

Trial Examination 2017

## 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 D**

Membranes are comprised of a phospholipid bilayer and the proportion depends on where the membrane is located (80% of plasma membrane is phospholipid and about 20% of the inner mitochondrial membrane is phospholipid). The other main component of membranes are proteins that have a variety of functions (transport, detection or adherence, for example).

**Question 2 C**

In a saline environment, water will move from the vacuoles of the plant cell into the solution. This will cause the cell membrane to pull away from the cell wall, which is called plasmolysis.

**Question 3 A**

When a membrane-bound vesicle fuses with the cell membrane to release the contents, the process is known as exocytosis (exiting the cell). Phagocytosis (also endocytosis) is when particles (bacteria, food) are engulfed by a cell to become membrane-bound within the cell. Passive movement is incorrect because the process requires energy to move the vesicle towards the cell surface. Proteins are too big and insoluble to move across membranes and so bulk transport is the usual way they are transported.

**Question 4 B**

Once genes are activated, the DNA template can be transcribed into pre-mRNA. The pre-mRNA is then processed and the final mRNA moves to the ribosomes in the cytosol where the mRNA transcript is translated into a protein.

**Question 5 A**

The DNA contains 15% adenine and therefore 15% thymine as well. This means there will be 30% of the DNA molecule containing A–T pairs. The remaining 70% would be G–C pairs. This is the complimentary base pairing rule.

**Question 6 D**

The four levels of the hierarchical structure for proteins are

- Primary: The amino acid order.
- Secondary: The coiling ( $\alpha$  helix) and folding ( $\beta$  sheets) caused by the local amino acid R groups.
- Tertiary: The overall three-dimensional shape of a single polypeptide as a result of folding and cross bonds (disulphide bridges).
- Quaternary: More than one polypeptide can be held together by chemical bonds forming a functional protein.

This functional protein is working at the quaternary level.

**Question 7 B**

Both prokaryotes and eukaryotes contain double-stranded DNA which provides a blueprint for protein manufacture. RNA polymerase is involved in the process in both cell types. Both cell types have the capacity to activate genes when necessary. It would be a waste of energy for eukaryotic cells to have each gene active all the time. Eukaryotes splice out introns while processing the RNA, whereas prokaryotes do not.

**Question 8 B**

Controlled conditions in experiments are those that are kept the same between each experimental group. In this particular experiment, the independent variable is the temperature and the dependent variable is the time taken for the jelly to run. The volume of jelly used, the time of temperature exposure, as well as the time the final solutions were left to set in the refrigerator, should all be the same.

**Question 9 C**

The jelly when set will stick to the inclined glass panel for longer. This means the enzyme is most active in temperatures where the time the jelly takes to run is high, so temperatures of 20°C to 40°C degrees would be optimal (an optimal range rather than 30°C being optimal). As the temperature increases, the number of collisions between enzyme and substrate would increase but the shape of the active site is compromised at the higher temperatures as the enzyme is denatured (at temperatures of 50°C or above). If the enzyme is denatured, the jelly will set and take a long time to run.

**Question 10 A**

NAD is a cofactor involved in the collection of hydrogen from glucose during cellular respiration. Once it collects hydrogen, it becomes NADH. The NADH moves into the mitochondria (or it is already there) to be an input into the electron transport chain (ETC). It offloads the hydrogen, then is able to collect more hydrogen from the Krebs cycle. The hydrogen carrier involved in the transferral of hydrogen during photosynthesis is NADP (making **B** incorrect).

**Question 11 C**

A prokaryote carries circular DNA as well as ribosomes, and both the mitochondria and chloroplast carry these structures. It should be noted that the ribosomes within both organelles are more similar to those that are found in prokaryotes when compared to the ribosomes located within the cytosol (eukaryotic ribosomes are larger than prokaryotic ribosomes). Both organelles have two membranes that provide evidence of endocytosis; when all this evidence is combined, the endosymbiotic theory emerges.

**Question 12 B**

Aerobic respiration uses glucose and oxygen as substrates and carbon dioxide and water as products (making **C** and **D** incorrect). The purpose of aerobic respiration is to break down the glucose and transfer the chemical energy within the molecule to ATP, which is done by binding a phosphate (Pi) to ADP. Theoretically, a net production of 36/38 ATP can be formed from one glucose molecule. To do this, 36/38 Pi would need to bind to 36/38 ADP.

**Question 13 D**

Polypeptides are formed at the ribosome and not the nucleus (making **A** incorrect). The first step of respiration is glycolysis, which occurs in the cytosol not in the mitochondria (making **B** incorrect). Transcription occurs in the nucleus as the first step of gene expression and does not occur at the ribosomes (making **C** incorrect). The light independent reaction does occur in the stroma of the chloroplast.

