answer A is incorrect because glucagon is secreted by the pancreas when the blood glucose level decreases to convert the glycogen stored in the liver and muscles into glucose.
- Answer C is incorrect because thyroxin is produced by the thyroid gland which controls metabolic reactions.
- Answer D is incorrect because adrenalin is produced by the adrenal glands to enable the body to face stressful situations for a fight or flight reaction.

Question 12: D

- **Answer D is correct** because the neurotransmitter is released by the vesicles in the terminal button of the axon of a neuron so that a nerve impulse can pass on from one neuron to the next.
- Answers to A, B and C are incorrect because enzymes, acetic acid and hormones are not released by the vesicles in the terminal button of the axon of a neuron.

Question 13: B

- **Answer B is correct** because homeotherms regulate their body temperature by producing heat by metabolic reactions from within as they are endotherms.
- Answer A is incorrect because poikilotherms cannot regulate their body temperature. Their body temperature varies according to the external temperature.
- Answer C is incorrect because ectotherms maintain their body temperature by absorbing heat from outside the body by basking in the sun or seeking shade when too hot.
- Answer D is incorrect because hemitherms such as fish and butterflies can sometimes regulate their body temperature by swimming or moving their wings.

Question 14: A

- **Answer A is correct** because long day plants require 16 hours of light and 8 hours of darkness. These plants need more daylight hours than darkness.
- Answer B is incorrect because short day plants require 8 hours of light and 16 hours of darkness.
- Answer C is incorrect because neutral day plants do not require a set amount of light and darkness.
- Answer D is incorrect because tundra plants grow in cold arctic and subarctic regions.

Question 15: A

- **Answer A is correct** because blood is filtered in the glomerulus, which is made up of capillaries.
- Answer B is incorrect because water and some salts are reabsorbed in the Loop of Henle.
- Answer C is incorrect, because urea is collected in the collecting duct before passing along the ureter to the bladder.
- Answer D is incorrect because salts and ions are absorbed in the distal tubule.

Question 16: B

- **Answer B is correct** because Neuron A is a sensory neuron as it has a short axon, a cell body to the side and a long dentrite. Neuron B is a motor neuron because it has a long axon and short dendrites which branch off from a central cell body.
- Answer A is incorrect because Neuron A is a sensory neuron and Neuron B is a motor neuron.
- Answers to C and D are incorrect because neither structure is of an interneuron.

Question 17: C

- **Answer C is correct** because the autonomic nervous system controls involuntary reflex actions such as knee jerks.
- Answer A is incorrect because the central nervous system controls voluntary actions.
- Answer B is incorrect because the peripheral nervous system carries messages from outside the body to the central nervous system.
- Answer D is incorrect because the sympathetic nervous system is a part of the autonomic nervous system, which acts in conjunction with the parasympathetic nervous system in controlling heartbeat, pupil size etc.

Question 18: C

- **Answer C is correct** because the spinal cord contains interneurones which connect the sensory and motor neurones.
- Answer A is incorrect because the sensory neuron labelled 2 carries nerve impulses from the sensory organ to the spinal cord.
- Answer B is incorrect because the motor neuron labelled 4 carries nerve impulses from the spinal cord to the effector organ.
- Answer D is incorrect because the dorsal root ganglion does not contain interneurones. It contains the cell body of the sensory neuron.

Question 19: A

- **Answer A is correct** because the sensory neuron carries nerve impulses from the sense organ to the central nervous system.
- Answer B is incorrect because only motor neurons carry nerve impulses from the central nervous system to the effector.
- Answer C is incorrect because the direction of the nerve impulse pathway is from the sense organ to the central nervous system, not from the central nervous system to the sense organ.
- Answer D is incorrect because the sensory neuron does not carry nerve impulses from the effector to the central nervous system.

Question 20: A

- **Answer A is correct** because the term used to describe white blood cells migrating and engulfing bacteria is phagocytosis.
- Answer B is incorrect because pinocytosis is the process by which cells can engulf and incorporate droplets of fluid.
- Answer C is incorrect because endocytosis is the process by which extracellular particles too large to cross the membrane are engulfed.
- Answer D is incorrect because exocytosis is the process by which cellular material is discharged from a cell.

