Neap

Trial Examination 2022

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 D

D is correct. The three components of DNA nucleotides are a deoxyribose carbohydrate, phosphate and a nitrogenous base.

A is incorrect. Ribose and uracil are components of RNA.

B is incorrect. Phosphate, not phosphorous, is a component of a DNA nucleotide.

C is incorrect. Ribose is a component of RNA and phosphate, not phosphorous, is a component of a DNA nucleotide.

Question 2 A

A is correct. There are 64 possible codons and only 20 amino acids specified by the codons. Some codons will code for the same amino acid. The term used to describe this is redundancy (or degeneracy).

B is incorrect. The same codon does not code for different amino acids.

C and **D** are incorrect. While these statements are true, they are not relevant to redundancy in the DNA code.

Question 3 D

D is correct. When proteins are heated, they are susceptible to denaturation. As the catalyst is found in a human cell, the covalent bonds could break when exposed to temperatures above 40°C. This would alter the shape of the catalyst.

A is incorrect. There can be more than one nucleotide sequence that codes for the same polypeptide due to redundancy.

B is incorrect. The protein is functioning at a tertiary level, as only one polypeptide chain is visible. The quaternary level of arrangement would involve more than one polypeptide chain.

C is incorrect. For this statement to be correct, the β-helices would have to be α-helices and the α-sheets would have to be β-sheets.

Question 4 A

A is correct and **B** is incorrect. In a multicellular organism, the genome in each cell is the same due to mitosis. However, the proteome is different between cells because a different combination of proteins are required in each cell, depending on its specialty.

C is incorrect. Proteomes are found throughout the cell; however, the nucleus encloses the genome.

D is incorrect. While they are integrally involved in metabolism, the proteome does not provide a blueprint for other molecules.

Question 5 B

B is correct. The synthesis of a protein such as insulin begins with a ribosome (3), which is then transported through the endoplasmic reticulum (4). It then concentrates at the Golgi apparatus (2) for modification, packaging and, after being packaged into a vesicle (1), exocytosis.

A is incorrect. The first structure listed in this option is a vesicle (1), which is the last structure involved in the synthesis of insulin.

C is incorrect. The first structure listed in this option is a mitochondrion (7), which is only indirectly involved in the synthesis of insulin.

D is incorrect. The first structure listed in this option is the nucleus (5), which is only indirectly involved in the synthesis of insulin.

Question 6 D

The Cas9 enzyme (3) and a section of guide RNA with two parts, the scaffold (5) and the spacer (4), are introduced into a cell. Once in the cell, the complex binds to the DNA strand (1), which occurs by the spacer RNA attaching to a target section of the DNA. This enables the DNA to be cut in a precise location (2), while the scaffold keeps the RNA and Cas9 complex in one place.

Question 7 B

B is correct. Once the CRISPR-Cas9 complex forms a cut in the DNA, a few outcomes can occur. If the cut is within a gene, it may 'knock out' that gene. Alternatively, the cut may provide an opportunity for the introduction of a new gene.

A is incorrect. New genes will be added to the DNA from the cell, not the guide RNA.

C is incorrect. Joining the DNA fragments back together would be counter-productive.

D is incorrect. Once the gene is inserted or knocked out, the role of the CRISPR-Cas9 complex is complete and does not need to be removed from the cell.

Question 8 C

There are two DNA fragments present. The plasmid is cut once; as it is circular in shape, this will form one linear strand. The small linear section of DNA is cut twice, which will form three linear strands. This makes a total of four strands, or fragments, of DNA in the mixture.

Question 9 B

B is correct. Primers are single-stranded and complementary to a binding site in the target genome. The primers bind both upstream and downstream of the target section to be amplified. If the sequence was shorter, the chance of the same complementary sequence being located in the genome would increase, so primers that are 20 nucleotides long are used.

A is incorrect. The *Taq* polymerase only needs to bind to a blunt-ended section of DNA (on the 5-end of the primer).

C is incorrect. Nucleotides will not be produced in the extension stage; they will be used.

D is incorrect. When the process is complete, the amplified samples will be used for further study, not purified and recycled.

Question 10 D

The number of strands doubles after each complete polymerase chain reaction (PCR) cycle. If five strands are used initially, there will be 10 strands after a single cycle. After two cycles, there will be 20 strands. After three cycles, there will be 40 strands. After four cycles, there will be 80 strands.

