Neap

Trial Examination 2021

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

C is correct. The question describes the movement of a large amount of material into a cell, which is referred to as endocytosis. **A** is incorrect. Pinocytosis is the movement of liquid into a cell. **B** is incorrect. Exocytosis is the movement of chemical packages out of a cell. **D** is incorrect. Facilitated diffusion is the movement of chemicals through a protein channel.

Question 2 C

C is correct. Cholesterol stabilises membranes by stopping the phospholipids from clustering and stiffening. **A** and **D** are incorrect. Neither of these factors contributes to the stability of a cell membrane in the situation described. **B** is incorrect. The statement gives incorrect information, as fatty acid tails are hydrophobic not hydrophilic.

Question 3 B

B is correct. The proteome is the entire set of proteins produced by an organism, more specifically the interacting proteins within a cell. This can be different to the proteomes in other cells of the same organism. **A** is incorrect. The genome relates to DNA not protein. **C** is incorrect. The spliceosome cleaves mRNA during processing. **D** is incorrect. The nucleosome is how DNA is packaged in a nucleus.

Question 4 C

C is correct. Ribosomes comprise protein and rRNA, which form two subunits that 'clamp' together around mRNA prior to translation. The other forms of RNA are involved in protein synthesis but are not ribosomal components. **A** is incorrect. mRNA is fed through the ribosome during translation. **B** is incorrect. tRNA carries anticodons that bind to codons. **D** is incorrect. mRNA and tRNA may be located at the ribosome but they are not structural components, whereas protein and rRNA are structural components.

Question 5 D

D is correct. The labels are for the protein structure of the biomacromolecule, which is made up of hierarchical levels. The primary level is the sequence of amino acids. Adjacent amino acids form predictable shapes (α-helices and β-sheets); this is the secondary level. The polypeptide forms a three-dimensional shape with disulfide bonds in the tertiary level. The quaternary level is multiple polypeptides interacting to form the final functional protein. **A, B** and **C** are incorrect. This question requires a process of elimination; label 1 represents an α-helix, which none of these options state.

Question 6 C

C is correct. For the template sequence GGA TGT CGA CTA GGC to be directly transcribed into mRNA, each base must be complementary (C–G and A–T) except that uracil (U) would replace thymine (T). **A** and **B** are incorrect. Both contain thymine. **D** is incorrect. The bases in the resultant molecule are not complementary to the template.

Question 7 A

A is correct. The transcribed pre-mRNA in eukaryotes can be further processed to cleave out introns and splice together exons in different orders, leading to different polypeptide chains. This is known as alternative splicing. **B** and **C** are incorrect. RNA processing (DNA is not processed) relates to how pre-mRNA is dealt with but this does not necessarily always involve alternative splicing. **D** is incorrect. Transcriptional modification is similar to RNA processing and so does not always involve alternative splicing.

Question 8 A

A is correct. In terms of the hierarchical levels of protein structure, the sequence of amino acids in a polypeptide is referred to as the primary level. **B** is incorrect. The secondary level refers to how adjacent amino acids form predictable shapes (helices and sheets). **C** is incorrect. The tertiary level refers to the three-dimensional shape of the resultant polypeptide. **D** is incorrect. The quaternary level refers to how multiple polypeptides interact to form the final functional protein.

Question 9 D

D is correct. The formation of a polypeptide from DNA follows two main steps. The first is transcription, which produces mRNA in the nucleus of a cell. The second is translation, which produces a polypeptide in ribosomes in the cytosol. **A, B** and **C** are incorrect. This question requires a process of elimination.

Question 10 B

B is correct. Enzymes have many features in common, one being that they are all reusable so that maintaining the metabolism does not require too much energy. **A** is incorrect. There are some RNA enzymes that function within bacteria, and ribozymes are RNA-based enzymes found in many eukaryotic organisms. **C** and **D** are incorrect. Enzymes can be reversibly or irreversibly inhibited depending on the type of enzyme.