Question 21: C

- **Answer C is correct** because mast cells release histamine and cause the itchy red welts associated with allergies.
- Answer A is incorrect because B cells are involved in humoral immunity and produce antibodies to react with antigens.
- Answer B is incorrect because T cells are involved in cellular immunity and destroy pathogens.
- Answer D is incorrect because white blood cells engulf pathogens that enter the body.

Question 22: A

- **Answer A is correct** because IgG immunoglobulins increase after a person is given a booster dose of a vaccine. These immunoglobulins are found in all body fluids and fight bacterial and viral infections.
- Answer B is incorrect because IgM immunoglobulins are the first type of antibodies produced in response to an infection. Their numbers do not increase as much as IgG levels after a person is given a booster dose of a vaccine.
- Answer C is incorrect because IgA immunoglobulins protect body surfaces that are exposed to the outside from foreign organisms and substance. They are not shown on the graph.
- Answer D is incorrect because Ig E immunoglobulins cause the body to react against foreign allergens and are involved in allergic responses and are not shown on the graph.

Question 23: A

- **Answer A is correct** because B cells are produced in the bone marrow.
- Answers to B, C and D are incorrect because B cells are not produced in the thymus gland, the lymph gland or the thyroid gland.

Question 24: C

- **Answer C is correct** because an antibody consists of four polypeptide chains, two heavy chains and two light chains.
- Answer A is incorrect because an antibody does not consist of two heavy chains and one light chain.
- Answer B is incorrect because an antibody does not consist of one heavy chain and one light chain. The light chains contain the antigen binding sites of an antibody.
- Answer D is incorrect because the antibody does not consist of one heavy chain and two light chains.

Question 25: B

- **Answer B is correct** because when patients are exposed to an antiserum containing antibodies they develop passive immunity because they are given antibodies from another source.
- Answer A is incorrect because when patients are exposed to antiserum containing antibodies they do not develop active immunity since they do not make their own antibodies.
- Answer C is incorrect because this is not natural immunity since the patient's body does not produce the antibodies.
- Answer D is incorrect because the antibodies given in the antiserum provide specific passive immunity against a particular pathogen.

Total 25 marks

PRACTICE EXAM 4 / SECTION B
SHORT-ANSWER QUESTIONS

Question 1a: 1 mark

Chloroplasts are found in photosynthetic plant cells such as leaves.

- Just mentioning plant cells will not score one mark because only leaves and green parts of the plants have chloroplasts.

Question 1b: 2 marks

Light dependent reaction

Light energy captured from sunlight splits water into hydrogen ions and oxygen (O_2). The O_2 Diffuses out of the chloroplasts. The light energy is converted to chemical energy, which is temporarily stored in ATP and NADPH.

$2H_2O \rightarrow 4H^+ + O_2$

Light-independent reaction

Hydrogen ions combine with CO_2 to produce glucose and water.

$6CO_2 + 24H^+ \text{ ------> } C_6H_{12}O_6 + 6H_2O$

- One mark will be given for the light reaction and one mark will be given for the light-independent reaction if both the explanation and the equation are written. If only the explanation is given and the equations are not written, the student will score one mark only. The equations need not be balanced as shown.

Question 1c: 1 mark

Photosynthesis is an endergonic reaction because light energy is required from an external source. It is converted to electrical energy first and then stored as chemical energy in the carbohydrate.

- An explanation of why this reaction is an endergonic reaction must be written to score one mark.

Question 1d: 1 mark

The rate of photosynthesis is highest at 400 and 680 wavelengths of light

- If only one wavelength is mentioned one mark cannot be given.
- Note: students must use a ruler to get the correct answer.

Question 1e: 2 marks

Aerobic respiration takes place in the presence of oxygen in mitochondria. Glucose is decomposed to produce carbon dioxide; water and 36 ATP molecules are produced

Anaerobic respiration takes place in the absence of oxygen. It occurs in the cytoplasm of the cell. In plants, pyruvic acid is converted into ethanol, carbon dioxide and two ATP molecules.