Question 11 A

A is correct. Several steps are required to produce transgenic bacteria with a recombinant plasmid. Initially, a plasmid and the section of DNA to be inserted are restricted with the same restriction enzyme (step 1). They are mixed together with ligase (step 2) and then exposed to the bacteria to be transformed (step 3).

B is incorrect. Restriction enzymes are added during step 1.

C is incorrect. Shock treatment is needed to introduce the plasmid into the bacteria in step 3.

D is incorrect. Using high temperatures may denature proteins and kill the bacteria.

Question 12 A

A is correct. Type 1 diabetics have been treated with genetically produced insulin for many years as a result of this technology.

B is incorrect. Pigs are not bacteria; modifying a pig's genes would require other techniques.

C is incorrect. This is a potential environmental problem, not a positive advancement.

D is incorrect. The ova would be transformed using different technology and this may not be seen as a positive advancement.

Question 13 D

D is correct. The dependent variable in an experiment is the factor that is measured to determine the effect of changing the independent variable. In this case, the factor that is measured is the time taken for the spinach discs to float.

A and **B** are incorrect. These variables have been changed during the experiment.

C is incorrect. The volume of water in the test tubes is a controlled variable.

Question 14 B

B is correct. According to the scientific method, experimental results should only be directly compared to each other if they differ by one factor. In this instance, light intensity and temperature have both been varied. The first three results are all conducted at low light intensity, so the only variable changed is temperature.

A, **C** and **D** are incorrect. These options each show a combination of trials in which there is more than one variable being compared.

Question 15 C

C is correct. The results show that, as light intensity increases, the rate of photosynthesis increases (trials 2 and 5). It also shows that, at low and high temperatures, the rate of photosynthesis decreases (trials 1, 2, 3, 4 and 5). Based on biochemistry, a high light intensity as well as a normal temperature would produce the fastest result. More light is available to drive the light-dependent reaction and the normal temperature allows for the maximum amount of collisions between enzymes and substrates, leading to maximum oxygen. Hence, these conditions cause the spinach disc to rise the fastest.

A is incorrect. Low temperature reduces the rate of collisions between enzymes and substrates; it does not denature the enzymes.

B is incorrect. Low light intensity still forms some oxygen, causing the spinach discs to rise. Low temperature has not been compared at different light intensities.

D is incorrect. With no light, there would be no light-dependent reaction to form the oxygen needed to make the spinach discs rise.

Question 16 D

D is correct. Enzymes can function at the tertiary level, which involves a single polypeptide. They can also function at a quaternary level, which involves more than one polypeptide. Enzymes have a three-dimensional shape (quaternary) as well as a specifically shaped active site (tertiary).

A is incorrect. Each enzyme has a complementary shape to a specific substrate (or substrates).

B is incorrect. The enzyme does not need to be replaced, as enzymes are reusable.

C is incorrect. At high temperatures, the three-dimensional shape of enzymes changes (or denatures), making the enzyme non-functional.

Question 17 C

C is correct. A competitive inhibitor has a complementary shape with the active site of the enzyme. The competitive inhibitor binds to the active site, 'competing' with the substrate for the site. This slows the reaction rate. The experiment tests how an increase in the concentration of the substrate will change the effect of the inhibitor. As the substrate concentration increases, the proportion of substrate to inhibitor also increases, making an interaction between enzyme and inhibitor less likely. At high substrate concentrations, the effect of the inhibitor is minimal.

A is incorrect. The high substrate concentration will negate the effect of the inhibitor, not increase it.

B is incorrect. The rate (dependent variable) should not be on the vertical axis.

D is incorrect. This graph represents how non-competitive inhibitors work at high substrate concentrations.

Question 18 D

D is correct. Coenzymes are organic molecules required for some enzyme-driven biochemical reactions. In the light-independent reaction, ATP (produced in the light-dependent reaction) is the coenzyme and ADP is a product. In the same reaction, NADPH provides hydrogen (produced in the light-dependent reaction) to produce NADP.

A, **B** and **C** are incorrect. ADP is produced, not used, and NADH is the coenzyme involved in respiration.

Question 19 B

B is correct. CAM plants are usually desert plants. These plants use carbon dioxide at night because their stomata are not open in daylight hours to minimise water loss. They combine the carbon from carbon dioxide with a three-carbon compound to form a four-carbon compound, which can be used during the day without the stomata being open.

A is incorrect. C3 plants carry out photosynthesis in daylight hours.

C is incorrect. C4 plants separate the fixation of carbon dioxide from carbon fixation.

D is incorrect. Rubisco is involved in all types of photosynthesis.

