Neap:

Trial Examination 2012

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

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SECTION A: MULTIPLE-CHOICE QUESTIONS

Question 1 D

Polymers are chains of monomers that are linked together by covalent bonds. Polysaccharides like glycogen are monomers of glucose (biomolecule 4). DNA is a polymer of nucleotides (biomolecule 3). Proteins are chains of amino acids (biomolecule 1). Fats are not polymers because they are not comprised of repeating components. For example, a triglyceride is made up of three fatty acid chains and a glycerol (biomolecule 2).

Question 2 C

Synthesising larger biomolecules such as proteins, triglycerides, DNA and glycogen from an anabolic reaction that produces water. Thus it is also a condensation reaction.

Question 3 B

Chemical *W* is the chemical that fits like a key into structure *X,* which is like a lock (the enzyme). Thus, chemical *W* is the substrate. A non-competitive inhibitor would bind to a location on the enzyme other than the active site and it would change the shape of the active site.

Question 4 D

Areas *a*, *b* and *c* are all part of the active site. They collectively form a shape that will be complimentary to the substrate so they 'fit' together. This puts pressure on the chemical bonds of the substrate, causing a faster reaction. A receptor is usually a protein that responds to signals. A cofactor is an inorganic chemical that plays a role in the functioning of a biomolecule. The quaternary structure is when several polypeptides combine together to form a functional protein.

Question 5 B

Storage carbohydrates such as starch and glycogen are polymers of monosaccharides such as glucose. They are hydrolysed by enzymes back into monosaccharides, which are used in respiration by cells. Options **C** and **D** are therefore incorrect. Option **A** is wrong because although starch and glycogen are chain-like molecules that can be folded compactly for storage, monosaccharides are carbohydrates too. It is the capacity of starch and glycogen to store large quantities of chemical energy in their bonds that makes them useful.

Question 6 D

The membrane shows phospholipids (*S*), glycolipids (*R*) and cholesterol (*V*). The other components labelled are protein and because both *T* and *U* have carbohydrate chains attached to them, they would be classified as glycoproteins.

Question 7 B

The external environment being hypertonic means the solute concentration is high (water potential low). Water will move from the intracellular environment (hypotonic) out of the cell. This process is called osmosis. Changing solute concentrations would not change the cholesterol dissolving ability and phospholipid stability.

Question 8 C

The genome is the entire DNA content within each cell. In a multicellular individual such as a human, each cell carries the same genome because of mitotic cell divisions. Different cells are specialised which means different genes are switched on and off. This produces a different combination of proteins enabling the cell to function in a particular fashion. All the proteins produced within a cell over its life is referred to as the proteome.

Question 9 B

Respiration is a catabolic process that releases energy exergonically, so **D** is wrong. While it is reasonable to imagine that some aspects of aerobic respiration (i.e. Kreb's cycle and oxidative phosphorylation) will be the same for both substrates, palmitic acid would have to be processed into acetyl coenzyme A through a different metabolic pathway from glucose. Option **C** is therefore incorrect. Statement **A** is unreasonable. While the oxidation of a molecule of glucose requires less oxygen than the oxidation of a molecule of palmitic acid, there is no obvious benefit because oxygen is not a limiting factor in the rat's environment. Drinking water, however, is in very short supply in the desert, so the rat survives using 'metabolic water' from the digestion and respiration of lipids in seeds.

Question 10 A

The image is of a chloroplast. **C** is incorrect because these labels are parts of a mitochondrion. The inner membrane of the chloroplast is folded into thylakoids, which are plate-like structures in which chlorophyll molecules are embedded. Stacks of these thylakoids are called grana (singular = granum). The fluid-filled interior of the chloroplast is the stroma. Options **B** and **D** therefore contain errors.

