Neap:

Trial Examination 2016

VCE Biology Unit 3

Written Examination

Suggested Solutions

SECTION A: MULTIPLE-CHOICE QUESTIONS

1	A	B	**C**	D
2	A	**B**	C	D
3	A	B	C	**D**
4	A	B	**C**	D
5	A	**B**	C	D
6	A	B	**C**	D
7	A	B	C	**D**
8	A	**B**	C	D
9	**A**	B	C	D
10	**A**	B	C	D
11	**A**	B	C	D
12	A	B	**C**	D

13	A	B	C	**D**
14	A	B	C	**D**
15	A	B	**C**	D
16	**A**	B	C	D
17	**A**	B	C	D
18	A	B	C	**D**
19	A	**B**	C	D
20	A	**B**	C	D
21	**A**	B	C	D
22	A	B	**C**	D
23	A	B	C	**D**
24	A	**B**	C	D
25	A	B	C	**D**

Question 1 C

Students should have strategies to recall the major groups of biomolecules as well as their subunits. Nucleotides are the monomers of nucleic acids, which can be DNA or RNA. Many hormones are protein (insulin, glucagon); however, hormones such as oestrogen and testosterone are lipids. Lipids can be divided into several classes, such as phospholipids (membrane component), steroids (sex hormones) and triglycerides (fat). A polypeptide is another word for a protein and all proteins are chains of amino acids.

Question 2 B

Water is the main biomolecule making up cells (and individuals). It is a polar molecule, meaning it is charged due to the nature of the bonding within the molecule. You can think of each water molecule like a little 'magnet'. This means they attract each other, which explains the cohesive nature and heat retention capacity of water. Many polar molecules mix freely with water, such as glucose and salts. The water is the solvent and the mixing chemicals are the solutes. Water molecules are constantly moving (kinetic theory), which explains why solutes mix well in water. If water was viscous it would take longer for chemicals to mix in it and metabolism would be a lot slower.

Question 3 D

The primary level of arrangement refers to the amino acid sequence of the polypeptide chain. This is assembled at the ribosome using the instruction of mRNA (translation). The amino acids interact with each other along the chain, and coil (α-helices) and fold (β-sheets). This is referred to as the secondary level of arrangement and the way this occurs is dependent on the amino acid sequence. The final three-dimensional shape of each polypeptide chain is held together by chemical bonds such as disulphide bonds (where two cysteine amino acids form a cross-bridge). This is referred to as the tertiary level of arrangement. Haemoglobin is functional at the quaternary level of arrangement because there are four polypeptide chains held together to form the functional protein.

Question 4 C

The reaction in the diagram is a condensation reaction. Two amino acids are joined to form a dipeptide and water is a by-product. This reaction occurs at the ribosomes within cells. Condensation reactions are anabolic, which means there needs to be an energy input. The mitochondria contains DNA as well as ribosomes and so protein synthesis does occur within that organelle.

Question 5 B

The phospholipids have their phosphate heads (R), which are polar (hydrophilic: water-loving), and fatty acid tails, which are non-polar (hydrophobic: water-hating). The region S is in the middle of the phospholipid bilayer and is a non-polar region, which would be lipophilic, not lipophobic. The protein channel (Q) would be a hydrophilic region, thus allowing water-soluble molecules to pass through. Region P is the top part of a protein that would be comprised of hydrophilic amino acids. The lower part of the protein would be comprised of non-polar amino acids.

Question 6 C

Most enzymes are protein. Their names generally begin with the type of reaction they are involved in catalysing (in this case, the catalysis of sucrose) and end with the suffix '-ase'. This enzyme is sucrase, which catalyses the hydrolysis of sucrose. Sucrose is a carbohydrate, RNA is a nucleic acid and guanine is a nucleotide.

Question 7 D

The genome is the complete set of genetic instructions (DNA) in the nucleus of a cell. The proteome is all the proteins a cell produces, which is only reliant on a small proportion of the genome. Cells are different, but not due to different genomes – rather it is as a result of the different combination of proteins the cell manufactures. The human genome is made up of about 2% genes and the rest (control, introns or no function as yet discovered) is the remaining 98%.

Question 8 B

Reverse transcriptase will convert the RNA strand in the stem of the question into a complimentary DNA strand. The DNA strand will be anti-parallel to the RNA strand, so it will be 5′ CTAGTCAGGT 3′. DNA is double-stranded and so the complimentary DNA strand to the one that was reverse transcribed would be 3′ GATCAGTCCA 5′.

