Neap:

Trial Examination 2008

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

Copyright © 2008 Neap ABN 49 910 906 643 96–106 Pelham St Carlton VIC 3053 Tel: (03) 8341 8341 Fax: (03) 8341 8300 TEVBIOU3_SS_08.FM

SECTION A: MULTIPLE-CHOICE QUESTIONS

Question 1 B

Water molecules are polar, as they have an uneven distribution of charge across them. This means that other polar molecules (e.g. nucleic acids, glucose and ions) can mix with water. Water is not non-polar, is not organic and is not solid at room temperature. This leaves **B** as the correct answer.

Question 2 B

Peptide bonds link amino acids in proteins. Hydrogen bonds are caused by particular attractive forces existing between some molecules (e.g. water). The covalent bonds that link glucose molecules together are termed glycosidic bonds. Phosphodiester bonds connect nucleotides in a polynucleotide chain.

Question 3 D

Glucose and cellulose are carbohydrates. Antibodies are proteins. DNA is a nucleic acid. Phospholipids, steroids and triglycerides are all types of lipids.

Question 4 C

When ATP is converted to ADP and inorganic phosphate, some energy is given off (this energy is then used for energy-needing cellular reactions). Because energy is liberated, the reaction can be termed 'catabolic'. The terms in **A**, **B** and **D** describe chemical reactions that require an input of energy.

Question 5 D

There are four different DNA nucleotides. Each one comprises a deoxyribose sugar, a nitrogenous base and a phosphate. The nitrogenous bases can be grouped into purines (double ring molecules such as adenine and guanine) and pyrimidines (single ring molecules such as thymine and cytosine).

Question 6 A

B and **D** are incorrect as these nucleotide sequences contain thymine (RNA contains uracil instead of thymine). Sequence **A** is complementary to the DNA sequence, sequence **C** is not.

Question 7 A

DNA is 'transcribed' to create an mRNA. 'Replication' uses a DNA template to create more DNA. The genetic information contained within an mRNA is 'translated' into the amino acid sequence of a protein. 'Protein synthesis' describes the entire process, from DNA to protein.

Question 8 C

There are about twenty different types of amino acids that combine together to make proteins. The order and number of amino acids lead to a specific protein. The sequence of amino acids causes a 'coiling of the amino acid chain' due to the effect one 'R' group has on other 'R' groups. This eventually leads to a unique three-dimensional protein shape. Each amino acid remains the same within the protein. They do not vary in size or property within the protein.

Question 9 D

Proteomics is a new branch of biology which investigates the structure and function of proteins. Genomics investigates the structure and function of DNA (so **A** and **C** are incorrect). As the combination of proteins needed to keep a cell alive differs during the life of the cell, **B** is incorrect.

Question 10 B

As the light intensity increases, the rate of photosynthesis also increases. At higher temperatures (30°C), the rate of photosynthesis is slightly higher due to the enzymes working faster. At point X, light intensity is the limiting factor, not carbon dioxide concentration (so **A** is incorrect). If chlorophyll were denatured, the rate of photosynthesis would drop, not level out (so **C** is incorrect). **D** is incorrect because there is no information about precisely which factor is limiting the rate of photosynthesis at point Y.

Question 11 A

If chlorophyll *a* was the only pigment involved in photosynthesis, the rate of photosynthesis graph would mirror the chlorophyll *a* absorption line. This does not occur. The statement in **A** is evidence of this. **C** and **D** do not reflect this logic. **B** does not reflect the information given in the graph.

Question 12 C

C is correct because the accumulation of the end-product (isoleucine) slows or stops its own production by inhibiting enzyme 1. There is no indication whether the inhibition of enzyme 1 is due to competitive inhibition, non-competitive inhibition or the denaturation of the enzyme (so **A** and **B** are not the best answers). Similarly, there is no indication whether or not 'X' is a catalytic reaction (so **D** is not the best answer).

