

Trial Examination 2014

## 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 |

**SECTION A: MULTIPLE-CHOICE QUESTIONS****Question 1      C**

Water has several properties that are very important for life:

- It is a polar (charged) molecule (hydrophilic).
- It allows polar solvents to mix freely within (that are also hydrophilic).
- It has a low viscosity.
- It does not mix with phospholipids as they are non-polar (hydrophobic).
- Its content both inside and outside cells is usually in balance.
- It is cohesive.
- It is an excellent medium for materials to mix and move in.

**Question 2      D**

Students should be aware of the fundamental structure of the four main groups of biomacromolecules (protein, lipids, nucleic acids and carbohydrates). Nucleotides are the building blocks of DNA and contain a phosphate component (not phosphorus), a 5-carbon sugar component (not sugar) and a nitrogenous base component (not base).

**Question 3      D**

The different shades in the diagram illustrate that four different polypeptides (proteins) make up the final functional protein. This is referred to as the quaternary level of structure. Each shaded polypeptide is at a tertiary level of structure. The coiling of the polypeptide is the secondary level and the amino acid sequence is the primary level of structure.

**Question 4      B**

The presence of mitochondria (structure *N*) suggests the cell has a high energy need. The presence of the microvilli (structure *M*) illustrates the cell has a large surface area across which chemicals would move. In the kidney it makes sense there would be movement across (into) the cell and energy could be required for it to move against a concentration gradient. There is not a lot of rough endoplasmic reticulum (structure *O*) and hence probably not a lot of need for exocytosis (not endocytosis) from the golgi (structure *R*).

**Question 5      A**

Students should be aware of the different reactions occurring in organelles. Structure *N* (mitochondria) carries out respiration. There will be a small amount of transcription occurring within the mitochondria but it is not its main function. Structure *P* (nucleus) carries out transcription (DNA to mRNA) rather than translation (mRNA to protein). Structure (or area) *Q* is the cytosol and is not involved in photosynthesis as **D** suggests. The RER (structure *O*) is involved in the transport of proteins (polypeptides).

**Question 6      D**

The polar heads of phospholipids are always facing towards the outside or inside of a membrane. This is because the polar heads are hydrophilic and both these environments are primarily water. The fatty acid tails are hydrophobic and so face away from both watery environments. This forms the phospholipid bilayer.

**Question 7      D**

The template can provide a blueprint for more DNA (the complementary strand) OR it can provide a blueprint for mRNA. Both strands will be anti-parallel and the nucleotides will orient in the 3' to 5' direction. The 3' represents the position on the 5 C sugar which the phosphate from the next nucleotide binds to.

A DNA template strand has the following sequence:

5' GATACAGG 3'

**Question 8      A**

Glycogen breakdown is an example of a catabolic process that is also a hydrolysis reaction. This means water is required for the breakdown process. Students should be aware of which different types of reactions are similar to each other.

**Question 9      B**

The dependent variable in an experiment is the variable that is measured, usually quantitatively. The independent variable is the factor which deliberately changes (in this case, the percentage of hydrogen peroxide). Controlled variables are those kept constant (in this case, the enzyme concentration, temperature and pH).

**Question 10      B**

The data illustrates that the rate of oxygen gas production increases up to 10% and then levels off. In a well-controlled experiment this would mean the enzyme is limiting the reaction. The enzyme's active sites are saturated with substrate and so cannot break down the hydrogen peroxide any faster. This is why the rate of oxygen production levelled off.

**Question 11      A**

Many molecular interactions in Unit 3 Biology can be learnt by using two-dimensional shapes to depict the interaction. Antibodies have two complementary antigen-binding sites per molecule. Receptors and signalling molecules could appear as illustrated but the signalling molecule does not change in the manner depicted in the diagram. Non-competitive drugs would bind to a position on the enzyme, causing a change in the shape of the enzyme active site. An enzyme has an active site that the substrate binds to, causing a structural change in the substrate, changing it into a product. The enzyme is then reusable.

**Question 12      D**

Glycolysis is the breakdown of glucose into pyruvic acid. Once the pyruvic acid is formed, if oxygen is present, it moves into the mitochondria. Initially it is converted into acetyl CoA (via the link reaction), which is inserted into the Krebs's cycle where carbon dioxide and ATP is formed. The H is picked up by a hydrogen carrier and the hydrogen becomes part of the electron transport chain. This produces the majority of the ATP generated via aerobic respiration.