Question 11 A

A is correct. The question asks about the amount of product formed rather than the rate of reaction. In this case, the phenylalanine reacts with the enzyme to produce tyrosine, which accumulates until there is no more substrate left or no more product is formed. **B** is incorrect. The horizontal axis is temperature, and this is not the independent variable. **C** is incorrect. When the rate of reaction plateaus, the reaction is still occurring. **D** is incorrect. Tyrosine is not the independent variable, and the amount of tyrosine does not decrease.

Question 12 B

B is correct. The coenzymes NADH and NADPH are both hydrogen carriers. NADH generally carries hydrogen in catabolic pathways and NADPH generally carries hydrogen in anabolic pathways. Respiration is a catabolic process and so uses the coenzyme NAD (in glycolysis) to produce NADH, whereas photosynthesis is an anabolic process and so uses the coenzyme NADPH (in the Calvin cycle).
A is incorrect. Phosphorylation relates to ATP production, not NADH production, and NADPH is formed from NAD, not NADH. **C** is incorrect. The stroma is located in the chloroplast and NADH is not found in the stroma, and NADH, not NADPH, is formed from the Krebs cycle. **D** is incorrect. NADH and NADPH may include nitrogen and phosphorus as part of their chemical structure, but their functions are not to 'carry' those elements from location to location.

Question 13 D

D is correct. Photosynthesis is a reaction that uses carbon dioxide (CO_2) and water (H_2O) to produce glucose ($C_6H_{12}O_6$) and oxygen (O_2). Metabolic water is also formed in the process. **A** and **B** are incorrect. Glucose is a product and not a substrate. **C** is incorrect. All the oxygen atoms produced come from the water substrate and so 12 molecules of water are needed to produce 12 atoms of oxygen.

Question 14 C

C is correct. The general name for signalling molecules that (usually) move between white blood cells or from white blood cells to target cells are called cytokines. They often have other names (for example, interleukin or interferon). **A** is incorrect. Pheromones are chemicals that move between members of the same species. **B** is incorrect. Hormones travel within organisms through transport networks (blood). **D** is incorrect. Neurotransmitters usually travel across synapses between neurons.

Question 15 A

A is correct. The receptors in the female pig are inside a cell (intracellular) and so the signalling molecule must be non-polar, lipid soluble or lipophilic. **B** is incorrect. Androstenone is not hydrophilic. **C** is incorrect. Androstenone is not lipophobic, as it binds to intracellular receptors. **D** is incorrect. The question states that androstenone is a signalling molecule for 'some species', suggesting it is not extremely common.

Question 16 A

A is correct. Signal transduction follows a predictable sequence of events where the gibberellic acid (A) binds to an extracellular receptor (C). This interaction sets off a cascade of events that involves second messengers (D) and, in this case, a protein secretion of amylase is the response (L). **B, C** and **D** are incorrect. The other letters are not relevant to the question.

- B does not have the required shape to bind to the receptor.
- E is the mitochondria and not directly involved in signal transduction.
- F is DNA and it does need to be activated to produce the protein.
- G is movement of mRNA to the ribosome.
- H is transcribing the amylase gene.
- I is movement of the amylase through the rough endoplasmic reticulum.
- J and K are packaging and eventual exocytosis of the amylase.

Question 17 C

C is correct. Apoptosis is programmed cell death that can be stimulated internally or externally. Apoptotic bodies are formed after caspase cleaves the cytoskeleton that retains the cell's structure, forming smaller structures that can then be removed by phagocytes. **A** is incorrect. The death receptor does not damage the cytoskeleton, but it may lead to the cytoskeleton becoming damaged. **B** is incorrect. The caspase may cleave the DNA, but the nucleus does not directly form blebs. **D** is incorrect. The apoptotic process, once activated, leads to internal damage.

Question 18 C

C is correct. If the rate of apoptosis (removal of cells) is greater than the rate of replication (addition of cells), then a decreasing number of cells would eventuate. This could lead to an autoimmune disease, such as multiple sclerosis. **A** and **B** are incorrect. Cancer is an increase in the number of cells, and cancerous cells are often undifferentiated. **D** is incorrect. Viral diseases can lead to cell death of the target cells, but the rate of apoptosis being greater than the rate of replication does not mean that a viral disease will replicate uncontrollably.