Question 20 B

The product of glycolysis (pyruvic acid) is fed into the Krebs Cycle in the mitochondria. Each pyruvic acid molecule is converted into acetyl-CoA before it is integrated into the cycle. Each turn of the cycle produces one ATP. As two pyruvic acid molecules are formed per glucose molecule, a total of two ATP are formed.

Question 21 C

C is correct. The mitochondria are the site for aerobic respiration, where the Krebs Cycle and electron transport chain occur. If isolated mitochondria are exposed to pyruvate as well as oxygen, they will be able to undertake these processes.

A is incorrect. Glucose needs to be converted into pyruvate by glycolysis.

B and **D** are incorrect. Oxygen is required, not carbon dioxide or glucose.

Question 22 C

C is correct. The electron transport chain is the final stage of aerobic respiration and occurs along the cristae, which are projections of the inner mitochondrial membrane that provide a large surface area for the reactions to occur.

A is incorrect. Glycolysis occurs in the cytosol, not the stroma of the chloroplast.

B is incorrect. Carbon fixation occurs in the stroma of the chloroplast, not the matrix of the mitochondria.

D is incorrect. The light-dependent reaction occurs in the grana of the chloroplast, not the cytosol.

Question 23 A

A is correct. Inputs of glucose (NAD and ADP) and outputs of pyruvate (ATP and NADP) are all related to the glycolysis biochemical pathway, which occurs in the cytosol of eukaryotic cells.

B is incorrect. The mitochondria are the site of aerobic respiration.

C is incorrect. There are five enzymes required, as shown in the flow chart.

D is incorrect. Two ATP is not a large amount of energy when compared to other parts of respiration.

Question 24 B

B is correct. If the pyruvic acid accumulates, it will reduce the pH of the cell and possibly move the cell outside the optimal conditions required for other enzymes.

A is incorrect. The pH will get lower, not higher.

C is incorrect. If it is uncontrolled, the pyruvic acid will continue to increase.

D is incorrect. The pyruvic acid would cause a problem regardless of slight temperature increases.

Question 25 B

B is correct. Being able to grow potatoes in more saline conditions could increase the availability of potatoes, as it would provide a wider area in which this staple crop could grow.

A is incorrect. C4 plants use carbon dioxide more efficiently than C3 plants.

C is incorrect. The data does not indicate gene interactions, only the number of genes altered.

D is incorrect. The data does not indicate the complexity of technology required.

SECTION B

Question 1 (8 marks)

a. **Step 1:** transcription — 1 mark

Molecule B: pre-mRNA — 1 mark

Structure E: ribosome — 1 mark

b. *For example, any two of:*

- Molecule F is mRNA and is shorter than molecule B because the introns have been removed, leaving the exons to be translated.
- Molecule F has the ends stabilised with a (methylated) cap and a (poly A) tail so they can attach and detach to the ribosome in the cytosol.
- Molecule B has not undergone RNA processing, whereas molecule F has undergone RNA processing.

2 marks

c. Step 3 is translation. — 1 mark

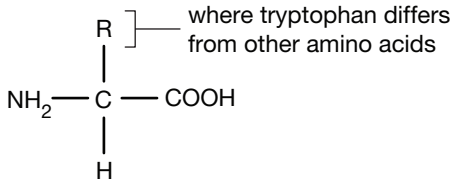
During this process, anticodons (molecule G) bind to the codons along the mRNA, which releases the attached amino acid. — 1 mark

The amino acid is added to the growing polypeptide chain (molecule D) via a condensation reaction. — 1 mark

Question 2 (8 marks)

a. Energy is conserved if genes are only expressed when required. — 1 mark

b.



2 marks

1 mark for a correct structural diagram.
1 mark for indicating where tryptophan differs.

c. **i.** **Component V:** promotor — 1 mark

Component X: structural genes — 1 mark

ii. At high tryptophan levels, the tryptophan binds to a repressor protein and changes its shape. — 1 mark

The repressor (with the *trp* bound) binds to the operator section of the *trp* operon. — 1 mark

The RNA polymerase binds to the promotor but is blocked from moving to the structural genes by the repressor, so the structural genes are not expressed. — 1 mark

Question 3 (6 marks)

a. Step 1: Denaturation occurs between 90–95°C, breaking the hydrogen bonds along the double helix. 1 mark

Step 2: Annealing occurs between 50–60°C, enabling the primers to bind to target sections on the DNA. 1 mark