Question 11 A

Plants take up CO_2 in the light because photosynthesis consumes CO_2. The rate of photosynthesis at a light intensity of *X* is 10 moles CO_2 consumed per m^2 per hour. Respiration evolves (gives off) CO_2 at a rate of 15 moles of CO_2 evolved per m^2 per hour. The rate of respiration is constant and independent of light intensity. Therefore, the plant produces more CO_2 than it consumes, at a net rate of 15 – 10 = 5 moles of CO_2 per m^2 per hour.

Note: it is important that students take a transparent ruler to the exam so that they can read values off graphs accurately.

Question 12 D

ATP provides energy for the formation of glucose from carbon dioxide during the light independent reaction. NADPH provides a source of hydrogen ions for the formation of glucose during the light independent reaction. These are both produced during the light dependent reaction when water is split to produce the 'energy' to form ATP and the 'hydrogen' to form the NADPH.

Question 13 C

Option **A** is untrue because two classic contexts for positive feedback in human hormonal coordination are childbirth and lactation. Option **B** is wrong; negative feedback occurs when the response reduces the intensity of the stimulus or removes it completely. This is useful in maintaining homeostasis. The regulation of blood glucose concentration within a limited, tolerable range is an example of this, so Option **D** is incorrect.

Question 14 D

In mammals, some hormones such as insulin are secreted by cells directly into the bloodstream from special ductless (endocrine) glands. However, plants (which also secrete hormones) have neither ducts nor blood, so **C** is incorrect. Option **A** incorrectly limits the possible functions of hormones. In humans, hormones such as thyroxine, insulin and glucagon are involved in homeostasis, while in plants ABA is involved in regulating stomatal opening and closure. Option **B** is incorrect because neurotransmitters are paracrine hormones (hormones that affect cells adjacent to the cells that secrete them). Water-soluble hormones bind to cell surface receptors, while lipid-soluble hormones bind to intracellular receptors located in the cell either in the cytosol or in the nucleus.

Question 15 B

The roots are growing out from the seed and all of the roots eventually bend downwards. This is referred to as positive geotropism (growing with gravity). The reason this occurs is due to the auxin accumulating on the lower side of the root tissue. This has an inhibitory effect on the elongation of the root tissue compared to the upper side of the root tissue. The net effect of this is for the root to bend downwards.

Question 16 B

Care is needed when reading the words in this question. It is not necessary for a lipid-soluble steroid hormone to bind to a cell surface receptor. It needs to enter the cell in order to bind to an intracellular receptor (4). Options **A** and **C** are therefore incorrect. The hormone-receptor complex (1) then activates the transcription of a gene (or series of genes) in the DNA within the nucleus (6). The transcribed mRNA would then move from the nucleus to the ribosomes for translation (3) into the proteins responsible for bringing about the cell's response to the hormone (2).

Question 17 A

Enzymes are re-usable, and so a single enzyme molecule can catalyse many reactions before it 'wears out'. If the product of the enzyme-catalysed reaction is another enzyme, a very large number of active enzymes can be produced very quickly by the action of one single signalling molecule. This is referred to as a cascade effect. If the signalling molecule is a peptide hormone, the cascade effect it produces might be mediated by a second messenger (a second signalling molecule, such as a G-protein or cAMP). However, second messengers are involved in signal transduction rather than 'signal amplification'. In addition, cascade effects can be brought about by lipid-soluble hormones that do not require second messengers. Option **B** is therefore incorrect. Option **C** is wrong because the cascade effect does not increase the intensity of the stimulus provided by the original signalling molecule.

Question 18 D

Lysozyme is an antibacterial enzyme that is contained in fluids secreted onto the surface of the eyes (tears), mouth (saliva) and airway (mucus on the surfaces of the trachea, bronchi and alveoli). Mucous membranes are useful for trapping pathogens on the surfaces of the mouth and airway but would obstruct vision. Acidity would be an effective anti-bacterial defence but would be corrosive in these three situations. (Stomach juices are acidic, but the stomach has a thick lining of mucus to protect its surface).