Question 19 B

B is correct. Bacteria are prokaryotes that, because they consume material inside a person, are defined as heterotrophs. Eukaryotic cells carry a nucleus. **A** is incorrect. Bacteria are not eukaryotic. **C** and **D** are incorrect. Bacteria are cellular.

Question 20 A

A is correct. The innate immune system does not include lymphocytes but does include cells such as mast cells, neutrophils, antigen-presenting cells and macrophages (and many others). At any one moment in a drop of blood, the most prolific white blood cell type are neutrophils (about 50%). This means they are more likely to be at the site of infection first. **B, C** and **D** are incorrect. These options are all white blood cells but are found in much smaller amounts in the bloodstream.

Question 21 C

C is correct. Dendritic cells or antigen-presenting cells are a type of macrophage that endocytoses pathogens and displays antigenic fragments on their surface. These cells move into the lymphatic system and migrate to lymph nodes where they meet B cells and T cells. In this case, the B memory cell with a complementary receptor will be activated. **A** is incorrect. Plasma cells are already stimulated to make antibodies. **B** is incorrect. T cytotoxic cells will be moving through the body towards the infection. **D** is incorrect. The B memory cell does not have a complementary receptor.

Question 22 D

D is correct. A naive B cell, once stimulated, undergoes clonal expansion of that specific cell. This leads to the production of B plasma cells that make antibodies complementary to the antigen originally presented. The antibodies move into the circulatory system and bind to the antigen at the site of infection. B memory cells are also formed; these remain in the system after recovery for a long time, thus allowing long-term immunity against the antigen. **A** is incorrect. The role of T cytotoxic cells is to apoptose target cells. **B** is incorrect. T helper cells coordinate the immune response. **C** is incorrect. B memory cells do not secrete cytokines into the circulatory system.

Question 23 B

B is correct. For an antibody to be an effective therapy it would need to be complementary to the antigens on target tissues. In this case, the antibody binds to PD1 on melanoma cells, stopping these cells from dividing. The production needs to occur in another organism (for example, rabbits or mice) to generate the antibody. The issue then is that the antibody may combine with other cells as well, and hence the therapy is a balance between eradication of the cancer and destruction of required cells, which may lead to side effects. **A** is incorrect. Antibodies are synthesised in B plasma cells. **C** is incorrect. The PD1 marker is a self-identification marker, presumably located on self cells throughout the body. **D** is incorrect. Antibodies comprise two light chains and two heavy chains.

Question 24 D

D is correct. After an initial vaccination, over a 2–3-week period clonal selection and expansion occurs, producing many antibodies as well as a large number of B memory cells. Within hours after the second vaccine (time Q) those memory cells differentiate into plasma cells because the chance of an interaction between the antigen in the vaccine and receptors on the memory cell is higher, and a much larger and faster response would be expected. **A, B** and **C** are incorrect. These times are not within the time frame expected.

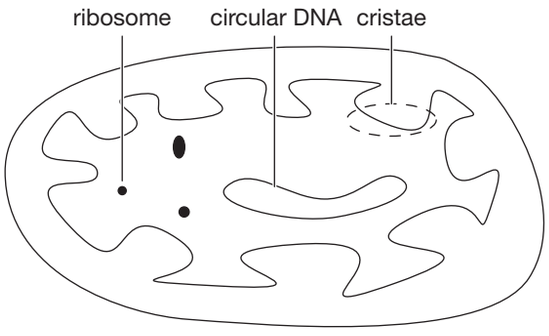
Question 25 D

D is correct. When the antibody level is at its peak, the greatest number of antibodies would be expected (time R). The other times **A, B** and **C** are incorrect. O is when the initial active response begins generating antibodies; P is when the initial plasma cells begin to apoptose as the concentration of antigens decreases, leaving B memory cells in the body; Q is when the second vaccine was administered.

SECTION B

Question 1 (6 marks)

a.



