Neap

Trial Examination 2020

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

The presence of a large amount of rough endoplasmic reticulum as well as a few Golgi apparatus is suggestive that this cell makes and secretes proteins. Lipid molecules (or hydrophobic molecules) would be able to diffuse directly across the membrane (like dissolves into like).

Question 2 D

The mitochondria is the site for two stages of respiration, namely the Krebs cycle and the electron transport chain (ETC). Vesicles that are a part of the Golgi apparatus are involved primarily in endocytosis. The endoplasmic reticulum is involved in intracellular transport, not intercellular transport. The nucleolus is involved in ribosome manufacture; it is the nucleus that is the control centre of the cell.

Question 3 D

It would be assumed that the experiment is valid as, based on the information provided, only one factor was varied, which was temperature. The experiment was reproducible because four people conducted the investigation. The experiment was repeated because each person repeated each temperature four times. There is no data that demonstrates precision (how close each of the four repetitions are for each temperature). The transparency percentage is the dependent variable, not a controlled variable, which should stay the same each time the experiment is conducted.

Question 4 B

High temperatures would denature membrane proteins and, since membranes are studded with proteins, fewer proteins would leave gaps for the betalain to move into the solution and lower the solution's transparency percentage. A high transparency percentage demonstrates that the beetroot membrane is intact; a result of 25% at 2°C would suggest significant membrane damage. Cholesterol helps with the fluidity of the membrane by slotting between the phospholipids, making the membrane less rigid in colder temperatures, meaning that cholesterol moving further into the membrane is incorrect.

Question 5 B

A condensation reaction (endergonic, anabolic) is a reaction that joins smaller molecules together, producing water as a by-product (**B** or **C**). Breaking down a protein (**A**) or glucose (**D**) is the opposite reaction to a condensation reaction. Formation of disulphide bonds (as in **C**) does not liberate water (as the formation of a dipeptide in the ribosome does).

Question 6 C

The DNA template strand transcribes into mRNA with a sequence of CUG AUG, so **D** is incorrect. The two anticodons complementary to CUG AUG are GAC UAC. Anticodons are located along a tRNA molecule and bind to codons within the ribosome during translation. **A** and **B** are incorrect as they contain thymine nucleotides.

Question 7 B

The DNA template would carry introns and exons and so would be more than 153 nucleotides long. The secondary level of protein arrangement carries α-helices and β-sheets not β-helices and α-sheets. The introns are the transcriptional sections cleaved out during RNA processing. The polypeptide chain must have the same amino acid order (primary sequence) in order for the folding to result in that particular arrangement.

Question 8 D

Body temperature (37°C) and a neutral pH are the optimal conditions for a human enzyme. A high concentration of dopa is on a different metabolic branch to that of tyrosine aminotransferase, and so it would have minimal effect on the optimal functioning of the enzyme.

Question 9 C

As a result of phenylalanine hydroxylase not being manufactured, the substrate (phenylalanine) would accumulate which leads to the symptoms of Phenylketonuria (PKU). A lower level of tyrosine would be formed (so **A**, **B** and **D** are incorrect). If one enzyme is missing that disrupts a metabolic pathway from the beginning, the other enzymes will not be produced in lower amounts. However, some metabolic pathways control gene expression due to lower levels of product, but there is no evidence in the question to conclude this.

Question 10 C

The mitochondrial matrix is the area inside the inner membrane of the mitochondria and is the location for the Krebs cycle. Glycolysis occurs in the cytosol, and ethanol fermentation is the product of anaerobic respiration in fungi and plants (also occurring in the cytosol). The electron transport chain occurs in the mitochondria along the cristae and so is partly exposed to the matrix, but also occurs in the inter-membrane space.

Question 11 D

The chemical reaction is photosynthesis, which can be divided into two reactions – light-dependent and light-independent. The location of the light-dependent reaction (reaction 1) is in the grana where water is split, and the location of the light-independent reaction (reaction 2) is in the stroma where carbon dioxide is converted into glucose.

Question 12 B

The coenzymes that move from reaction 1 to reaction 2 are ATP and NADPH. ATP is formed as a result of hydrogen ions from the splitting of water moving through an enzyme (ATPase) embedded in the thylakoid membranes. NADP collects the surplus hydrogen ions and electrons that are now in the stroma to form NADPH. ATP is used as energy to drive the light-independent reaction, and the hydrogen is an element that, with carbon dioxide, leads to the formation of glucose.