**Question 13      B**

It can be seen clearly that there are two pyruvic acid molecules produced per glucose molecule. More obscure are the other products. There is a net 2ATP produced in total (two used and four produced). There are also two NADH formed.

**Question 14      C**

Programmed cell death can be triggered in two ways, intrinsic and extrinsic. Intrinsically, once a cell has 'worn out', there are internal 'damage' signals that trigger cell death. Extrinsically, signals from outside the cell bind to receptors on the cell to trigger cell death. Both forms of cell death are known as apoptosis.

**Question 15      C**

The effector is the place where the response occurs. In this case, a brush touching the eye is the stimulus, which sends a nerve message to the central nervous system (via sensory nerves) and then directs a response (via motor nerves) to the muscles controlling the eyelids. This causes a blink reflex.

**Question 16      C**

The eyelid is connected to the CNS via sensory neurons (III) (part of the peripheral nervous system). This picks up the stimulus (brush). The sensory neurons are connected to interneurons (II), which in turn are connected to the motor neurons (I). This triggers a blink.

**Question 17      A**

There are many different types of signalling molecules. They are all released from one place and bind to receptors elsewhere. This initiates a response via signal transduction. There are several types of signalling molecules. These include hormones (protein and steroid), pheromones, plant growth regulators and neurotransmitters.

**Question 18      A**

ADH binds to a receptor on the surface of the kidney cell. Diagram 2 shows that after the interaction between ADH and the receptor, protein water channels bind to the kidney cell on the side that urine is moving through. This allows water to move back into the bloodstream. Between the ADH binding there must be a series of intracellular events that lead to the water movement. This is known as signal transduction.

**Question 19      B**

Bird flu is potentially lethal to humans but it only has a 50% mortality rate in humans. There is no information in the stem about the mortality rate in birds but it is unlikely to be 100%. The stem suggests the method of contraction is through contact so there is not a vector involved. As the virus causes disease, it would be referred to as a pathogen.

**Question 20      D**

Physical barriers are those that have a clear structure and are distinguished from chemical barriers in that chemical barriers involve a chemical that offers a specific kind of protection. In the context of the question, the waxy cuticle on the leaf surface as well as the ciliated lung bronchi would both be physical.

**Question 21      B**

The lymphatic system is a one-way system that provides an avenue for material exchanged at the capillaries to move through. Along the lymph ducts there are lymph nodes that contain lymphocytes (both B and T) that are reasonably mobile. When there is a pathogen within the body, there is a chance some may be introduced into the lymphatic system and this will mean there is a greater chance of contact between the pathogen and a lymphocyte (immune cell). There are many different types of pathogens, including virus and bacteria.

**Question 22      A**

The humoral response relates to body humors or fluids. This involves B-cells that, when selected, clone and differentiate into plasma cells. The plasma cells make antibodies that are released into the blood plasma to circulate around the body. The helper T-cells lead to an activated B-cell response but it will still occur to a much lower degree without them. Other T-cells are associated with the cell-mediated response, and the macrophages are part of the non-specific immune response.

**Question 23      C**

When a mother is breastfeeding in the first few days of a baby's life there is a transfer of antibodies from the mother to the baby via the breast milk. This will provide a short-term immunity against pathogens the baby is likely to be in contact with because the mother has produced antibodies actively against those pathogens. This is known as natural passive immunity because the baby is not producing their own antibodies.

Examples of the other types of immunity include:

- active artificial immunity: a vaccine
- passive artificial immunity: a snake bite anti-venom (antivenin)
- active natural immunity: getting over chicken pox

**Question 24      B**

The more self-shapes on the surface of the potential donor cells there are in common with the recipient, the greater the chance of a successful transplant. Donor 1 has one self-shape in common, donor 2 has three self-shapes in common and donor 3 has two self-shapes in common.