3 marks

1 mark for the double membrane.
1 mark for each correct distinguishing feature other than the double membrane.
Students must show two of ribosome, circular DNA and cristae for full marks.

b. **i.** The outer membrane is from the eukaryotic cell and the inner membrane is from the prokaryotic cell. 1 mark

ii. *Any two of:*

- presence of circular DNA (inferring bacterial origin)
- presence of ribosomes (to manufacture protein)
- organelle size similar to that of prokaryotic cells
- independent reproduction (like bacteria)

2 marks

Question 2 (9 marks)

a. The human genome comprises linear strands of DNA in a nucleus. 1 mark

The *Escherichia coli (E. coli)* genome comprises a circular strand of DNA found in the nucleoid region. 1 mark

b. **i.** The *lac*I gene is a regulatory gene because the protein produced activates other genes. 1 mark

The repressor protein controls the expression of the *lac* operon structural genes (*lac*Z, *lac*Y and *lac*A). 1 mark

ii. The repressor protein can bind to the operator region of the *lac* operon when lactose is absent as the shape of the repressor is complementary to a region in this section of the gene, thus preventing RNA polymerase from transcribing the gene. 1 mark

The repressor protein is unable to bind to the *n* operator section of the *lac* operon when lactose is available because the lactose binds to a site on the repressor, causing a conformational change in shape of the repressor, making it unable to bind to the promotor, which allows the *lac* operon to express the genes. 1 mark

c. The promotor region of the *lac* operon is for the RNA polymerase to bind to. 1 mark

d. In a lactose-rich environment, the permease allows the lactose to move from the external environment into the cytosol of the bacteria. 1 mark

The β-galactosidase breaks the lactose into monosaccharide to be used as an energy supply. 1 mark

Question 3 (10 marks)

a.

Name of stage	Input	Output	Cellular location
glycolysis	glucose	**pyruvic acid OR NADH, ATP**	**cytosol**
Krebs cycle	**pyruvic acid OR acetyl CoA**	carbon dioxide	**matrix**
electron transport chain	**NADH OR oxygen**	**ATP OR water**	cristae

4 marks

Note: Award 1 mark for six correct answers. Award 2 marks for seven correct answers. Award 3 marks for eight correct answers.

b.

Type of respiration	Advantage	Disadvantage
aerobic	**provides enough ATP for the muscles for most of the race**	**not sustainable for the duration of the race**
anaerobic	**provides a small amount of energy quickly near the end of the race**	**not long lasting nor sustainable, only useful for a distance less than 400 m**

4 marks

1 mark for each correct advantage.
1 mark for each correct disadvantage.

c. *Any one of:*

- more mitochondria to generate more ATP available to sustain energy demand
- more power/strength in the muscles so the athlete does not tire as easily
- greater capacity to absorb more oxygen from blood for aerobic respiration

2 marks

1 mark for identifying a benefit.
1 mark for describing how it would assist the athlete.

Question 4 (9 marks)

a. Extracellular receptors face the outside of the plant cell and have a complementary shape to auxin, which is a polar molecule and unable to pass through the non-polar membrane. 1 mark

Auxin, being polar, would need to move through protein channels to bind to intracellular receptors that would be complementary to auxin in the cytosol of the cell. 1 mark

b. Different second messengers are activated, which lead to different responses. 1 mark

This could lead to the production of growth proteins in growing cells and the activation of DNA replication in dividing cells. 1 mark

c. Plant hormones such as auxin diffuse slowly from where they are made to where they stimulate a response (or move through phloem). 1 mark