Question 13 B

There are many factors that drive the rate of photosynthesis, such as light intensity, carbon dioxide, water and the amount of chlorophyll. As light intensity increases, other factors (carbon dioxide, water, chlorophyll) will become limiting on the reaction if they do not also increase, and so the factor that is least available will result in the product (glucose) plateauing.

Question 14 D

All signalling molecules have a mechanism that enables them to get from the source of production to the site of the response. Signalling molecules made in a gland and then transported in the bloodstream are hormones. Water-soluble hormones (hydrophilic) bind to cell surface receptors and water-insoluble molecules (hydrophobic) bind to intracellular receptors.

Question 15 C

Receptors have sites on them that enable specific signalling molecules to bind with them. In this case, the binding site on the receptor has a complementary shape to the gibberellic acid. If the receptor were not bound onto the surface of the cell, the gibberellic acid would be unable to bind to activate the cellular response. This is due to the properties of both the signalling molecule and the receptor.

Question 16 D

After the signalling molecule binds to the receptor, a series of second messageers is activated – this is signal transduction. In this case, the response is to activate a gene to be expressed; this would involve transcription followed by translation.

Question 17 A

Based on this information, one signalling molecule activates five G protein complexes. The activated receptor mobilises the ligand/receptor complex in some manner, which enables the complex to move through the membrane. Each event leads to a greater level of potential response. An initial single activated receptor can lead to (in this case) thousands of growth proteins. This is known as signal amplification.

Question 18 A

The full-grown human body has a consistent number of cells. Cell replacement (mitosis) and cell removal (apoptosis) are generally in balance. If more cells are being replaced, this could lead to an oversupply, which could be defined as a type of cancer. Autoimmune conditions lead to cell removal, not replacement. HIV depletes T cells and so is more related to cell removal. Allergies stimulate the release of histamines from mast cells and so there is no degeneration or replacement of cells.

Question 19 D

Based on the diagrams, it is reasonable to assume that pathogen 1 is a protein (non-cellular and therefore not prokaryotic), 2 is a virus (non-cellular), 3 is a bacteria (cellular) and 4 is a nucleated cell. The only appropriate answer is that pathogen number 4 is cellular and eukaryotic. A malarial plasmodium is a single-celled eukaryote that causes malaria.

Question 20 A

Chemical barriers to infection destroy pathogens on the outer body surface, at body openings and on inner body linings (such as in the stomach). Sweat, mucus, tears, and saliva all contain enzymes that kill pathogens. Waxy cuticles and thick epidermal layers are physical barriers, not chemical barriers. Sparsely spaced stomata may reduce the incidence of pathogenic entry, but this is a structural adaptation rather than a chemical defence.

Question 21 D

Inflammation is usually triggered by chemicals (cytokines, histamines). Inflammation leads to more blood directed towards the area, which makes the capillary beds more porous and thus allows more macrophages out of the circulatory system. If there is an infection, the macrophages can endocytose the pathogen, display fragments and migrate towards lymph nodes. The inflamed area is quite warm, which is detrimental to the pathogen and potentially allows faster metabolism for the cells attacking the pathogen.

Question 22 A

T helper cells can carry antigenic fragments on their surface (MHCII) as a result of being previously exposed to a specific antigen. If the T helper cell encounters a B (naive, memory) cell or a T (memory) cell, it can activate it by secreting cytokines.

Question 23 D

Mast cells are found in high concentrations near body surfaces (skin, throat) and can be sensitised with antibodies against allergens. When an individual is subsequently exposed to the allergen, the allergen and antibody complex leads to a secretion of histamines from the mast cell, which leads to an inflammatory response.

Question 24 A

If an antibody is manufactured artificially outside the body and administered for therapy, it is regarded as an artificial form of immunity. The antibody will bind to the target (in this case the CD52 antigen) and make it more visible to the immune system for destruction. The antibody is only present for a short period of time and does not have an immune response directed against it. It is a passive form of immunity.

Question 25 A

Based on the information provided, the HIV does not enter the T helper cells and so the immune system is functional. The viral antigens are not complementary to the CD4 receptor sites and do not bind to them, meaning the virus does not enter the T helper cell. The virus is then in the bloodstream and enables a humoral response against it, which leads to the production of HIV antibodies, making the individual HIV positive.