Question 19 A

The complement system is innate (present from birth) and consists of a number of small proteins found in the blood, normally circulating as inactive precursors. The basic functions of complement proteins are:

1. Opsonisation – enhancing phagocytosis of 'non-self' material
2. Chemotaxis – attracting macrophages and neutrophils to the location of 'non-self' antigens
3. Lysis – rupturing membranes of 'non-self' cells
4. Clumping of 'non-self' material (agglutination).

Option **B** is incorrect because these proteins are synthesised by hepatocytes (liver cells), macrophages and monocytes, while helper T cells produce specific signalling molecules called interleukins. Complement proteins are only converted into active form when antibodies bind to 'non-self' antigens. Therefore they do not function independently of other parts of the immune system, so option **C** is also wrong. Option **D** is incorrect because the complement is not specifically antiviral.

Question 20 C

The observations in Options **A** and **B** are evidence of the body's capacity to mount an adaptive immune response to a specific antigen, but neither option refers to the idea that this response can be repeated upon re-infection as if 'learnt' or 'remembered'. Option **D** relates to pathogenic virulence, not immunity.

Question 21 A

Histamines promote vasodilation as part of the non-specific, innate immune response. Anti-histamines counter this vasodilation and are hence useful in treating the hyper-sensitive vasodilation that accompanies allergic reactions. Histamines have no known role in any of the other situations described in the question.

Question 22 B

Options **C** and **D** are incorrect. All three of the listed infectious diseases still exist in all countries of the world. The vaccination of school-age children is desirable because any maternal antibodies received prenatally or in infancy will have denatured, so **A** is wrong. Non-vaccinated children may receive protection via herd immunity, i.e. where the proportion of immune individuals in the population is large enough to prevent the spread of the disease from an infected individual to new hosts.

Question 23 C

Helper and suppressor T cells secrete cytokines/lymphokines that are molecular signals to promote or inhibit the activity of other cells in the immune system. They do not kill cells themselves. Plasma cells produce antibodies: they are not T cells but differentiate from B cells.

Question 24 A

A vaccine contains a specific antigen which has been detached from a pathogen or deliberately manufactured. Either way, the antigen is 'artificial', so Option **D** is incorrect. A mammal with a competent immune system actively manufactures its own antibodies when exposed to this specific antigen. Option **B** is wrong because passive immunity is acquired when the body is supplied with antibodies against an antigen (for example, by injection, or via the placenta or breast milk). This can occur because the recipient either has an incompetent immune system and cannot make these antibodies (for example, young babies), or because they cannot make them quickly enough (for example, in snakebite cases). Option **C** is incorrect, because in auto-immunity 'self' antigens are not recognised as such by the immune system and consequently 'self' cells are attacked and destroyed. This is normally unrelated to vaccination.

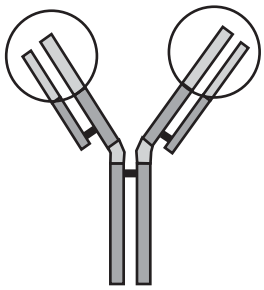
Question 25 B

This graph illustrates the primary and secondary responses of the mammalian adaptive, 'humoural' (antibody) response to infection by an antigen. Option **C** is wrong because it implies only a single infection by the antigen and the incorrect idea that the immune system produces antibodies in waves to replace those consumed in the immune response. Option **A** is wrong because the first infection by the antigen took place on day 0 and was followed by a second 'challenge' by the *same* antigen on the day 29. After infection it takes the immune system time to encounter and identify a 'non-self' antigen. It then takes more time for a clone of B lymphocytes to be selected for proliferation and differentiation into a large number of plasma cells, capable of secreting measurable quantities of an antibody. Option **D** is incorrect. The memory B cells that persist after the primary infection do not produce antibodies themselves, but must also multiply and differentiate into the plasma cells that generate the massive secondary response.