Neurotransmitters move across a synaptic cleft rapidly where they stimulate a response by binding to post-synaptic receptors. 1 mark

d. **i.** 4.8 arbitrary units of auxin 1 mark

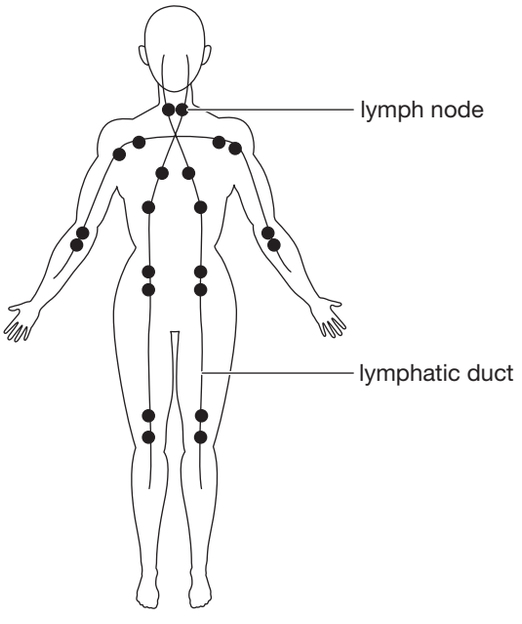
Note: Responses in the range of 4.7–4.9 are acceptable.

ii. As the auxin diffuses away from the tip of the root, it is forced by gravity to accumulate on the lower side of the root. 1 mark

The higher concentration of auxin on the lower side inhibits growth and the lower concentration on the higher side stimulates growth, as indicated in the graph. This causes the root to bend downwards. 1 mark

Question 5 (9 marks)

a.



2 marks

1 mark for each correct label.

b. Material (antigens) moving through the lymphatic system often have an immune response directed against them within the lymph nodes. 1 mark

These immune response factors (antibodies, lymphocytes) empty into the circulatory system near the heart so they can be circulated around the body to reach the area that requires an immune response. 1 mark

c. **i.** *For example, any one of:*

– Stomach acidity kills most bacteria in consumed food.

– Lysozyme in tears is antibacterial and thus reduces the incidence of eye infections.

1 mark

Note: Both the barrier and an explanation of how it prevents infection are required.

ii. T helper cells control the active immune response. 1 mark

Upon stimulation, they bind to B cells and T cells and communicate with them using cytokines, which leads to their clonal expansion and differentiation. 1 mark

d. Nilaa's argument is correct. 1 mark

In people with allergies, the allergen is regarded as an antigen in their immune system because they develop an immune response against the allergen, but in non-allergic people the allergen is not antigenic and so does not activate an immune response. 1 mark

Question 6 (7 marks)

a.

Method	Active/passive/ both	Natural/artificial/ both	Long-term/ short-term/both
Milk-feeding baby calves	passive	natural	short-term
Antivenom	passive	artificial	short-term
Seasonal vaccination	active	artificial	long-term
Chickenpox parties	active	natural	long-term

4 marks

1 mark for each correct row.

Note: While the flu-season immunity method results in long-term immunity against that strain of the flu, the flu virus mutates rapidly and so the immunity gained will not protect against subsequent strains, resulting in the apparent short-term benefits.

b. *Any one of:*

- Milk-feeding baby calves:

  The mother produces antibodies against pathogens that she is exposed to during pregnancy. 1 mark
  After birth, these antibodies are passed to the calf in the milk it gets from its mother, 1 mark
  providing protection against pathogens that the mother was exposed to. 1 mark

- Antivenom:

  An animal, such as a horse, is activated to produce antibodies by being exposed to venom antigens, such as the venom of a funnel-web spider. 1 mark
  The antibodies are administered to a victim of a funnel-web spider bite via an injection. 1 mark
  The antibodies bind to the venom antigens, negating the venom. 1 mark

- Seasonal vaccination:

  People are injected with flu antigens that are part of an attenuated vaccine. 1 mark
  Their immune systems develop antibodies and memory cells against the antigens. 1 mark
  If they come into contact with the virus in the future, they will have memory cells that provide protection. 1 mark

- Chickenpox parties:

  A child is exposed to the chickenpox virus via close contact with an infected individual. 1 mark
  The child will contract the chickenpox and their immune system will develop antibodies and memory cells against the virus. 1 mark
  If they come into contact with the virus in the future, the child will have memory cells that provide protection. 1 mark

3 marks

1 mark for the origin of the antibodies.
1 mark for how the antibodies are encountered.
1 mark for the protection provided by the treatment.