**Question 14 A**

If a human secretes a chemical that diffuses through the air to be absorbed by another human and elicits a response, then the chemical is a pheromone. The other responses act within the body of the organism. Neurotransmitters are released by exocytosis from axons into a synapse to trigger an action potential on dendrites on the postsynaptic side of the synapse. Animal hormones are secreted by glands into the bloodstream and plant growth regulators generally work on target cells within plants (exception with ethylene).

**Question 15     B**

Apoptosis is programmed cell death and cell reproduction is the formation of new cells. If, in a particular part of the body more cells are forming than are being removed, a cancer can develop. The cell cycle is controlled by genetic triggers (checkpoints) and apoptosis is controlled by internal or external signals.

**Question 16     A**

Signal transduction involves three main stages. Stage 1 is reception, where a signalling molecule binds to a receptor (labelled 1 in the diagram). Stage 2 is conduction, where the initial message is converted by a series of secondary messages within the cell (labelled 2 in the diagram). Stage 3 is the response, where there may be an enzyme activated leading to a product (labelled 3 in the diagram).

**Question 17     A**

Cellular pathogens include bacteria (prokaryotes) as well as eukaryotes. They have the capacity to cause disease. Non-cellular pathogens such as viruses also have the capacity to cause disease. Viruses are non-cellular as they are not membrane bound and do not carry out any metabolism (which is why they are not classified as cellular).

**Question 18     D**

Microbiological barriers would include ones that have some kind of organism that reduces infection. Such barriers could be bacteria in the gut that reduce the chance of infection. Unbroken skin is a physical barrier that reduces infection. Ciliated cells lining the respiratory tract are also a physical barrier that reduces the chance for viruses to enter the body. Tears containing lysozyme is a chemical barrier that reduces infection.

**Question 19     A**

Macrophages are involved in the endocytosis of foreign material (or phagocytosis). This is when the cell wraps its cell membrane around the material to be consumed and eventually moves into the cell. This is an active process. **B** depicts the release of histamines from a mast cell. **C** depicts the action of complement on a target cell. **D** depicts an antigen presenting cell (APC) destroying and displaying an antigen for the immune system. It initially consumes the pathogen, but then displays markers.

**Question 20     C**

The lymphatic system begins at the site of the cells, and via a series of ducts and nodes, ends up emptying lymph into the circulatory system near the heart. The main purpose is to collect some of the tissue fluid from the region of the cells that may contain antigens (possibly on the surface of pathogens). Muscle contractions move the fluid towards the body core, which moves through the lymph nodes where there may be contact between antigens and naive lymphocytes. They may help remove the build-up of liquid in the extremities, however this is not the main purpose.

**Question 21     C**

Active immunity is where either the B cell (humoral) or T cell (cell-mediated) response is initiated depending on the nature of the antigen present. Naive B cells differentiate into B plasma cells and B memory cells whereas naive T cells differentiate into T cytotoxic cells and T memory cells (and T helper cells).

**Question 22     D**

Apart from protecting those who receive a vaccine, the purpose of mass-vaccination programs is to reduce the places where pathogens can grow and spread, which is known as herd immunity. This means the vulnerable (young, old and unvaccinated) are less likely to contract disease, which will reduce potential medical costs.

**Question 23     B**

Autoimmune disease is when the body's immune system is activated against its own cells. MS is an example of an autoimmune disease, whereas AIDS (virus), Creutzfeldt–Jakob disease (prion) and allergy to pollen (hypersensitivity) are not.

**Question 24     B**

On first exposure, an individual sensitive to an allergen will elicit a typical B cell response. The antibodies formed bind to receptors on the surface of mast cells, which then inhabit areas of the body that are likely avenues of allergen entry in the future (skin, nose and throat). Upon further exposure to the allergen, the mast cells are activated because the allergen binds to the antibodies on the mast cell stimulating the secretion of histamines. **A** is a plasma cell, **C** is a macrophage and **D** is an antigen presenting cell (APC).

**Question 25     D**

When someone is bitten by a snake, antivenin needs to be administered. The injection contains antibodies that have complementary binding sites to the toxin in the snake venom. This provides a short-term cure because the antibodies are able to neutralise the snake venom toxicity. The immune system is not activated because the antigen (toxin) has not been in the body for long enough. This form of immunity is often referred to as artificial and passive.