Question 9 A

Chemicals A and B are substrates (sometimes called reactants) and C is the enzyme. A, B and C connected altogether is called the enzyme–substrate complex. A and B joined together is the product (an anabolic reaction) and the enzyme (C) is available to catalyse more reactions (it is reusable). Enzymes do not look for substrates, they simply collide with them. If the collision is in the correct orientation, a chemical reaction will occur.

Question 10 A

Students need to be able to make the link between the cellular organelle and the particular function of that organelle. RNA is not replicated in the chloroplast, it is translated (making **B** incorrect). Lipid biosynthesis occurs in the smooth endoplasmic reticulum, not vacuoles (making **C** incorrect). The protein component of a glycoprotein is synthesised at the ribosomes and the carbohydrate component would be added at the Golgi (making **D** incorrect). The mitochondria contain DNA that is able to replicate when cells divide or more mitochondria are required within a cell.

Question 11 A

The independent variable (IV) in a well-designed experiment is the factor that is deliberately changed by the scientist. In the case of this experiment, the IV is the temperature. The dependent variable (DV) is the factor being measured, and to ensure a fair test, all other factors need to be controlled (such as light and gases).

Question 12 C

10°C and 50°C are at the extremes in this particular experiment. The amount of carbon dioxide that is removed from the Perspex container is less than at the other temperatures. This is due to the enzymes which are driving metabolism not functioning at their optimum at these temperatures. The reasons for the low activity of these enzymes are different for both temperatures. At the low temperature, the number of collisions between enzyme and substrate is less frequent because there is less kinetic energy in the environment. However, at the higher temperature, there is more kinetic energy in the environment, but that puts pressure on the three-dimensional shape of the enzymes and they start to denature. Conclusions about the rates of metabolic processes such as respiration and photosynthesis cannot be made because the IV is temperature, not light.

Question 13 D

At the experimental light intensity the carbon dioxide (CO_2) absorbance was 155 ppt. The rate of photosynthesis (CO_2 in) is higher than the rate of respiration (CO_2 out), which explains the decrease of CO_2 in the Perspex container. If the light source is removed, photosynthesis will no longer occur, but respiration will continue (all living cells respire all the time). The result should be that CO_2 levels would move back to the initial level because respiration will put CO_2 back into the Perspex container.

Question 14 D

Testosterone, being a lipid hormone, will bind to intracellular receptors because it is able to dissolve through the plasma membrane. Protein hormones bind to extracellular receptors because the protein is lipid-insoluble and unable to pass through the membrane. Hormones do not move directly to target tissues; they are secreted into the bloodstream and move indirectly through the circulatory system. As a general rule, lipid hormones activate genes and protein hormones activate enzymes, which means lipid hormones have a longer-lasting response and are secreted in smaller quantities than protein hormones.

Question 15 C

For a reflex response as illustrated in the stem of the question, the stimuli is detected by receptors (in this case, the starting pistol is the stimulus and the nerves in the ear are the detectors). Once the stimulus is converted into a nerve message it will move to the CNS (via sensory neurons) for processing. When processing has occurred, the message will move from the CNS (via motor nerves) to an effector (in this case, leg muscles). The number of neurons would be pretty much the same; however, taller people will have longer axons in the peripheral nervous system (PNS). The PNS contains sensory and motor neurons which will vary in length. Nerve messages travel at about 10 m s^{-1} along an axon, but the chemical message across the synapse is slower.

Question 16 A

P is binding to an extracellular receptor (Q), making P a protein hormone. The series of arrows represents signal transduction, where the initial message is converted via a series of steps into an appropriate response (S).

Question 17 A

The tetradecadien is secreted from a moth (presumably a male) and clearly attracts female moths. A chemical secreted from a member of a species that elicits a response from another member of the same species is called a pheromone, a type of signalling molecule.

Question 18 D

Based on the diagram, auxin binds to a receptor (auxin-repressor), which changes the shape of the repressor, detaching it from the auxin-response genes. The auxin and the receptor are complimentary to each other. Once this is achieved, RNA polymerase is able to bind to the gene region and express the auxin-response genes (possibly leading to elongation). This process would occur in the nucleus of the plant cell, meaning auxin is permeable to the cell. RNA polymerase is available for all activated genes and so would not be one of the auxin-response genes.

Question 19 B

Virus structure is different to the typical structure of a cell. There is a nucleic acid core (either DNA or RNA) surrounded by a protein shell (capsid). Occasionally viruses have a phospholipid bilayer on the outside of the capsid; however, this is from the cell the virus was released from. A virus is very small compared to a bacteria.