Pyruvic acid → ethanol + carbon dioxide + 2 ATP

In animals pyruvic acid is converted into lactic acid and 2 ATP molecules

Pyruvic acid → lactic acid + 2 ATP

- Explanation and equations for aerobic and anaerobic respiration need to be correct to score two marks.

Question 1f: 1 mark

Glycolysis is the process by which glucose is converted to pyruvate and ATP is generated in the absence of oxygen.

- The correct definition of glycolysis and the name of the product, pyruvate must be mentioned to score one mark.

Total 8 marks

Question 2a: 2 marks

The cell membrane is made up of a double layer of phospholipid molecules forming the phospholipid bilayer. According to the fluid mosaic model the plasma membrane is like a thick and sticky fluid in which a mixture of proteins, carbohydrate and cholesterol molecules move around, creating a mosaic-type arrangement.

- Phospholipid molecules, protein molecules, carbohydrate molecules and cholesterol molecules must be mentioned to score two marks. If only phospholipid molecules and protein molecules are mentioned students will score only one mark.

Question 2b i: 2 marks

Alcohol and detergent solutions damage phospholipid molecules in the cell membrane and the membrane surrounding the vacuole. The pink pigment contained in the vacuole called anthocyanin, comes out and the solutions in dish 2 and 3 turn pink.

- If students explain the cause of the damage caused to the phospholipid layer in both membranes surrounding the vacuole and the cell they will score one mark. If they mention that the coloured pigment comes out of the vacuole due to the damage to the membranes, they will score one more mark.

Question 2b ii: 1 mark

Water enters the beetroot cells passively by diffusion, which does not require energy.

- Just mentioning diffusion will not be sufficient to score one mark

Question 2b iii: 2 marks

Energy from ATP is required during active transport because materials are transported against the concentration gradient through transport protein molecules in the cell membrane. In simple diffusion energy is not required as molecules move from a region of higher concentration to a region of lower concentration between the phospholipid molecules.

- Students need to mention two points: the energy requirement and the passage through transport protein molecules or lipid molecules to score two marks

Total 7 marks

Question 3a: 2 marks

A hypotonic solution is a solution with a salt concentration that is lower than that in the cytoplasm of plant and animal cells so that water flows into the cells by osmosis.

A hypertonic solutio: is a solution with a salt concentration that is higher than that in the cytoplasm of plant and animal cells so that the water is drawn out of the cells by osmosis.

- Students must mention the salt concentration of both solutions and also mention how water moves in or out of the cell by osmosis to score two marks.

Question 3b: 1 mark

When red blood cells are placed in distilled water, which is hypotonic, they gain water by osmosis and the cells burst because they do not have a cell wall. This bursting of the cell is known as lysis. If plant cells are placed in distilled water, which is hypotonic, the cell contents swell and become turgid. Since they have cell walls they do not burst. The cells gain water from the surrounding solution because it has a higher concentration of solutes than the surrounding hypotonic solution.

- To score one mark, students must explain how the presence of a cell wall protects the plant cells from bursting while its absence in red blood cells causes bursting.

Question 3c: 1 mark

When red blood cells are placed in seawater, which is hypertonic, they lose water by osmosis and the cells shrivel up. This process is known as crenation. When plant cells are placed in seawater, the cytoplasm pulls away from the cell wall leaving a gap between the cell wall and the cell membrane and the cell becomes flaccid. This process is called plasmolysis.

- To score one mark students must explain the difference between crenation and plasmolysis

Total 4 marks

Question 4a: 1 mark

The bending of shoots towards light is known as positive phototropism and the movement of roots away from light is known as negative phototropism.

- A clear explanation of positive and negative phototropism must be given to score one mark.

Question 4b: 2 marks

In diagram A, question 4, since the light is coming from the top of the shoot, auxin produced by the tip of the shoot moves down on both sides of the shoot. Therefore the cells on both sides of the shoot are enlarged and the shoot grows straight.

