

Trial Examination 2015

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**

Polysaccharides are a subgroup of carbohydrates. Students should be aware of examples of polysaccharides (starch, glycogen, cellulose and chitin), disaccharides (sucrose, maltose and lactose) and monosaccharides (glucose, ribose and fructose). There are a lot to learn and putting them together in a mind map would be recommended.

Question 2 C

The manufacture and secretion of biomacromolecules such as insulin is an example of linking cell structure with function. Protein hormones, such as insulin, are manufactured at the rough endoplasmic reticulum (*O*). They are then packaged and modified at the Golgi apparatus (*P*), and finally secreted by exocytosis from the cell within vesicles (*Q*). The nucleus (*N*) provides the blueprint for the manufacture of the insulin and the mitochondria (*M*) provide the ATP for any endergonic activity within the cell.

Question 3 D

Students should be aware of the elements present in the different groups of biomacromolecules. In general, carbohydrates contain carbon, hydrogen and oxygen (there are some exceptions, such as chitin, which contains nitrogen as well). Lipids such as steroids and triglycerides contain carbon, hydrogen and oxygen (some phospholipids contain phosphorus and nitrogen). Proteins such as phenylalanine hydroxylase contain carbon, hydrogen, oxygen and nitrogen (and other trace elements). Nucleic acids such as DNA contain carbon, hydrogen, oxygen, nitrogen and phosphorus.

Question 4 C

An understanding of diagrammatic representations of cellular processes is important in biology. The diagram illustrates a process occurring at the ribosome, which is protein synthesis. Molecule *R* is mRNA (formed from the DNA by transcription), which provides a blueprint that is read at the ribosome. This enables the correct amino acid to be assembled in the correct position in a polypeptide (molecule *Q*). The reaction that assembles the protein is a condensation reaction (hydrolysis is the opposite).

Question 5 B

Water makes up about 70% of most living things. As such, it is important to understand some of the properties that make it such an important molecule. Some of these properties are listed below.

- It is a polar molecule (enabling other polar molecules such as glucose and many proteins to mix in it).
- It is liquid at room temperature, making it an ideal medium for chemicals to mix and move through.
- It has a low viscosity, allowing chemicals to move through it reasonably easily (allowing efficient metabolism).
- It is transparent, allowing light to penetrate (this allows photosynthetic organisms to exist underwater).
- It has the capacity to absorb a lot of heat prior to evaporating (making it useful for heat regulation).
- It is cohesive and has surface tension; this allows it to move upwards through xylem in plants (called capillarity).

Question 6 A

Globular proteins are the workhorses of metabolism. Examples of these are enzymes, hormones and antibodies are examples. This particular protein is comprised of several amino acids (*P*) joined by peptide bonds (*O*). The primary sequence (order of amino acids) dictates how they interact with each other to form α -helices (*M*) and β -pleated sheets (*N*). This gives the secondary structure of the protein. The final shape of the polypeptide forms the tertiary structure of the protein.

Question 7 C

Component *R* is a phospholipid that is an integral part of the cell membrane. The phosphate heads are hydrophilic (polar) and face towards the intracellular and extracellular environments. The fatty acid tails face towards each other as they are hydrophobic (non-polar). The fatty acids are joined to the phosphate heads with glycerol. Component *S* is cholesterol, which is a steroid that mixes within the phospholipid bilayer. It is able to mix slightly with water but is mainly lipophilic. Cholesterol helps to maintain the fluidity of the membrane. In a cold environment there is a higher amount of cholesterol, which prevents the phospholipids (and hence the membrane) from solidifying.

Question 8 A

Enzymes are reusable, which means they are unchanged after the completion of the chemical reaction they catalyse. This reaction is a catabolic one, where the substrate is broken into two smaller products. End-product inhibition usually occurs when the product has a complementary shape to an allosteric site on an enzyme that is part of the metabolic pathway that produced it. This slows the whole reaction down. There is no evidence of the optimal conditions for the enzyme in the question, making **D** incorrect.