Question 20 B

Sebum acts as a form of chemical barrier that reduces the chance of pathogens entering the body and causing disease. It is a part of the first line of defence and is similar to the effect of mucus (pathogens get stuck in it), stomach acidity (kills many bacteria) and lysozyme (a chemical in tears that has antibacterial properties).

Question 21 A

There are two antibody peaks, suggesting two exposures to the same antigen. Initially there had been no prior exposure because there were no antibodies in the bloodstream. This would typically be the case when a person is vaccinated or has come into contact with a pathogen for the first time. The immune system is activated to form antibodies that increase in concentration. Once the pathogen is removed the level of antibody drops, but memory cells remain. Upon second exposure prior to November 2015, the memory cells divided and produced more plasma cells, explaining the highest level of antibodies at that time. Each subsequent exposure leaves more memory cells behind (the immune system becomes sensitised). The low level of antibody in April 2015 is due to the plasma cells starting to drop in numbers because the antigen is no longer in the bloodstream causing a threat.

Question 22 C

A naive B cell, when in contact with a helper T cell, will be stimulated (via the action of lymphokines) to clone and differentiate. The helper T cell can be thought of as the 'quality control' cell of the immune system. The immune system will function without them, but the response will be much more directed with them. Cytotoxic T cells destroy viral-infected cells. Mast cells lead to inflammation. Antigens are not subject to apoptosis; rather it is the cells that have antigens present on their surface which are susceptible.

Question 23 D

Artificial passive immunity is the artificial passing of already manufactured antibodies into a person to provide a short-lasting defence against disease. The antibodies can be administered via a needle and are typically given after a snake bite/spider bite which is life-threatening. The immune system is not activated in this case, but it does offer short-lasting immunity. Receiving a chickenpox vaccine is artificial active immunity. A baby gaining antibodies via breast milk is a form of natural passive immunity. Getting ill due to contracting the swine flu is a form of natural active immunity.

Question 24 B

Multiple sclerosis (MS) is a disease where the immune system attacks the cells of the body for no apparent reason. This is referred to as an autoimmune disease, and involves self cells somehow being transformed into non-self cells. This triggers the immune system to attack its own cells. In the case of MS, these are the cells producing myelin, which leads to the disease's symptoms.

Question 25 D

In the stem of the question it is stated that as you move south, the incidence of MS increases. This eliminates **A** and **C**, as they show MS decreasing as you move south. If there is a correlation between both vitamin D deficiency, herpes and MS, they should follow a similar pattern on the graph.

SECTION B: SHORT-ANSWER QUESTIONS

Question 1 (7 marks)

a. **i.**

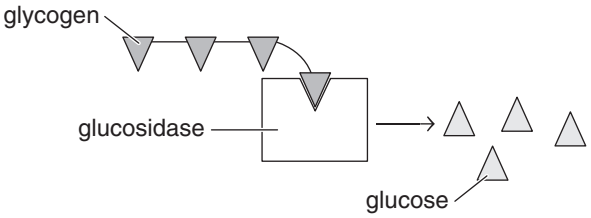
Type of enzyme	Substrate	Product(s)
protease	*protein*	amino acids
glycosidase	polysaccharide	*monosaccharides*

2 marks

1 mark for each correct answer.
Note: Accept glucose as a monosaccharide.

ii. exocytosis 1 mark

b. **i.**



2 marks

1 mark for correct labelling of glucosidase, glycogen and glucose.
1 mark for correctly drawn diagram showing glucosidase with an active site, glycogen as a polysaccharide and glucose as a monosaccharide.

ii. Pompe disease appears due to a lack of glucosidase to convert glycogen into glucose. This means less glucose is available for energy-driven reactions.

*For example, any **two** of the following symptoms:*

- muscle weakness
- breathing difficulty
- eating difficulty
- walking difficulty
- being constantly tired

2 marks

Note: Anything reasonable that requires energy and would inhibit human functioning should be accepted.

Question 2 (7 marks)

a.