SECTION B

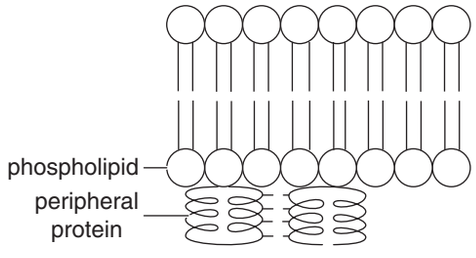
Question 1 (5 marks)

a. The tertiary level of protein structure refers to the three-dimensional shape of each polypeptide in a protein. Each polypeptide has α-helices forming two coils in them. 1 mark

The quaternary level of protein structure refers to the way polypeptides are held together to form the functional protein. In this case, the two polypeptide chains are held together by bonds (such as disulphide bonds). 1 mark

b. A peripheral protein is both in contact with the membrane and in contact with the cytosol or external environment of the cell. 1 mark

The R groups of the amino acids facing the membrane would be hydrophobic, and the R groups of the amino acids facing the external environment would be hydrophilic. 1 mark



1 mark

Note: Diagram should show peripheral protein on the surface of the membrane (specific quaternary structure not needed) with a phospholipuid bilayer.

Question 2 (8 marks)

a. **i.**

G	C	A	T	A	C	G	T	C	A	T	C	A	T	G
C	**G**	**U**	**A**	**U**	**G**	**C**	**A**	**G**	**U**	**A**	**G**	**U**	**A**	**C**

1 mark

ii. The mRNA moves into (attaches to) a ribosome. 1 mark

The tRNA carries a specific amino acid and an anticodon, then binds to the complementary mRNA codon. 1 mark

The specific amino acid from the tRNA binds through a condensation reaction to the growing polypeptide. 1 mark

b. *Any two of:*

- Eukaryotes cleave out introns (combining exons), whereas prokaryotes do not.
- Eukaryotes transcribe in the nucleus and translate in the cytosol, whereas prokaryotes transcribe and translate in the cytosol.
- Eukaryotes undergo RNA processing, whereas prokaryotes do not.
- Eukaryotic gene expression regulation occurs at many levels (transcriptional and translational), whereas prokaryotic gene expression usually occurs at the transcriptional level only.

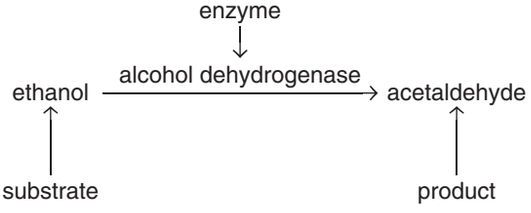
2 marks

c. **i.** A repressor is bound to the operator when lactose is absent (preventing transcription) and the repressor is not bound to the operator in a lactose environment (allowing transcription). 1 mark

ii. RNA polymerase binds to the promoter and, if the repressor is not bound to the operator, the *lac* operon structural genes can be transcribed. 1 mark

Question 3 (6 marks)

a.



1 mark

b. Alcohol dehydrogenase (ADH) has an active site that has a shape complementary to the ethanol and speeds up the reaction. 1 mark

When the ethanol collides (correct orientation) with the active site, a conformational change occurs to the ethanol, making acetaldehyde and leaving the ADH to react with more substrates. 1 mark

c. Alcohol-damaged livers would be expected to take longer to convert ethanol into acetaldehyde because less ADH would be available. 1 mark

Increased alcohol consumption takes longer to break down as indicated by Test 1 (70 AU, showing that 10 g of ethanol has been broken down) compared to Test 2, which used five times as much ethanol but the same amount of acetaldehyde. In Test 2, four additional hours would be needed for the ADH to break down the additional 40 g of ethanol. 1 mark

Alcohol-damaged livers would have less available ADH to break down alcohol, which can be seen by comparing Tests 2 and 3. This comparison indicates that it is taking longer for the colour intensity to increase (30 AU at an ADH level of 0.5 g compared to 70 AU at double the ADH level). 1 mark

Question 4 (8 marks)

a. **i.** If running speed increases (km h^{-1}), then the blood lactic acid concentration (mmol/L) will increase. 1 mark

Note: Both the independent variable and the dependent variable should be present, and there should be a prediction over a range of the independent variable.

ii. 7.5 1 mark

Note: Accept responses in the range of 7.3–7.7 A transparent ruler is a useful tool for questions of this type and can be brought into the exam.

b. *Any two of (inputs):*

- glucose
- NAD
- ADP
- Pi

1 mark

Any two of (outputs):