Step 3: Extension occurs at 72°C, allowing the *taq* polymerase to bind to the primers and synthesise more DNA on both strands. 1 mark

b. 'Gel' refers to the material used for the process. DNA samples are added to wells that have been formed in a solid, porous gel through which the DNA can move. 1 mark

'Electrophoresis' refers to the electric current applied to the gel in a buffer solution, which pushes the DNA through the gel due to its negative charge. 1 mark

c. One band from the child (lane 4) will be common with the mother (lane 3) and the other band will come from the father. Lane 2 has a common band with the child and is, therefore, the father. 1 mark

Question 4 (8 marks)

a. **i.** protein 1 mark

ii. ribosome 1 mark

iii. quaternary 1 mark

b. Rubisco has an active site that is complementary to the substrates carbon dioxide, ribulose-1,5-biphosphate and the cofactor magnesium. 1 mark

At an optimal temperature and pH, the substrates will collide with the enzyme with sufficient force and orientation. 1 mark

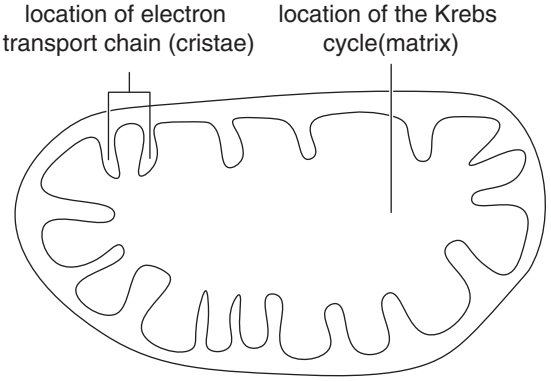
A conformational change occurs where the substrates' molecular structures are rearranged into products like 3PGA. 1 mark

c. 3PGA needs to be energised to form glucose, so ATP from the light-dependent reaction is used. 1 mark

3PGA needs hydrogen to form glucose, so NADPH from the light-dependent reaction is used. 1 mark

Question 5 (7 marks)

a.



2 marks

1 mark for a correct labelled diagram showing the matrix and cristae.
1 mark for indicating where the two stages occur.

b. Acetyl coenzyme A (acetyl-CoA) is the (two-carbon) molecule that is formed in the link reaction and becomes a substrate for the Krebs Cycle. 1 mark

c. Carnitine will accumulate. 1 mark

Acetyl-CoA will not be formed (or formation will be reduced). 1 mark

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

- Low body fat may result in poor heat regulation.
- Low energy may occur, as only glucose is available.
- Poor hormonal control may occur, as steroid hormones are fat-based.

1 mark

Note: The symptom must relate to a low-fat diet.

ii. *For example, any one of:*

- Wear warmer clothes.
- Include more glucose in their diet.
- Take steroid medication.

1 mark

Note: The response must relate to the symptom outlined in ***Question 5d.i.***

Question 6 (8 marks)

a. **i.** Air contains carbon dioxide, a substrate for the light-independent reaction of photosynthesis. Carbon dioxide is required to form glucose. 1 mark

This occurs within the stroma. 1 mark

ii. Water is split by light energy in the light-dependent reaction of photosynthesis, resulting in the production of NADPH and ATP. 1 mark

This occurs in the grana. 1 mark

b. *For example, any two of:*

- more efficient use of light due to more leaves
- more efficient use of light due to more chloroplasts per cell
- more efficient use of light due to more chlorophyll per chloroplast
- leaves with greater surface area

2 marks

c. A plant requires glucose to grow, which is produced via photosynthesis. If neglected, water or light availability may be lower than optimal, which will lower the rate of photosynthesis. 1 mark

If the rate of photosynthesis and respiration is equal, the plant will be able to survive without growing. 1 mark

Question 7 (5 marks)

a. Cellulose is a polymer of glucose. Hydrolysis of the cellulose involves breaking the bonds holding the glucose molecules together and using water in the process. 1 mark

Enzymes are used to speed up the process of hydrolysis. The active site in the hydrolytic enzyme will be complementary to the locations of the cellulose's chemical bonds. 1 mark

Heat is used because an increase in heat will increase the kinetic energy within the environment where hydrolysis occurs. This leads to more collisions between the enzyme and substrate, speeding up the production of glucose. 1 mark

b. The fermentation of glucose requires an absence of oxygen and the presence of required enzymes, such as those provided by microorganisms like yeast. 1 mark

Any two of the following inputs:

- glucose
- ADP
- inorganic phosphate
- NAD

Any two of the following outputs:

- ethanol
- carbon dioxide
- ATP
- NADH

1 mark