Organelle	Specific function of the organelle
ribosome	site of insulin production
endoplasmic reticulum	transport of insulin within the cell
Golgi apparatus	*modification, packaging and secretion of biomolecules*

2 marks

Note: The ribosome is the site of protein manufacture. If students say 'ribosomes on the rough endoplasmic reticulum' that would be reasonable, but saying just the rough endoplasmic reticulum would be too general.
Students should say 'endoplasmic reticulum' or 'rough endoplasmic reticulum' for the transport network.

b. **i.** The primary level of protein structure is the sequence of amino acids along the polypeptide. This is controlled by the mRNA sequence moving through the ribosome. 1 mark

ii. The disulphide bonds form cross-links between amino acids within the functional protein. Some are between amino acids within the one polypeptide chain and contribute to the tertiary structure of that polypeptide. 1 mark

Some are between polypeptides, holding them together and contribute to the quaternary structure of the functional protein. 1 mark

c. DNA carries the blueprint for protein synthesis, and when the gene(s) for insulin are activated, mRNA is formed by transcription. 1 mark

The mRNA moves to the cytosol where it binds to a ribosome (on the RER) and the mRNA is translated into the insulin protein. 1 mark

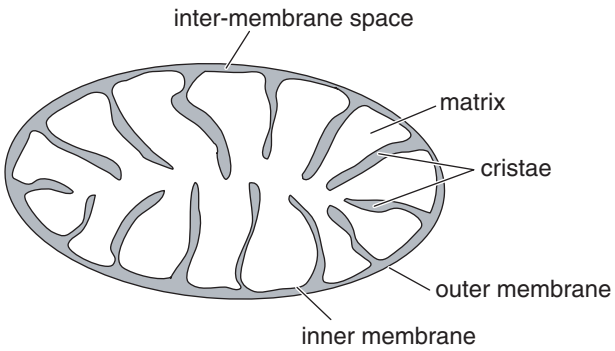
Question 3 (8 marks)

a. Morgan is correct because the mitochondria are energy-producing organelles and all cells need energy. 1 mark

Both plant cells (autotrophic eukaryotes) and animal cells (heterotrophic eukaryotes) carry mitochondria because they are membrane-bound organelles and are involved in energy production for the cell. 1 mark

Note: Some recognition of the terms eukaryotic, autotrophic and heterotrophic should be included for full marks to be awarded.

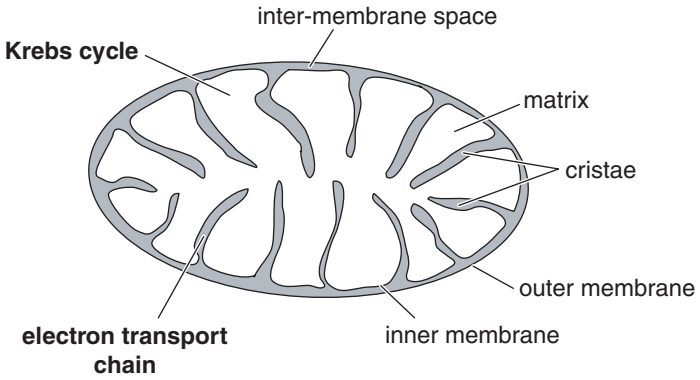
b. **i.**



2 marks

1 mark for accurate diagram with a double membrane and the inner membrane folded.
1 mark for correct labelling of the matrix and cristae.

ii.



2 marks

1 mark for labelling the Krebs cycle as occurring in the mitochondrial matrix.
1 mark for labelling the electron transport chain as occurring on the cristae.

c. *Any **two** of the following differences:*

- The Krebs cycle produces 2 ATP per glucose, while the electron transport chain produces 34 ATP per glucose. *(More or less ATP would be appropriate.)*
- For the Krebs cycle, the inputs are pyruvate, NAD (FAD), ADP and P; while for the electron transport chain, the inputs are NADH (FADH) and O_2.
- For the Krebs cycle, the outputs are CO_2, ATP, NADH (FADH); while for the electron transport chain, the outputs are H_2O, NAD (FAD) and ATP.

2 marks

Note: Students must specify the difference as well as which process demonstrates the difference.

Question 4 (9 marks)

a. **i.** The type of response is a nerve response. 1 mark

Once the truck was seen, a rapid electrical response along neurons (sensory, interneurons, motor) moved directly to the leg muscles, causing them to move. 1 mark

ii. The adrenalin is secreted from a gland upon stimulation, moves through the bloodstream and attaches to receptors on target cells, in this case, the heart muscle. 1 mark

This interaction leads to an increased heart rate and is slower than a nervous response because it takes more time for the hormone to travel in the bloodstream from the gland to the heart. 1 mark

b. Neurotransmitters pass the nerve message across a synapse from neuron to neuron. 1 mark

They are secreted by exocytosis from the axon and diffuse across the synapse. They bind to neurotransmitter receptors on the postsynaptic membrane, which triggers gated ion channels to open, leading to depolarisation. 1 mark

c. Part 1: The shape of adrenalin is complimentary to the receptor. This specific interaction is required before a response can be triggered. 1 mark