SECTION B: SHORT-ANSWER QUESTIONS

Question 1

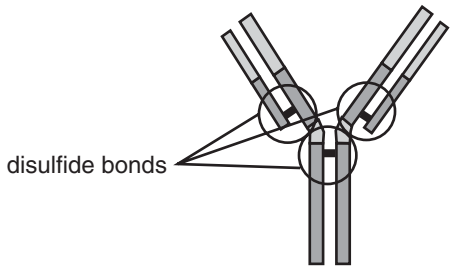
a. **i.**



1 mark

The importance of disulfide bonds in the quaternary structure of the antibody illustrated is to hold together the four polypeptides that are part of the overall antibody structure. They are covalent links between amino acids (cysteine) that are located in a similar area on the functional protein. 1 mark

ii.



1 mark

b. Antibodies are manufactured by B cells and have a complimentary shape to the antigen on the surface of the bacteria. 1 mark

Antibodies bind to the antigen which 'flags' the bacteria for its destruction. Due to two binding sites per molecule, the antibodies may clump the bacteria together for more efficient phagocytosis.
1 mark

c. *Any one of:*

- Receptors: detection of changes in the external environment and then to produce an appropriate response
- MHC: detection of self
- Channels: transport of materials across membranes
- Adherence: joins cells together

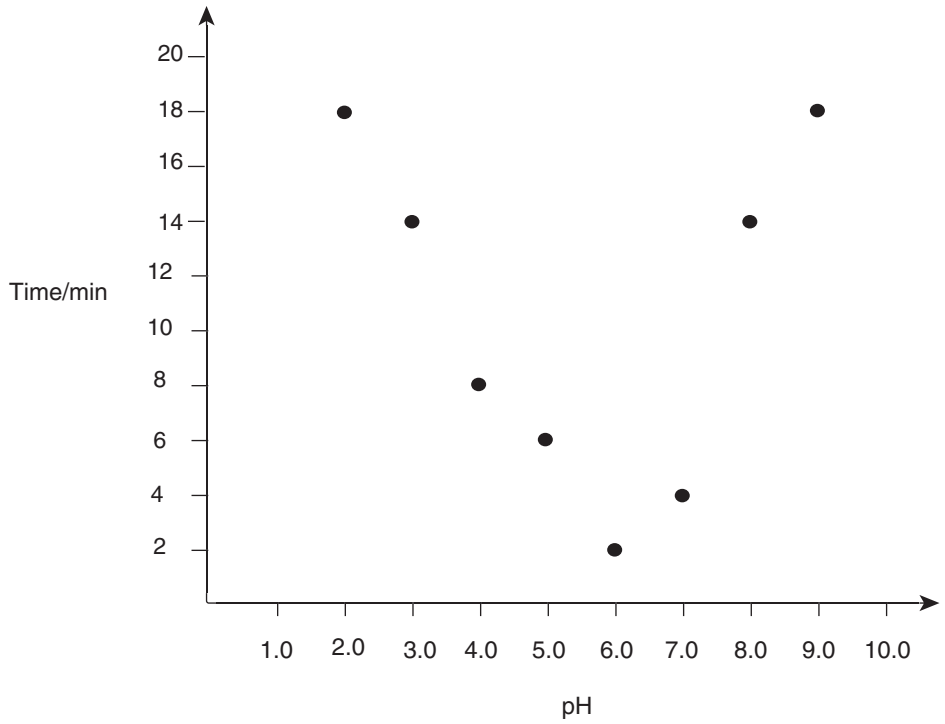
1 mark
Total 6 marks

Question 2

a. A starch polymer is broken down into maltose monomers, using water to complete the reaction.

1 mark

b.