Question 13 B

Enzymes convert substrates into products. Therefore, if threonine and enzyme 1 are present, intermediate A would be produced. If enzymes 2–5 are also present, intermediates B–D and isoleucine would be produced. No intermediates need to be added. Threonine and enzymes 1–5 will suffice.

Question 14 D

The diagram shows that increased testosterone production is stimulated by both FSH and LH (so **D** is correct). FSH and LH production is stimulated by GnRH, so a reduction in GnRH will not increase sperm production (so **A** is incorrect). There is no information in this question connecting the drug and testis size (so **B** is not the best answer). Testosterone increases sperm production in most male animals. It also follows that any drug treatment that increases testosterone production has the potential to reduce male infertility.

Question 15 C

FSH is a hormone that is secreted into the bloodstream from the pituitary gland and acts at a distant location (testes) (so **C** is correct). Neurotransmitters are released across a synapse (so **A** is incorrect). Pheromones are released into the air to trigger responses in other organisms (so **B** is incorrect). Exocrine glands secrete chemicals into the external environment (not the bloodstream) (so **D** is incorrect).

Question 16 C

Interstitial fluid (tissue fluid) forms when blood plasma is forced out of capillaries (due to blood pressure) and into the body's tissues. This fluid delivers solutes such as glucose, oxygen, amino acids and hormones to cells, and receives from them the waste products of metabolism such as carbon dioxide and urea. Some tissue fluid finds its way back into the blood capillaries, but most drains into the lymph vessels. The fluid ultimately returns to the bloodstream through the sub-clavian veins at the base of the neck.

Question 17 B

To reduce spoilage losses, fruit is often transported unripe to wholesalers or supermarkets where it is treated prior to retail sale with ethene (ethylene). Ethylene is also naturally produced by ripening fruit and accelerates the ripening process (so **B** is correct). Elevated temperatures may conceivably accelerate ripening, but there is no evidence in the question that such a temperature difference exists (so **A** is not the best answer). Auxins promote fruit formation and gibberellins promote fruit enlargement. Neither auxins nor gibberellins are volatile hormones that diffuse through the air, and neither causes fruit ripening (so **C** and **D** are incorrect).

Question 18 A

Phytochrome is the plant pigment involved in the sensitivity of plants to changes in daylength. The mutant plants cannot produce it, and so do not respond. The antibiotics produced by plants that are under attack (e.g. from bacteria or fungi) are called phytoalexins (so **C** is incorrect).

Question 19 D

All three of these cell types present antigens. The main function of dendritic cells is to process antigen material and present it on the surface to other cells of the immune system, i.e. to act as antigen-presenting cells. They have no relationship to neurons or the nervous system. Dendritic cells are present in small quantities in tissues that are in contact with the external environment including the skin (where they are often called Langerhans cells) and the inner lining of the nose, lungs, stomach and intestines. Once activated, they migrate to the lymphoid tissues where they interact with T cells and B cells to initiate the adaptive immune response. Dendritic cells have branched projections (dendrites) that give these cells their name.

Question 20 C

The data show that testis size is always large if the pineal gland is removed (*Pinx* group) (so **A** and **D** are incorrect). When the pineal gland is present (*Sham* group), the testes are larger under long day conditions than under short day conditions (so **B** is incorrect). Short days are a stimulus for the pineal gland to cause a reduction in testis size. Syrian hamsters are reproductively most active in the early spring as the days lengthen.

Question 21 C

Statement 1 is incorrect since avian influenza is caused by a virus, not a bacterium. Viruses can be denatured or destroyed by cooking, so statement 4 is incorrect. Statements 2, 3 and 5 are all correct. Avian influenza affects many different species of birds, but has only recently mutated to become transmissible to humans. Because of their specificity, pre-existing flu vaccines would only have been effective against human influenza viruses.