Part 2: The changed receptor activates adenyl cyclase to convert ATP to cAMP, which in turn activates another enzyme (kinase). This signal cascade carries the message into the cell, where specific enzymes are activated that will lead to a contraction. 1 mark

Part 3: The enzyme kinase catalyses a contraction of the heart muscle, leading to an increased heart rate that will pump blood to the leg muscles (for example) for extra energy. 1 mark

Question 5 (5 marks)

a. This is due to the presence of receptors specific for GA being present on some cells but not others. Those with the receptors will respond via signal transduction to a particular response (flowering, growth or germination). 1 mark

b. **i.** Low GA would be appropriate when the conditions are not appropriate for seed germination, flowering or growth.

*For example, any **one** of the following conditions:*

- in drought there is a scarcity of water for seeds to germinate and so low GA is appropriate
- in winter it is too cold for stem growth so low GA is appropriate
- light intensity/period may be inappropriate for flowering so low GA would inhibit flowering

1 mark

ii. The IV is the different amount of GA (high or low) and the DV is the effect of the IV (flowering, elongation or germination). For conclusions to be made, all other factors would need to be kept constant (controlled variables).

*For example, any **two** of the following factors:*

- amount of water availability
- temperature of environment
- time the tissues are incubated for
- amount of light plants are exposed to (or lack of)
- level of gases in the air around the plant

1 mark

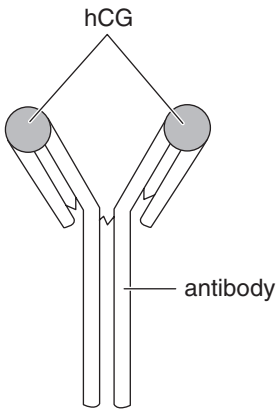
iii. Quantitative measurement is numerical measurement that can easily be compared. 1 mark

When investigating germination, a quantitative measure could be the percentage of seeds that germinate when exposed to the different levels of GA. 1 mark

Question 6 (8 marks)

a. It makes testing easy and convenient so the potentially pregnant female can get information quickly and in a confidential manner. 1 mark

b.



2 marks

1 mark for correct labelling of diagram.

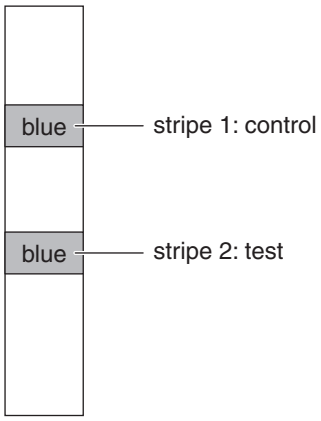
1 mark for correct structure with two binding sites and four polypeptide chains in correct formation.

c. The hCG is non-self to the mouse immune system and comes in contact with antibodies against hCG on the surface of a naive B cell. 1 mark

The B cell clones and differentiates into B plasma cells. 1 mark

The plasma cells contain RER and Golgi, which synthesise and secrete antibodies against hCG by exocytosis. 1 mark

d. **i.**



1 mark

ii. The control stripe turns blue regardless of pregnancy or not. If it does not change colour, the strip may not be functioning properly. 1 mark

Question 7 (6 marks)

a. Of the three antigenic markers on the surface of brother 1, the altruistic donor has two in common, whereas brother 2 has only one in common. 1 mark

b. The marker that is not in common between brother 1 and the altruistic donor will be recognised as foreign by brother 1's immune system. 1 mark

This will activate the immune system to produce specific B and T cells against the antigen, which will lead to the destruction of the cells with the antigen (in this case, the transplanted kidney. 1 mark

c. The immune system can be suppressed. Drugs such as cyclosporine suppress the T cell response but maintain the B cell response. 1 mark

d. There are more people in need of kidneys than there are kidneys available for donation. When a kidney becomes available, there are other factors that need to be taken into account so that the correct recipient is selected. If, for example, there are four potential recipients that are equally compatible, then other factors will determine the most appropriate recipient.

*For example, any **two** of the following factors:*

- health status of the potential recipients
- blood type of the recipients would need to be the same
- age of the recipient (a younger recipient may be better than an older recipient)
- a recipient with dependants may be better than a recipient without dependants
- geographical location of the donor and recipient should be reasonably close
- body compatibility (a small kidney should be transplanted into a smaller individual)
- amount of time the recipient has been waiting

2 marks