Question 9 D

Controlled conditions are those that need to be kept constant in each experimental set-up. This means there will be only one difference between the experimental groups (the independent variable). In this particular experiment, the independent variable (IV) is the temperature and the dependent variable (DV) is the change in dry mass. The initial mass should be approximately the same, but since the DV is expressed as a percentage, it is not necessary. The light intensity would need to be constant across all experimental groups.

Question 10 B

Analysing graphs is an important aspect of scientific interpretation. There are two ambient temperatures where a 20% change in mass occurs. These temperatures are 17°C and 50°C. It is recommended that students take a transparent ruler into the exam so that accurate graph readings can be completed.

Question 11 A

This particular experiment clearly shows that there is a maximum change in dry mass at a temperature of 30°C. Temperatures below this would slow the rate of collisions, rather than denature the enzymes catalysing photosynthesis. Changing another factor, such as carbon dioxide, may indeed change the rate of photosynthesis, but based on the graph provided there is no evidence to support this. The change in dry mass decreases above 30°C because the enzymes start to denature.

Question 12 D

Plants respire all the time; however, the rate of photosynthesis during the day would be higher than the rate of respiration because plants need to generate enough organic material for the food web. Photosynthesis uses carbon dioxide, and so during the day it would be expected that the levels of carbon dioxide would drop (making **A** incorrect). **B** is incorrect because at the point where photosynthesis is equal to respiration, the amount of carbon dioxide exchange between the environment and the air would be equal, and the graph does not show this point. **C** is incorrect because respiration occurs all the time. **D** is correct because it can be read directly from the graph.

Question 13 C

The Krebs's cycle occurs in the matrix of the mitochondria, and involves the combining of a 2-carbon compound from glycolysis with a 4-carbon compound to produce a 6-carbon compound. This is then converted back (losing carbon dioxide as it does so) into the same 4-carbon compound (hence the Krebs's cycle). There is 1ATP per revolution of this cycle (as well as NADH and FADH). In contrast, the electron transport chain uses the NADH (and FADH) from Krebs's, as well as glycolysis, to produce 34ATP molecules. This is achieved when the surplus hydrogen moves from the mitochondrial intermembrane space through ATPase (on the cristae), and then combines with oxygen and electrons to form water.

Question 14 A

A chemical that is released by one member of a species which affects the behaviour of members of the same species is called a pheromone. Pheromones are also signalling molecules, but the term pheromone is a more accurate answer.

Question 15 D

Signal amplification occurs when an initial signalling molecule relays a message via secondary messenger molecules that influences the activity of more than one enzyme or gene. This leads to an amplified response because the initial signalling molecule is usually in very low concentrations. Response **D** shows how one molecule of gibberellic acid can activate 50 protein kinase enzymes. All the other responses do not demonstrate an amplified response.

Question 16 A

Stimulus/response mechanisms should, in Units 3&4, relate to molecular interactions. However, students should be able to interpret a diagrammatic representation. In the context of this diagram, the receptor (the location detecting the change) would be the skin and the effector (the location that responds) would be the muscle.

Question 17 B

Nerves interconnect with each other where sensory neurons (**B**) detect the change and direct a nerve message to the CNS. Here, the interneuron (**C**) collects the message and directs it to where it is needed. In this case, the nerve message would be directed to a motor nerve (**D**) to elicit a response. These nerve cells are not in direct contact with each other and the name of the space between is called a synapse (**F**). Neurotransmitters are released from the presynaptic side to diffuse across the synaptic cleft and bind to receptors on the postsynaptic side. This passes the message in one direction and stops the message going backwards.

Question 18 D

This question illustrates how receptors pick up messages from signalling molecules which are complementary to them. It also illustrates how a combination of signalling molecules can change the way a cell will behave. For a cell to differentiate into a nerve cell, only receptors *B* and *C* need to be activated.