**SECTION B – SHORT-ANSWER QUESTIONS****Question 1** (5 marks)

a. E, D and H

DNA is located in the nucleus as well as the mitochondria and chloroplast. 1 mark

*Note: All three responses are required to be awarded the mark.*

b. D, H and L

ATP manufacture occurs in the cytosol (glycolysis) the mitochondria (Krebs cycle and electron transport chain (ETC)) and the chloroplast light dependent reaction (LDR). 1 mark

*Note: All three responses are required to be awarded the mark.*

c. L OR E

Lipophobic signalling molecules are able to dissolve through the cell membrane and bind to receptors in the cytosol or the nucleus. 1 mark

*Note: Only one response is required to be awarded the mark.*

d. D

Thylakoid membranes are located within the chloroplast. They are the membranes that form the grana. 1 mark

e. J, then F, then A

The manufacture of a protein involves a ribosome which is on the endoplasmic reticulum for transport to the Golgi apparatus. The nucleus carries the DNA blueprint and so is indirectly involved and the mitochondria provides the ATP and is also not directly involved. 1 mark

*Note: Response must be in the correct order to be awarded the mark.*

**Question 2** (8 marks)

a. i. Qualitative data is descriptive, and in this experiment the result at 1% and 10% ethanol was pink, so there is no difference in the results. 1 mark

Quantitative data is measurable, and in this experiment the transparency percentage at 1% ethanol (85%) compared to 10% ethanol (60%) shows a difference. 1 mark

*Note: Students must make reference to data and make a comparison.*

ii. The experimental control is used as a comparison; in this case the effect of the independent variable (ethanol percentage on the dependent variable (transparency percentage)). 1 mark

b. Ethanol mixes into the phospholipid bilayer as it is a lipophilic substance, but also mixes with water on either side as it is also hydrophilic. Increasing ethanol disrupts the bilayer so that it no longer holds the membrane together, enabling the betalain to move out into the external environment, decreasing the transparency percentage. 1 mark

- c. Obtain 100  $1 \text{ cm}^3$  cubes of beetroot. Divide them into five groups of 20 samples.  
 sample 1: expose to a pH 7 solution (control)  
 sample 2 to 5: expose to pH 3, 5, 9 and 11 respectively  
 The changing of pH is the IV. 1 mark  
 Each sample will be left for 30 minutes and then the transparency percentage can be measured. This is the DV. 1 mark  
 Ensure that all other factors (apart from pH) are kept the same. For example, temperature, amounts of beetroot, volumes of water used and time of incubation. These are called controlled conditions. 1 mark  
 The expected results would be that at pH 7 the transparency percentage would be close to 0%. As the pH deviates away (both higher and lower), the transparency percentage would increase. 1 mark
- Note: Other responses are accepted, but the mark allocation should be split according to the guide above.*

**Question 3** (6 marks)

- a. 5' UAUGCUAUCAGC 3'  
 The mRNA sequence is determined from the template strand and the RNA polymerase makes the new strand in a 5' to 3' direction. 1 mark
- b. tyrosine-alanine-isoleucine-serine 1 mark
- c. The anticodon is a part of tRNA and is complementary to the mRNA codon in the ribosome. 1 mark  
 The tRNA also carries a specific amino acid that will form a peptide bond onto the growing polypeptide chain moving out of the ribosome. 1 mark
- d. The R groups of amino acids play a role in the shaping of a protein. When more than one polypeptide chain combines to form a functional protein, chemical bonds hold the chains together. 1 mark  
 For example, disulphide bonds between amino acids in different polypeptide chains will hold the quaternary structure of the functional protein together. 1 mark
- Note: Disulfide bonds would presumably be the most common example given by students. Other bonds like hydrogen or ionic would also be acceptable.*

**Question 4** (8 marks)

- a. *For example:*  
 In the natural environment, from the surface of the ocean, factors other than light intensity would vary. Temperature (which would decrease as depth increased), pressure (which would increase as depth increased) and as other factors such as sea currents would vary. 2 marks  
*Note: Award one mark for each problem identified.*  
*For example (temperature):*  
 As depth increases, temperature increases. This means enzymes catalysing metabolism will act more slowly at a deeper depth compared to enzymes at a shallower depth. This means the test is an unfair test, as there is more than one variable being investigated. 1 mark  
*Note: Other factors can be explained.*
- b. Autotrophs are organisms/cells that are able to convert inorganic molecules (such as water and carbon dioxide) into organic molecules (such as glucose) using an external source of energy (such as light energy). 1 mark