2 marks
1 mark for vertical axis labelling
1 mark for coordinate placement

c. With extreme pH values (pH 2 or 3 and 8 or 9) the rate of hydrolysis is slow (takes more than 12 minutes). The optimum pH is 6 as this has the fastest rate of hydrolysis (the starch has disappeared in less than 2 minutes). 1 mark

Outside the optimum, the enzyme's three-dimensional structure changes shape due to the amino acids in the protein reacting with the changed conditions they are exposed to. 1 mark

Total 5 marks

Question 3

a. glycerol 1 mark

b. **i.** Glycolysis is in the cytosol/beta-oxidation is in the mitochondria. 1 mark

Note: the comparison must be made

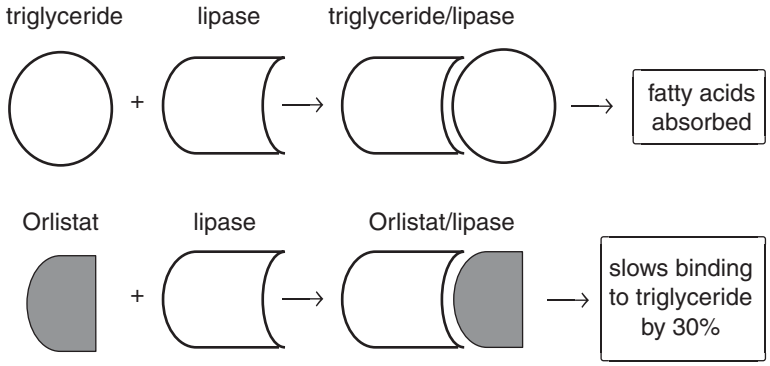
ii. NADH used in the ETC (electron transport chain) 1 mark

H^+ ions are passed into the inter-membranal space to create a high concentration there. They then move through ATP synthase (a protein embedded in the inner mitochondrial membrane) by facilitated diffusion. This provides the energy to make ATP from ADP and P. The H^+ ions then combine with the oxygen and electrons from the ETC to form water. 1 mark

Note: students should make the link between the H^+ and ATP to earn the mark

c. Genes coding for the receptor proteins will be transcribed 1 mark
and translated. 1 mark

d.



2 marks

Note: diagrams need to clearly show the competitive nature and effect of orlistat

Total 8 marks

Question 4

a. **i.** sensory nerves (neurons) 1 mark

ii. So long as there is a receptor for the pheromone, then it could lead to a response. 1 mark

b. **i.** The cAMP opens a protein channel for sodium ions. 1 mark

The influx of sodium ions leads to a change in charge across the membrane, which means the membrane has become depolarised. 1 mark

ii. One signal (odorant) and an internal response (channel protein opening) 1 mark

The receptor mobilises a G protein, which activates adenylate cyclase to form cAMP. This opens the protein channel. 1 mark

c. only a few protein receptors isolated

one isolated receptor protein being sensitive to more than one different type of odour

only a few genes coding for the receptors found

2 marks

Note: only two pieces of evidence are needed

Total 8 marks

Question 5

a. **i.** Amino acids enter the epithelial cell by **facilitated** diffusion (or **facilitated** co-transport) with Na^+ ions. 1 mark

Note: In this case, the diffusion must be facilitated.

ii. The active transport of sodium ions out of the epithelial cell maintains a concentration gradient for the continuous diffusion of Na^+ into the cell from the lumen of the small intestine; since the amino acids are co-transported with the Na^+ ions, they are also absorbed continuously. 1 mark

b. **i.** Only these cells possess receptors (in their cell surface membranes) to which the cholera toxin can bind; other cells lack these receptors and are therefore unaffected by the toxin. 1 mark

ii. A high concentration of ions reduces the water concentration in the lumen, so water is drawn out of the walls of the intestine by osmosis; this greatly increases the water content of the faeces. 1 mark

c. **i.** Vaccines contain antigenic material, and for most pathogens this material consists of proteins. 1 mark

Most proteins are hydrolysed by stomach acid and digestive enzymes, so the antigenic material in vaccines taken orally is not absorbed intact to be encountered and recognised by lymphocytes. 1 mark

ii. Memory cells die with the passage of time, in due course reaching numbers that are too low to generate a rapid and massive immune response. Re-vaccination then becomes necessary. 1 mark

Total 7 marks

Question 6

a. *Any one of:*

- The antibiotic may be distributed unevenly around the various locations in the body, so that MIC is not reached at the site of infection OR
- The antibiotic may be broken down/metabolised/excreted so quickly that MIC is not maintained long enough to kill enough bacteria OR
- In order to ensure that all the microorganisms/bacteria are killed and survivors do not reproduce in sufficient numbers to make the patient ill again OR
- The strain of bacteria causing the infection may be more resistant to the antibiotic than the strain used to determine the MIC, so higher doses are needed.