Question 19 C

A plant callus is undifferentiated, and mixing it with varying amounts of auxin and cytokinin will allow it to grow either root or shoot tissue. As root tissue is required, the graph shows that the hormone mix would need to contain a high amount of auxin and a low amount of cytokinin. There is no evidence that cytokinin is not present, making **D** incorrect.

Question 20 B

Pathogens that sexually reproduce are likely to carry surface antigens which vary from individual to individual. Vaccines work on the premise that the antigens do not change. The vaccine can then promote specific lymphocytes to become activated. These same lymphocytes would be ineffective if the surface antigens were changing.

Question 21 B

The treatment for pathogenic diseases varies. A bacterial disease would be typically treated with antibiotics, which kill the bacteria without killing the host (or having too many side effects). A virus is more difficult to treat, but some antiviral medication is on the market (for example, Tamiflu for influenza). However, a vaccine is a preventative measure, not a treatment. Bedrest and anti-inflammatories are useful, but these are only treating the symptoms (fever and inflammation).

Question 22 D

The cell-mediated immune response is directed against cells that pose a threat to the body. This is anything cellular that carries non-self markers, and includes viral-infected cells, bacteria, unicellular parasites and even transplanted cells. The response generates cytotoxic T cells that attack the specific cells with precision-like accuracy. Prions in the brain are protein, and even if they were abnormal, a T cell response would be a waste of energy. Neurotoxins will elicit a humoral response because the toxins are small and need to be neutralised by specific antibodies.

Question 23 B

Helper T cells are the 'Generals' of the immune cell response. Without them the immune response would occur, but with a distinct lack of coordination. Naive T cells, upon initial contact with an antigen, will clone and then differentiate into cytotoxic, macrophage and helper T cells. The helper T cells then communicate (via lymphokines) with activated B cells, as well as the activated T cells, to proliferate in a fashion that is best for the individual. The helper T cells also help to suppress or switch off the immune system when it is no longer needed in that particular circumstance.

Question 24 D

Structure *Q* is an antibody that has been produced by a B plasma cell in response to the body being exposed to an allergen (*P*). Most people do not respond in this way to the allergen, which illustrates a genetic link to allergies. The antibodies bind to receptors (*R*) on the surface of the mast cell. The mast cells aggregate near the likely pathway of entry of the allergen. Upon exposure to the allergen, the mast cell secretes vesicles (*S*) full of histamines (*T*) that promote inflammation around the site of entry, which is often the nose and throat.

Question 25 D

Allergies are a learned response, meaning the more times an individual is exposed to a particular allergen, the more mast cells cluster near the site of entry. These mast cells have more antibodies on their surface, which means that a lot of histamine can be exocytosed from each cell. The immune system is hypersensitised to the allergen.

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

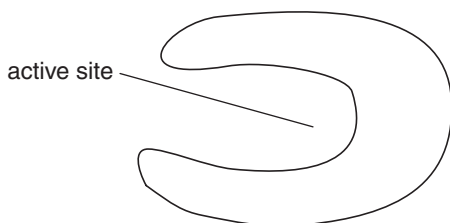
- a. A, D and E 1 mark
All three are required to be awarded the mark.
- b. D (thylakoids are the grana membranes within the chloroplast) 1 mark
- c. E (electron transport is the last step of respiration occurring in the mitochondria) 1 mark
- d. F, C and G (water would move out of the cell by osmosis) 1 mark
- e. C (receptors are located on the cell membrane) 1 mark

Note: Students should be able to relate the structure of cells to their function, particularly in reference to the behaviour of biomolecules within the cell.

Question 2 (6 marks)

- a. quaternary structure (more than one polypeptide needed for a functional protein) 1 mark

- b. i.