- c. The location of chlorophyll is in the chloroplasts of algae such as *U. lactuca*. 1 mark  
Chlorophyll is a cluster of proteins that are located in the thylakoid membranes as part of the grana of the chloroplast. 1 mark
- d. i. At low depth (0 m) there is a high level of chlorophyll so as to maximise photosynthesis in high light intensity, whereas at high depth (10 m) there is a low level of chlorophyll so that energy is not invested in producing unnecessary chlorophyll. 1 mark  
*Note: A contrasting comment should be made.*
- ii. between 65 to 70  $\mu\text{g/L}$  1 mark  
*Note: There is a range of appropriate answers. Any answers outside this range are incorrect. Additionally, answers that are expressed as decimals (like 67.5) are incorrect as the scale does not allow for this sort of accuracy.*

**Question 5 (7 marks)**

- a. i. synapse 1 mark  
ii. exocytosis 1 mark
- b. The binding of the neurotransmitter from axon A to the complementary receptor on the surface of the target cell causes an ionotropic change, such as opening a gated protein channel (stimulating an action potential). 1 mark  
The binding of the neurotransmitter from axon B to the complementary receptor on the surface of the target cell causes a metabotropic response where a gene is activated to produce a protein (possibly forming more dendrites). 1 mark  
*Note: The key here is to recognise which neurotransmitter carries out which job.*
- c. The neurotransmitters (A and B) bind to surface receptors making them hydrophilic (water soluble) and unable to pass through the cell membrane, which is hydrophobic. 1 mark
- d. Ionotropic: A protein channel opens for the duration of the stimulus. Once neurotransmitter A is no longer available, the response will cease. 1 mark  
Metabotropic: A gene is activated and a protein is subsequently formed. Once neurotransmitter B is no longer available, the protein formed will continue to function until it becomes non-functional. 1 mark

**Question 6 (7 marks)**

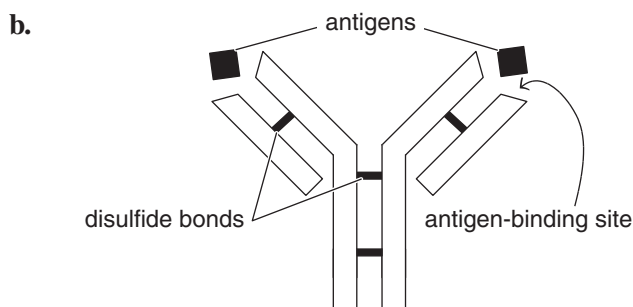
- a. A virus is comprised of a protein shell (capsid) surrounding a nucleic acid core (DNA or RNA). 1 mark  
*Note: Do not accept DNA and RNA.*
- b. The MMR vaccine would need to contain antigens that will stimulate the body to direct active immunity against measles, mumps and rubella. The antigens could be on the surface of attenuated virus or free-floating antigens within the vaccine. 1 mark
- c. After the first vaccine there are many memory B cells remaining in the vaccinated body. 1 mark  
Each subsequent vaccine leaves an increasing number of memory B cells because once the antigen is administered, the chance of contact between the antigen and many of the B memory cells is high. Each interaction will lead to a similar response as the initial response. This makes the response faster and greater (more antibodies). 1 mark



- d. i. helper T cells ( $T_h$  cells) 1 mark
- ii. The nucleic acid within the virus **mutates**, changing the nucleic acid sequence. Once inside a  $T_h$  cell the nucleic acid expresses protein that forms the virus capsid and the nucleic acid is also **replicated** so that more virus can be manufactured. The released virus has slightly different **antigens** on their surface. 2 marks
- Note: All three words need to be correctly used for full marks.*

### Question 7 (9 marks)

- a. Self-antigens are those chemicals (usually protein) within the body that do not stimulate an immune response against them. Non self-antigens are chemicals that enters the body that the body directs an immune response against. 1 mark



For full marks, the following points need to be clearly shown on the diagram.

- four polypeptide chains in the correct orientation
- two antigen-binding sites
- complementary binding sites to the original antigen
- bonds shown joining the polypeptide chains together (does not have to be disulphide)

3 marks

*Note: Subtract a mark from the maximum assessment for any missing from the above list.*

- c. Within the mouse's immune system is a naive B cell that has surface receptors complimentary to the antigen injected into the mouse. 1 mark
- Once the naive B cell is activated, it clones and differentiates (clonal expansion) into B plasma cells (antibody production) and B memory cells (for activation with future exposures). 1 mark
- d. i. Cancerous lymphocytes contain more CD52 antigens than normal lymphocytes and so the presence of antibodies against CD52 will be more likely to lead to the destruction of the cancerous cells rather than the normal ones. 1 mark
- ii. One potential side effect is a reduced immune response against other diseases as some normal lymphocytes may be destroyed. 1 mark
- iii. A targeted response generally has less side effects than the more general treatment of chemotherapy and radiotherapy. 1 mark