1 mark

b. **i.** *P* 1 mark

ii. *S* 1 mark

c. Initially there would be a slight increase, because although total numbers of bacteria have been reduced by the first dose of antibiotic, among the survivors there will be a larger proportion of resistant bacteria than in the original population. 1 mark

The repeating of this process throughout the course means that the proportion of resistant bacteria (and reproducing) increases rapidly/exponentially with each successive dose. 1 mark

Note: Effectively, this is a process of natural selection (more about this in Unit 4).

d. *One mark for each of two of the following:*

- Isolation/quarantine of infected individuals to prevent contact with other hosts;
- Screening/testing (of patients/doctors etc.);
- Sterilisation of wards/equipment/other reasonable method for improving hygiene and preventing transfer of MRSA

2 marks
Total 7 marks

Question 7

a. $6CO_2 + 6H_2O \xrightarrow[\text{chlorophyll}]{\text{light}} C_6H_{12}O_6 + 6O_2$ 2 marks

1 mark for each correct side of the equation

Note: An acceptable (and, in some ways better, alternative is $6CO_2 + 12H_2O \xrightarrow[\text{chlorophyll}]{\text{light}} C_6H_{12}O_6 + 6O_2(g) + 6H_20$

b. **i.** Physical barriers to prevent the settlement, entry or germination of fungal spores include:

- hair-lined stomata, to prevent spores from entering the mesophyll and germinating there OR
- a continuous thick waxy cuticle that is smooth and water-resistant, so that spores cannot adhere and get blown off by wind/washed off by rain before they can germinate OR
- bark/thick layer of epidermis, so that even if spores germinate on the surface the hyphae cannot penetrate into the plant

1 mark

ii. Plants vary in their response to prevent the spread of the mycelium. Responses can include:

- deposition of additional cellulose/lignin/suberin/silicon in cell walls (especially those of epidermal cells and phloem cells), to increase mechanical strength and prevent penetration by hyphae OR
- blockage of xylem vessels with gums or resins, to prevent growth of hyphae/transport of spores through these vessels OR
- production of toxic/phenolic substances that kill/inhibit the growth of fungal cells OR
- hypersensitive cell death when penetrated by fungal hyphae, so that fungus 'starves' and ceases to grow

1 mark

Note: In these parts of the question, a mark can only be obtained if the suggestion is accompanied by an explanation. For example, in part (i), 'thick, waxy cuticle' by itself is insufficient to score.

c. Four minutes after the fungal toxin was administered, the rate of photosynthesis started to decrease steeply and continued to do so for the duration of the experiment. 1 mark

The closure of the stomata caused by the toxin prevents carbon dioxide from diffusing into the mesophyll cells for use in the light-independent reactions of photosynthesis, so the rate declines.

1 mark

d. Grow several groups (five is a good minimum number) of genetically identical plants (ten is a good minimum number) under identical conditions (i.e. soil, light intensity, water supply, temperature, CO_2 concentration in air, etc.) and infect all the plants with the fungus in the same way. 1 mark

Prepare solutions that contain a range of concentrations of the anti-fungal (one for each group of plants), including a 0% solution/distilled water for use as a control, and by means of a spray, administer an equal volume of just one concentration to each group of plants as soon as signs of fungal infection appear on every plant in the group. 1 mark

The minimum effective dose is the lowest concentration of the anti-fungal that results in the survival of all plants in the group. 1 mark

Total 9 marks