1 mark

- ii. DNA nucleotides are being joined together (condensation reaction) and are complementary to the template single strand of DNA, so that double-stranded DNA is the result. 1 mark
- c. Carbohydrates such as glucose provide the chemical potential energy that, via cell respiration, provides the ATP required for endergonic reactions such as protein synthesis. 1 mark
- Nucleic acids, such as the gene for DNA polymerase, provide the blueprint for the transcription (formation of mRNA) of the gene. 1 mark
- Proteins such as RNA polymerase and other enzymes (respiratory enzymes) are required to facilitate the joining of amino acids to form the DNA polymerase. 1 mark

Note: There are many ways in which students could tackle this question. Use your professional judgement to mark the question; however, students should clearly explain how the biomolecule relates to the formation of DNA polymerase.

Question 3 (9 marks)

- a. The cotton wool in this scenario would serve three main purposes:
- it would prevent the entry of unwanted particles into the flask
 - it would allow gases to diffuse out so that pressure build-up did not occur
 - it would provide more insulation so that temperature loss was minimised

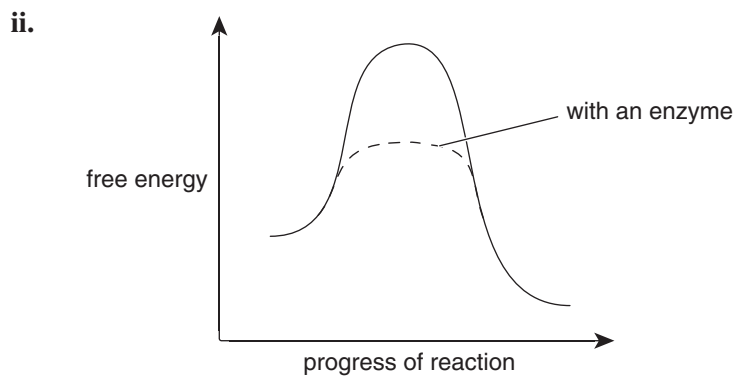
1 mark

Note: Students should be able to visualise a variety of experimental designs and relate them to the context of the course design.

- b. i.** The yeast in flask 1 already had organic molecules within it, such as glucose. 1 mark
 Glucose was broken down by respiration (which is a catabolic process) and heat was produced, which caused the flask to increase in temperature. 1 mark
- ii.** $15^{\circ}\text{C} \pm 1^{\circ}\text{C}$ (if a graph was plotted, the temperature would be seen to level off) 1 mark
- c. i.** presence of ethanol 1 mark
- Note: Whilst fewer yeast cells, lower temperature increase and carbon dioxide could be accepted as answers, students must include ethanol.*
- ii.** Aerobic respiration is more efficient at providing energy (36ATP) compared to anaerobic respiration, which provides less energy (2ATP). 1 mark
- d.** Glycolysis occurs in the cytosol of the cell. 1 mark
 The input is glucose, which is broken down by enzymes. 1 mark
 Outputs include pyruvate, ATP and NADH. 1 mark

Question 4 (5 marks)

- a. i.** Catabolic reactions convert substrates that are at a lower energy level into products that are at a higher energy level. To accomplish this, an input of energy (ATP) is required. 1 mark



1 mark



- ii.** The three shapes are complementary to the active site of the enzyme. 1 mark
 By binding to the active site, the virus would be unable to cut itself free from the cell and serve as an effective drug to use. 1 mark

Question 5 (7 marks)

- a.** Most amino acid-based hormones are not lipid-soluble and so bind to surface receptors on the cell membrane. 1 mark
 Thyroxine is an amino acid (tyrosine) that has been modified with iodine. It is lipid-soluble and can pass across the cell membrane to bind with intracellular receptors. 1 mark

- b. i. The table should be filled in as follows:

Number	Name of step/component represented
1	thyroxine
3	thyroxine receptor
5	transcription
6	mRNA
7	translation
9	glycogen
10	glucose

2 marks

1 mark penalty for any errors

- ii. Step 2 illustrates thyroxine diffusing into the cell, whereas step 11 illustrates glucose moving out of the cell by facilitated diffusion. 1 mark
- iii. Signal transduction is initiated by a signalling molecule (thyroxine) binding to a receptor, which triggers a set of secondary messengers and leads to a specific response (glucose release). Signal transduction would therefore involve all of steps/components 3–11. 1 mark
- c. stimulus: high metabolic rate
response: thyroxine levels fall 1 mark