**Question 25      C**

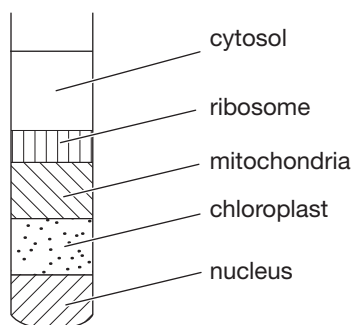
Regardless of how compatible the donor is, there will always be some of the self-markers that are unique to the donor which are foreign to the recipient. As a result there will be rejection of the transplant over time. To reduce the chance of this occurring, immunosuppressant medication is prescribed for life. These usually suppress the cell-mediated response and allow the humoral response to continue.

**SECTION B: SHORT-ANSWER QUESTIONS****Question 1 (7 marks)**

- a. Proteome: all proteins expressed within a cell for the duration of the life of the cell 1 mark  
 Genome: the entire DNA content of the cell 1 mark
- b. i. Enzymes have a specifically shaped active site that is complementary to a specific substrate so a rapid chemical reaction can occur. 1 mark
- ii. Channel proteins have a specific shape that allows a particular chemical (often hydrophilic) to move through a membrane, either by facilitated diffusion or active transport. 1 mark
- iii. Receptors have a specific shape that allows a specific signalling molecule to bind to it, which will lead to a cellular change (signal transduction). 1 mark
- c. The genome carries genes (sections of DNA) that provide the blueprint for protein synthesis. 1 mark  
 Certain sections of the DNA are transcribed into RNA and then translated into a protein within the cell so that the specific function of the cell can occur. 1 mark

**Question 2 (9 marks)**

- a. i. top of cuvette



2 marks

*Deduct one mark for any error.*

- ii. The cytosol enables the chemicals required for photosynthesis to move towards the chloroplast (carbon dioxide and water) and the products of photosynthesis to move away from the chloroplast (oxygen and glucose). 1 mark
- b. *Any two of the following:*  
 Protein: specific enzymes which are necessary for photosynthesis, such as RuBisCO  
 Nucleic acid: cDNA provides instructions for proteins required within the chloroplast  
 Lipid: phospholipids provide a membrane bilayer that allows compartmentalised reactions to occur, such as the light-dependent reaction in the grana  
 Carbohydrate: glucose is the product of photosynthesis

2 marks

*Students can choose two of the above but they must give an appropriate function.*

- c. i.** *Any two of the following:*
- temperature
  - light intensity
  - amount of chloroplasts
  - pH of medium in which chloroplasts are immersed
  - initial level of CO<sub>2</sub>
- 1 mark
- ii.** Chloroplasts reflect green light and so no photosynthesis would be recorded. 1 mark
- iii.** Red and blue wavelengths of light provide the energy to split water and produce ATP and NADPH via the light-dependent reaction. 1 mark
- The products of the light-dependent reaction (ATP and NADPH) and enzymes in the stroma drive the light-independent reaction that extracts CO<sub>2</sub> from the medium to manufacture glucose. 1 mark

**Question 3 (8 marks)**

- a. i.**  $C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O$  1 mark
- 36/38ADP + 36/38Pi → 36/38ATP 1 mark
- ii.** *Any one of:*
- aerobic produces 38 ATP compared to anaerobic which produces 2 ATP
  - aerobic occurs slower than anaerobic
  - aerobic produces CO<sub>2</sub> and H<sub>2</sub>O and anaerobic produces lactic acid
  - aerobic is longer lasting than anaerobic
- 1 mark
- iii.** 550 m (give or take about 25 m) 1 mark
- b.** Athletes have about a 90% reliance on aerobic and 10% reliance on anaerobic respiration. 1 mark
- This is most efficient at providing maximum amount of ATP (38 ATP per glucose) (with maximum sustainable effort for that distance). 1 mark
- c.** Reliance is mainly on anaerobic respiration (about 80%), so a strength-based training schedule would be best, 1 mark
- such as building up muscle using weights
- OR
- repetitive maximum effort short sprints. 1 mark

**Question 4 (7 marks)**

- a. i.** Pathway A is a lipid-insoluble protein hormone that binds to surface receptors. 1 mark
- Pathway B is a lipid-soluble steroid hormone that binds to receptors in the cell cytosol. 1 mark
- ii.** Pathway B activates genes which in turn produce proteins. Pathway A activates only a protein. 1 mark
- Genes remain active for longer because each gene may produce more than one mRNA strand, and each mRNA strand produces many proteins. The mRNA strands may last for a long time. 1 mark