Question 22 D

Each B lymphocyte (P) produces a specific antibody. When this antibody (located in the cell membrane) binds to a corresponding antigen, the B cell undergoes repeated mitotic divisions to produce a clone of plasma cells (Q) that all produce the same antibody. Antibodies (R) are 'Y-shaped' proteins with specific antigen-binding sites at the two ends of the forked section. Antibodies, like most proteins, are synthesised in the endoplasmic reticulum (S).

Question 23 A

The host cell of HIV is the human T-helper (T_H) lymphocyte. These lymphocytes normally secrete cytokines (signalling proteins) that cause other T and B cells to multiply and produce the cell products that constitute the immune response. When T_H cells are killed by the virus, the immune response to pneumonia cannot be mounted (so **A** is correct).

Question 24 C

Tissue rejection usually results from the destruction of grafted cells by the host's cytotoxic 'killer' T lymphocytes (known as T_K cells or T_C cells). These T cells mature in the thymus gland and so are very much reduced in number in mice from which this gland is removed (so **C** is correct). Antibodies are not significantly involved in tissue rejection (so **A** is incorrect). The surgery is time-consuming and expensive (so **B** is incorrect). Hairlessness provides a good way of recognising such mice, but has nothing to do with their inability to reject tissue grafts (so **D** is incorrect).

Question 25 A

If the area of the plant under attack dies, the remaining areas of the plant may not get infected by the pathogen (so **A** is correct). If cell division is stimulated in diseased cells, the pathogen could spread to more cells (so **B** is incorrect). If the response was to cause less salicylic acid to be released, the SABP2 receptors will not be stimulated and hence an innate response would not be possible (so **C** is incorrect). If SABP2 changed its tertiary (three-dimensional) structure, it would no longer have salicylic acid binding to it regardless of the levels around the receptor. This would be an ineffective action for the restriction of infection (so **D** is incorrect).

SECTION B: SHORT-ANSWER QUESTIONS

Question 1

a. Any two of:

- DNA carries coded genetic information that can be transcribed to an mRNA copy via complementary base pairing (A–U, T–A, G–C and C–G).
- Nucleotides are held together with covalent bonds so that the DNA can be read in order without being mixed up.
- Due its double-stranded structure, DNA is much more stable than single-stranded RNA. This means that DNA is not easily degraded, and can code for mRNA sequence and amino acid sequence over the entire life of the cell.
- The two strands of DNA are held together by relatively weak hydrogen bonds. This means that the 'DNA ladder' can be 'unzipped' to allow transcription of the genetic code to make mRNAs.
- The 'DNA' ladder is twisted, coiled and supercoiled. This means that a very long piece of DNA takes up a very small amount of space. This allows all of the genetic information necessary to make an entire organism's proteins to fit inside one small cell nucleus. Without this feature, DNA would be an unsuitable storage for genetic information.
- any other suitable answer

2 marks
1 mark for each feature

b. The tertiary shape of a protein is its three-dimensional shape. It is determined by the protein's primary structure (amino acid sequence) and secondary structure (helices and sheets). 1 mark

Some interactions between amino acids that help to determine tertiary shape include disulfide bonds, hydrogen bonds, ionic bonds and the hydrophobic or hydrophilic nature of the amino acid side-chains. 1 mark

Total 4 marks

Question 2

a.

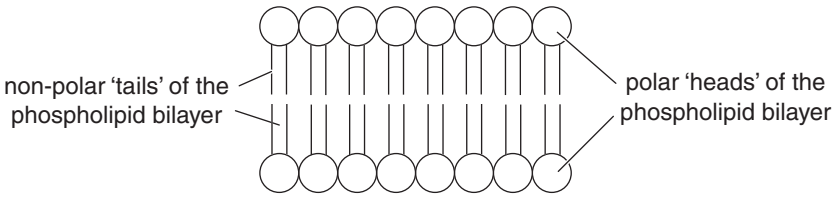
Type of movement	Membrane component involved	Definition	Example
active transport	protein pumps	low to high	absorption of glucose into the blood
facilitated diffusion	protein channels	high to low	the movement of sodium into a cell
diffusion	phospholipid bilayer	high to low	the movement of oxygen into a cell

2 marks
2 marks for all three correct answers
1 mark for two correct answers

b. **i.** exocytosis 1 mark

ii. rough endoplasmic reticulum; Golgi apparatus; secretary vesicles 1 mark

c.