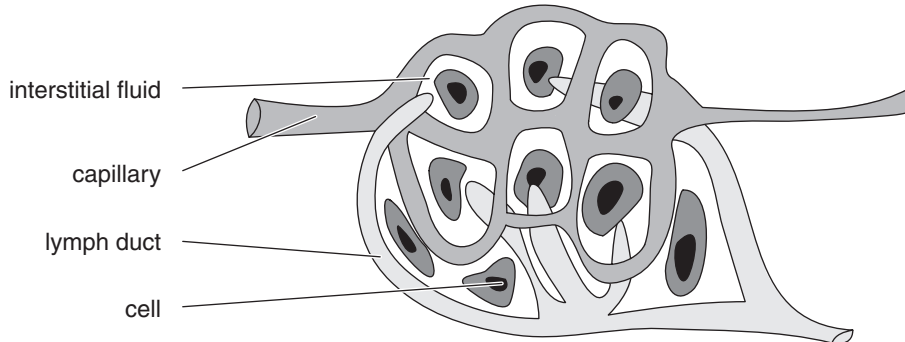
Question 6 (7 marks)

- a. Less auxin would be absorbed by the cells on the exposed side (cell 1 and to a lesser extent, cell 2) due to closure of auxin channels. 1 mark
- Cell 3 would have more auxin transported into it (due to opening of auxin channels), causing the cells on the shaded side to elongate more, and therefore the tip to bend towards the light source. 1 mark
- b. i. If light is directed to a shoot tip from one side, then the activation of lateral channels in cells 1 and 2 will be higher (more red fluorescence in cells 1 and 2, but less in cell 3). 1 mark
- Note: A hypothesis should make a prediction. Students should present a clear sentence that shows that if something changes (light from one side), then something measurable (fluorescence) should happen.*
- ii. Get a sample of 100 wheat seedlings (*Triticum monococcum*) germinated in the dark. Divide them into two groups.
- Group 1 are left in the dark as a control group.
 - Group 2 are exposed to light from one side (independent variable).
- 1 mark
- Make sure both groups of plants are exposed to the same conditions (temperature, water availability and oxygen). The experiment should also be repeated until results seem concordant. 1 mark
- Test group 1 and group 2 for the presence of red fluorescence in areas of the shoots containing cells 1, 2 and 3 (dependent variable). 1 mark

- iii. Results supporting the hypothesis would show more red fluorescence in cells 1 and 2 compared to cell 3. This would direct more auxin to the shaded side, resulting in more growth and the shoot bending towards the light source. 1 mark

Question 7 (5 marks)

a.



2 marks

Each incorrect label incurs a 1 mark penalty.

- b. Different 'naive' T cells have different surface T cell receptors that each have an affinity for different surface antigens, as presented by antigen-presenting cells (APC). 1 mark
- c. A cytotoxic T cell (T_c) is formed from clonal expansion and subsequent differentiation of a naive T cell. The T_c cell comes in contact with the target cell because the surface T cell receptors are complementary to the antigens on the surface of the target cell. 1 mark
- The T_c cell secretes 'signals' such as perforin (which forms holes in the target cell membrane) and granzymes (that leads to programmed cell death or apoptosis of the cell). 1 mark

Question 8 (6 marks)

- a. ACTX antigens come in contact with surface receptors on naive B cells in the rabbit. 1 mark
- These B cells clone and differentiate into plasma cells, which produce antibodies specific to ACTX. 1 mark

b.



2 marks

*1 mark for indication of two higher peaks that get steeper
1 mark for indication of slow tapering off*

- c. It is regarded as artificial because the antibodies have been given as an injection. 1 mark
- It is regarded as passive because the immune system has not been activated to act on the ACTX. 1 mark