In diagram B, question 4, since the light is coming from one side, the auxin moves away from the light side to the dark side. This makes the cells on the dark side elongate and the shoot bends towards the light.

- The way the direction of light source affects the production and movement of auxin and its effect on cell elongation in both diagrams must be explained clearly to score two marks.

Question 4c: 2 marks

Set-up a:
Since the shoot tip was not covered auxin was produced and the shoot bent towards the light.

Set-up b:
Since the shoot tip was covered with an opaque cap through which light could not pass, no auxin was produced and hence the shoot did not bend towards the light.

Set-up c:
Since the shoot tip was covered with a clear cap so that light could pass through the cap auxin was produced and the shoot bent towards light.

Set-up d:
Since the opaque sleeve did not cover the tip of the shoot auxin was produced and the shoot bent towards the light.

- A clear explanation of why the shoot bends or does not bend towards the light in each set-up must be given to score two marks.

Question 4d i: 2 marks

The roots growing downwards toward the ground exhibit positive geotropism. The advantage of this tropism is that it helps the plant to be anchored in the soil and to absorb water from the ground.

- The definition of geotropism and the advantage of this tropism must be written clearly to score two marks.

Question 4d ii: 2 marks

In phototropism, auxin migrates to the 'dark side' of the growing shoot, causing the cells to elongate more and so the shoot bends towards the light. In geotropism, auxin collects on the lower side of a growing root and inhibits cell elongation at high concentrations on the lower side of the root. The upper side of the root elongates and this causes the root to bend downwards.

- The effect of auxin in phototropism and geotropism must be explained clearly to score two marks. If only one tropism is explained the student will score one mark.

Total 9 marks

Question 5a: 1 mark

Prion is a type of protein found in nerve tissues. Normal PrP^c protein is found in brain cells.

- The definition of prion must be stated correctly and that PrPc protein is found in brain cells must be mentioned to score one mark.

Question 5b: 2 marks

PrP^{sc} converts normal PrP^c molecules into PrP^{sc} by inducing them to change shape. The PP^C has 43% of alpha helix and twists into a specific kind of spiral. PrP^{sc} contains 30% alpha helix and 43% beta sheet and is fully extended.

- The difference in folding and the presence of alpha helix and beta sheet must be mentioned to score two marks.

Question 5c: 1 mark

When the meat of an infected cow or sheep is ingested, the PrP^{sc} protein in the meat enters the brain and changes the structure of normal PrP^c protein. The transplantation of the cornea or the use of contaminated surgical instruments or the injection of growth hormone derived from human pituitaries also cause prion-related diseases.

- One mode of transmission and the way the normal prion protein PrP^C is changed to PrP^{sc} must be mentioned to score one mark.

Question 5d: 1 mark

CJD in humans and mad cow disease in cattle or scrapie in sheep are caused by prions.

- Two diseases caused by prions must be mentioned to score one mark.

Total 5 marks

Question 6a: 1 mark

Any foreign substance such as pollen, dust or a pathogen that stimulates the immune system to react against it is called an antigen.

- The correct definition of an antigen and two examples must be written to score one mark.

Question 6b: 1 mark

Macrophages engulf the antigens and present antigen proteins on their surfaces. This stimulates helper T cells.

- The ways macrophages engulf antigens and present antigen proteins to stimulate T cell must be written to score a full mark.

Question 6c: 1 mark

Helper T cells stimulate B cells and cytotoxic T cells.

- Both B cells and cytotoxic T cells must be mentioned to score a full mark.

Question 6d: 1 mark

B cells produce plasma cells, which in turn produce antibodies.

- The production of plasma cells and antibodies must be mentioned to score a full mark.

Question 6e: 1 mark

Memory B cells activate plasma cells to produce more antibodies quickly. Memory T cells stimulate the production of active cytotoxic T cells.

- Both Memory B cells and Memory T cells must be mentioned to score full marks.