1 mark

An accurate diagram and correct labels are required for this mark

As water is a polar molecule, the phospholipid bilayer is arranged so that the polar ends are facing the water on either side of the membrane. 1 mark

Total 6 marks

Question 3

a. Enzymes are biological catalysts. Most are proteins. 1 mark

A few ribonucleoprotein enzymes have been discovered and, for some of these, the catalytic activity is in the RNA part rather than the protein part. These are called 'ribozymes'.

b. For this reaction to occur in a cell, an amount of energy (x) is required for it to start. This amount of energy is called the activation energy (E_A) of the reaction. 1 mark

The catalyst for this reaction, urease, reduces the activation energy from x to y. 1 mark
This enables the reaction to go faster.

c. **i.** 6.8 1 mark

ii. The activity of the enzyme is due to the specific three-dimensional shape of the active site, which is determined by bonds and interactions between amino acid side-chains at various points on the polypeptide chain.. 1 mark
A move in pH away from the optimum changes the nature and distribution of these bonds and interactions so that the active site changes shape irreversibly, and the enzyme molecule becomes denatured and loses its catalytic function. 1 mark

d. Any one of:

- temperature
- urease/enzyme concentration
- urea/substrate concentration

1 mark

Total 7 marks

Question 4

a. **i.** aerobic respiration 1 mark

ii. The internal membrane is highly folded (cristae). This allows more electron transport chain reactions to occur, which leads to more ATP production. 1 mark

b. The mitochondrial membrane contains a PDH carrier protein. This carrier protein is not found in the membranes of other organelles. 1 mark

c. **i.** For example:
A two-carbon molecule from pyruvate combines with a four-carbon molecule. The resulting six-carbon product loses two carbons and generates ATP. This leaves the same four-carbon reactant to further combine with two-carbon molecules to form pyruvate. 1 mark

Any suitable answer which refers to the cyclical nature is sufficient

ii. anaerobic respiration 1 mark

iii. Anaerobic respiration is about twenty times less efficient than aerobic respiration (a net result of 2 molecules of ATP compared with 36–38 molecules of ATP). 1 mark

It is not enough to say 'aerobic is more efficient'

Total 6 marks

Question 5

a. rational drug design 1 mark

b. Increasing flavonoid intake to >19 mg/day reduced the number of deaths from coronary heart disease in the sample population from 22 to 11 (by 50%). 1 mark
(Information from the table must be used and included for a response to earn this mark.)

c. A drug derived from flavonoids might be a useful treatment or for men suffering from coronary heart disease or a preventative medicine for those men yet to develop symptoms. 1 mark

d. Yellow tomatoes could be genetically modified to contain the gene coding for the synthesis of chalcone isomerase. 1 mark

e. When adrenaline binds to receptors on the post-synaptic membrane, smooth muscles contract, blood vessels vasoconstrict and cardiac muscles to contract more powerfully. 1 mark

The combined effect of these events is to increase heart rate and to raise blood pressure. Kaempferol (with a similar molecular shape to adrenaline) binds competitively to the post-synaptic adrenaline receptors and prevents adrenaline from binding to them. (Kaempferol binding does not cause muscle contraction or blood vessel vasoconstriction, so blood pressure and heart rate are not increased.) 1 mark

Total 6 marks

Question 6

a. Any two of:

- the desire to quit smoking
- the age of the subjects
- the gender of the subjects
- the overall health of the subjects
- where the subjects live
- any other suitable answer

1 mark

b. The vaccine is twice as effective as the placebo (a 16% success rate compare with an 8% success rate). 1 mark