- b. i.** signal amplification 1 mark
- ii.** energy conservation 1 mark
- One signalling molecule binding to one receptor activates a million enzymes so a high concentration of enzyme can be maintained. 1 mark

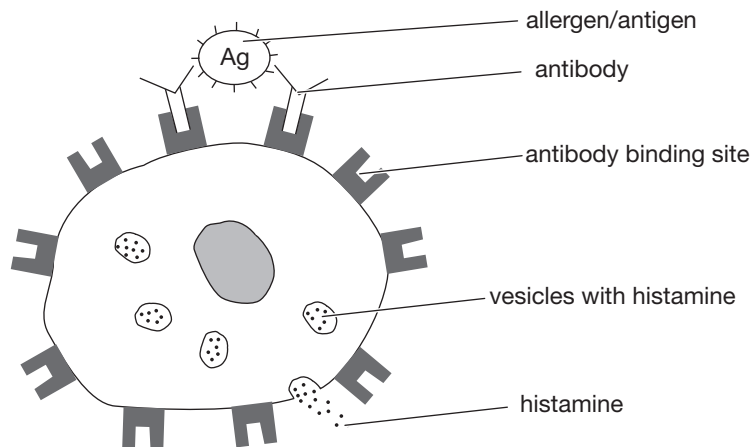
**Question 5 (6 marks)**

- a.** Have two groups of radish plants with same size and same number of leaves exposed to same set of conditions.
- One group of radish plants will have nothing done to them as a control group. 1 mark
- One group is exposed to the caterpillar (independent variable). 1 mark
- Then measure the amount of glucosinolates (dependent variable) in radish leaves. 1 mark
- b.** Drugs have not been synthesised artificially but have been extracted from a plant and have been seen to have a therapeutic use. 1 mark
- c.** *Any two of:*
- relatively inexpensive
  - minimal side effects
  - successful human trials
  - scientific evidence of a high chance of success

2 marks

*Two logical comments are required for two marks.***Question 6 (9 marks)**

- a.** The virus binds to surface receptors on specific cells. 1 mark
- Virus is engulfed/nucleic acid introduced into cell, the cell organelles read the nucleic acid and more virus is manufactured. 1 mark
- b.** Pandemic: an infectious disease that has spread across a large region – sometimes across continents. 1 mark
- c. i.** HIV copies increase from  $10^2$  to  $10^6$ . 1 mark
- T-lymphocyte count decreases from 1000 to 500. 1 mark
- ii.** Less  $T_H$  cells means less control over the immune system. The  $T_H$  cells control the immune system by signalling the B-cells and T-cells to clone and differentiate once an antigen has been encountered. The immune system is unable to function properly. 1 mark
- d.** The vaccine targeting the less variable antigens is likely to provide longer-lasting immunity because the immune system only makes one type of antibody against the antigen (lock and key). 1 mark
- The vaccine against the more variable regions will be less effective because the antibody initially generated will be ineffective with the future generations of HIV, as the antigen has changed shape. 1 mark
- e.** An attenuated form is a dead or weakened form of the live virus which is in the vaccine. This contains antigens the body can mount an immune response against. 1 mark
- Peptides are single proteins (antigens) that the body can mount an immune response against. 1 mark
- Students must make the comparison for the mark.*

**Question 7 (4 marks)****a.***Any three of:*

- Allergen: a generally harmless factor that (due to previous exposure) binds to antibodies on the surface of the mast cell
- Antibody: produced by the immune system against the generally harmless factor (allergen) that binds to the surface of the mast cell
- Antibody binding site: the antibodies bind to these receptors and become an integral part of the mast cell
- Vesicles: loaded with histamines as a form of non-specific body defence
- Histamine: released once allergen binds to the mast cell, leading to an inflammation response known as an allergy

3 marks

*Students need to correctly link the three correctly labelled structures to the correct function for full marks.*

- b.** Our immune system is immature at birth and needs to be activated by exposure to a 'normal' environment. Increased cleanliness means a lower exposure to factors in the environment that promote an immune system to mature fully, which may lead to an increase in allergies. 1 mark