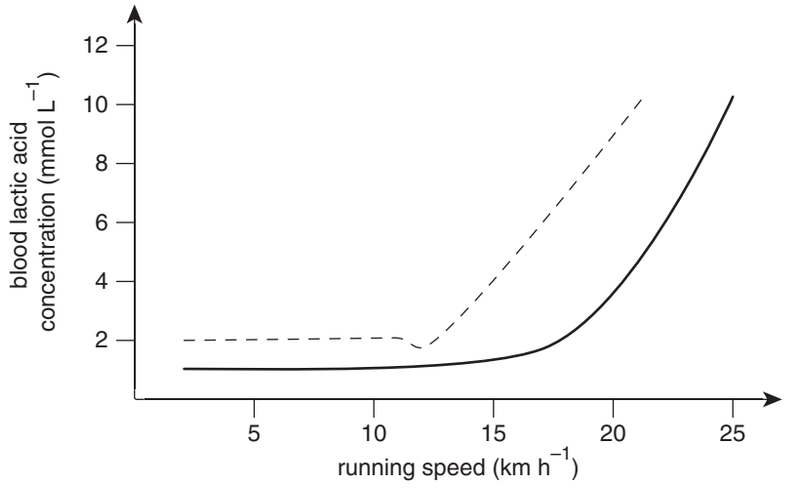
- lactic acid
- NADH
- ATP

1 mark

The cellular location of the process is the cytosol (not the cytoplasm). 1 mark

Note: Award full marks for a complete reaction equation or a similar description.

c.



1 mark

d. *Any two of:*

- No repetition: Robert was only tested once at each stage of the test.
- No reproducibility (1): Participants other than Robert should have been subjects in the test.
- No reproducibility (2): Other experimenters should have completed the same test.
- Low validity: Different subjects may respond to the same exercises differently.
- Controlled conditions: Other factors such as humidity or ambient temperature were not controlled.

2 marks

Note: For data to be scientifically supported, many factors should be taken into consideration. The options given above are in the context of this specific question.

Question 5 (8 marks)

a. **i.** ribosome 1 mark

ii. A chaperone protein could bind to an enzyme, which would allow its functionality as part of metabolism to be maintained at higher temperatures. 1 mark

Otherwise the enzyme may denature, which is disadvantageous for survival. 1 mark

b. **i.** *Any one of:*

- Water is an excellent solvent, enabling a wide variety of chemicals to mix in it.
- Water is a good buffer, enabling a neutral pH much of the time.
- Water is a liquid at cellular temperatures, enabling an efficient metabolism.
- Water is not very viscous, enabling easy movement of chemicals within it.

1 mark

ii. Cells can remain isotonic in a dry environment, as the outside of cells would become more concentrated with less water; increasing the glucose in the cell through increased production of internal osmolytes retains an equal concentration gradient (and minimises water loss from the cell). 1 mark

c. **i.** Abscisic acid is water soluble (hydrophobic), as it binds to surface receptors. 1 mark

ii. Once abscisic acid binds to a receptor, a series of intracellular events will be activated (signal cascade). 1 mark

The final step in the process is a cellular response, which would be either the opening of a gated ion channel to allow the diffusion of ions into the cell, or the 'switching on' of a protein pump to allow the active transport of ions into the cell. 1 mark

Question 6 (8 marks)

a. The pathogen would be recognised as non-self by monocytes/macrophages/mast cells. 1 mark

A secretion of cytokines/histamines would lead to vasodilation of blood vessels, which would cause inflammation almost immediately. 1 mark

b.

Step	Cells involved	Type of response	Location within the body of the step
2	antigen-presenting cell AND naive B or T cell OR T helper cell	active	lymph node
4	pathogen AND cytotoxic T cell	active	site of infection
6	macrophage	innate	site of infection

6 marks

Award 2 marks for each correct column of the table.

Question 7 (7 marks)

a. **i.** A vaccine contains attenuated viral antigens that will activate an immune response against a disease but will not make the individual sick. 1 mark

ii. The antigen (or an antigen-presenting cell with antigen displayed) will be transported through the lymphatic ducts to a lymph node. 1 mark

The antigen will encounter a naive B cell, which will clone and differentiate into B plasma cells that form antibodies – these will eradicate the antigens present. 1 mark

B memory cells will remain in the body to act against the live strain of the virus if it enters the body in the future. 1 mark

b. Karla is correct. 1 mark

Over time, a T cell response (cell-mediated) will have T memory and T helper cells, and the humoral response will have B memory cells. 1 mark

The T memory cells will coordinate the humoral and cell-mediated responses upon further exposure to the virus. 1 mark