A comparison of the success of the drug and the success rate of the placebo must be made

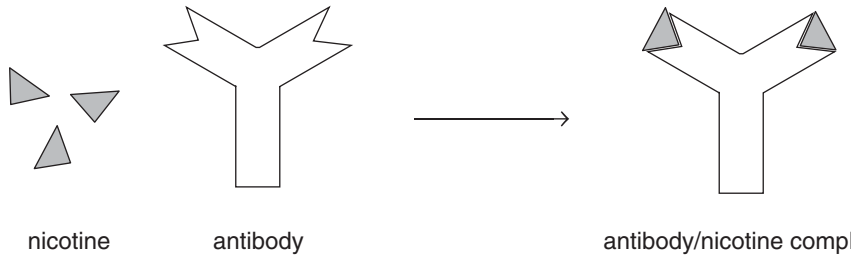
c. Any one of:

- Dendritic cells (macrophages) recognise non-self antigens (nicotine).
- B lymphocytes. The correct surface receptors matching the antigen displayed by the dendritic cells enables a specific B lymphocyte to be selected.
- Helper T cells combine with the correct B lymphocytes and trigger them to clone.
- Plasma cells (B cells) generate large quantities of antibodies that combine with the antigen (nicotine).
- Memory cells quickly clone to form plasma cells that trigger a faster response.

2 marks

1 mark for identifying an appropriate cell type
1 mark for correctly describing the cell type's function

d.



2 marks
1 mark for a correct diagram
1 mark for appropriate labelling
Total 6 marks

Question 7

a. Thyroxine passes through the phospholipid bilayer of the target cell's plasma membrane by diffusion. 1 mark
Calcitonin is hydrophilic and cannot pass through a phospholipid bilayer, so it binds to a receptor on the extracellular surface of the plasma membrane. The calcitonin–receptor complex exerts its effect by activating an intracellular 'second messenger' that causes the cellular response. 1 mark

b. Thyroxine may enter the nucleus and bind to a nuclear protein receptor. The resulting thyroxine-receptor complex would bind to DNA and initiate transcription of genes that code for certain enzymes. 1 mark
These enzymes increase the metabolic rate of the target cell. 1 mark

c. **i.** A protein or other molecule on the surface of a pathogen or foreign body that initiates or stimulates the body's immune response. 1 mark

ii. an autoimmune disease 1 mark

d. Cortisone causes vasoconstriction, which reduces the supply of blood to the joint. This therefore reduces the amount of swelling. (Swelling is an accumulation of tissue fluid.) 1 mark

Histamines increase the permeability of capillaries and the ease with which tissue fluid can 'leak out' to cause swelling. The antihistamine effect of cortisone counters this. 1 mark

Total 8 marks

Question 8

a. These ensure that the array is being viewed the right way up 1 mark
and that the antibodies in the wells are operating correctly. 1 mark

b. Yes. Both the serum from the cancer patient and that from the elderly woman contain levels of tumour necrosis factor α and interleukins 1β, 6, and 8 that are much higher than those in normal serum. These are recognised markers for bowel cancer. 1 mark

c. Cytokines are secreted by lymphocytes in response to infection by non-self antigens, and interferons are produced by virus-infected cells. 1 mark
The body is under constant attack from microbial pathogens (even when we are not sick), so an immune response is continuously operating. Therefore, cytokines and interferons are always present in our serum. 1 mark

d. **i.** Tumour necrosis factors cause (apoptotic) cell death. They are produced in large amounts during cancer to reduce the size of tumours by causing tumour cells to die. High levels of TNFs will therefore be expected in cancer patients. 1 mark

ii. Granulocyte macrophage-colony stimulating factor (GM-CSF) causes macrophages to proliferate so that they can engulf and digest cells with non-self antigens such as some tumour cells. High levels of GM-CSF will therefore be expected in cancer patients. 1 mark

Total 7 marks