Question 6f: 2 marks

HUMORAL IMMUNITY	CELL-MEDIATED IMMUNITY
B cells are produced in bone marrow.	T cells are produced in thymus gland from precursor cells formed in bone marrow. The four types of T cells have different functions:
In response to antigens B cells produce plasma cells, which produce specific antibodies and Memory B cells. Antibodies combine with antigens.	Cytotoxic T cells produce toxic chemicals which kill bacteria and viruses directly.
Memory B cells survive longer and stay inactive but are ready to respond if similar antigen reappears.	Helper T cells produce chemicals that help B cells to divide.
	Memory T cells produce more T cells
	when the antigen reappears.
	Suppressor T cells suppress the action of
	B cells and T cells after the bacteria and virus are killed.

- The place of production and the function of each type of B cell and T cell must be written in detail to score two marks.

Total 7 marks

Question 7a: 1 mark

The Anopheles mosquito acts as the vector.

- The name of the mosquito species must be mentioned to score one mark.

Question 7b: 1 mark

When the mosquito bites a human, the sporozoites from its salivary glands enter the human bloodstream.

- The entry of sporozoites by the mosquito bite must be mentioned to score one mark.

Question 7c: 1 mark

The parasites reproduce asexually in the liver first and then in the red blood cells.

- Both the liver and red blood cells must be mentioned to score one mark.

Question 7d: 1 mark

When red blood cells burst and release the sporozoites into the bloodstream, the person suffers from high fever and chills.

- The stage when the symptoms occur must be mentioned to score one mark.

Question 7e: 1 mark

Plasmodium can withstand attack by the human immune system and the digestive enzymes. It is able to survive in humans and mosquitoes and has two types of lifecycles to increase its chance of survival and its transmission from one host to another host.

- The way the mosquito adapts to withstand the human immune system and how its two types of lifecycles increase the chance of survival must be mentioned.

Total 5 marks

Question 8a: 2 marks

Osmoregulation in humans is controlled by a negative feedback mechanism as shown below:

If the sodium concentration is high and less water is present in the blood, osmoreceptors in the hypothalamus detect the change and send chemical messages to the posterior pituitary gland next to it. The pituitary gland secretes anti-diuretic hormone (ADH) into the bloodstream. When the hormone reaches the nephrons in the kidney it increases the permeability of the collecting duct in the kidney, thereby increasing the amount of water reabsorbed by the body. This puts more water back in the blood, increasing the concentration of the urine. Thirst is induced so that more water is taken in by drinking.

When less sodium and too much water are present in the blood, the hypothalamus causes a reduction in the secretion of ADH in the blood. This increases the amount of water excreted by the kidneys, producing large quantities of dilute urine. Thus the concentration of sodium and water in blood is maintained hy the negative feedback mechanism whereb ythe response affects the original stimulus to maintain homeostasis.

- The role of osmoreceptors in the hypothalamus, the secretion of ADH by the posterior pituitary gland and the effect of ADH on the permeability of the collecting tubule to water must be mentioned in detail to score two marks.

Question 8b: 2 marks

Saltwater fish

These fish are hypotonic to their surroundings. Their blood has a higher water concentration and less salts than the surrounding salt water. They lose water and gain salts through their gill membrane and skin so they drink large amounts of water to balance water loss. Their gills actively secrete Na+ through chloride cells in their gills. Large amounts of salt and small amounts of water and ammonia are excreted as concentrated urine.

Freshwater fish

These fish are hypertonic to their surroundings. This means their blood has a lower water concentration and more salt than the surrounding fresh water. Due to the concentration gradient they gain water and lose salts through their gill membrane and skin. So they do not drink water. Na+ is actively pumped in through the chloride cells in the gills. Small amounts of salt and large amounts of water and ammonia are excreted as dilute urine.

- Why and how water and salts are gained and lost due to the concentration gradient must be described in detail as shown to gain two marks.

Question 8c: 1 mark

When a freshwater fish is placed in salt water which contains a higher concentration of salt, it loses water through its body surface by osmosis and dies due to dehydration.

- Students must mention why the fish loses water to the surrounding salt water to score one mark.

Total 5 marks
Total for Section B 50 marks
Grand total 75 marks