2024 VCE Biology (NHT) external assessment report

Specific information

This report provides sample answers, or an indication of what answers may have included. Unless otherwise stated, these are not intended to be exemplary or complete responses.

Section A

Question	Correct answer
1	A
2	C
3	D
4	B
5	D
6	A
7	D
8	D
9	B
10	C
11	A
12	D
13	A
14	D
15	B
16	C
17	A
18	A
19	B
20	C

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Question	Correct answer
21	D
22	B
23	C
24	A
25	D
26	A
27	B
28	D
29	D
30	B
31	C
32	D
33	C
34	B
35	B
36	A
37	D
38	C
39	A
40	C

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Section B

Question 1a.

The code is considered universal because the same codons/triplets code for the same amino acids in all living things. The code is considered degenerate because more than one codon/triplet may code for the same amino acid.

Question 1b.

Any two of:

- mRNA, which contains the code for the synthesis of the protein
- tRNA, which transfers amino acids to the ribosome
- rRNA, which helps in peptide bond formation / helps in mRNA-tRNA interactions / forms the structure of a ribosome.

Question 1c.

Organelle A is the Golgi apparatus / Golgi body. Its function is to modify and package the protein into a vesicle for transport to various locations within the cell, including to the cell membrane for secretion.

Question 2a.

CRISPR-Cas9 edited wheat seeds do not have a gene from another species inserted into the genome.

This reduces unknown harmful effects on people OR reduces risk of disease OR improves public perception / increases consumption.

Question 2bi.

Arrow 2

Question 2bii.

sgRNA is a complementary sequence to the target DNA and guides Cas9 endonuclease to where to cut the DNA.

Question 2ci.

The control wheat seeds have higher phytic acid content (1.6 micrograms/gram) compared to the genome-edited wheat seeds (1.2 micrograms/gram).

The control wheat seeds have lower iron content (50 micrograms/gram) compared to the genome-edited wheat seeds (70 micrograms/gram).

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Question 2cii.

Not all wheat seeds treated with the CRISPR-Cas9 complex had their *IPK1* genes knocked out OR phytic acid may be synthesised by other genes / biochemical pathways.

Question 3a.

In the presence of the drug, pyruvate does not enter the mitochondria and the cell consumes more glucose to be able to meet its energy needs.

Lactate production increases because the cell cannot break down pyruvate in the mitochondria and relies on fermentation for its energy production.

Question 3b.

The NADH and $FADH_2$ formed in the Krebs cycle pass their electrons onto the electron transport chain found on the inner mitochondrial membrane or cristae.

Question 3c.

Any three of:

- In different test tubes, add varying concentrations of glucose.
- In each test tube, add the same concentration/volume of 2-DG OR same mass of liver / concentration of enzyme OR run at same experimental temperature/pH.
- Repeat measurements for each test tube condition multiple times.
- In one test tube, add no glucose.

AND

If 2-DG is a competitive inhibitor, increasing the glucose concentration results in higher amounts of glucose-6-phosphate being formed. At very high concentrations of glucose, the amount of glucose-6-phosphate formed would be similar to that of the uninhibited enzyme. This is because competitive inhibition can be overcome by adding more substrate to the enzyme.

AND

If 2-DG is a non-competitive inhibitor, increasing the glucose concentration beyond a certain concentration will not result in any further formation of glucose-6-phosphate. This is because non-competitive inhibition cannot be overcome by adding more substrate to the enzyme, as it does not compete with the substrate for the active site.

The dependent variable (the measured formation of glucose-6-phosphate) was provided in the question stem, so this was not given a mark in the student's outlined experiment.

Question 4a.

This is because chlorophyll does not absorb green light, allowing for less production of ATP and NADPH in the light-dependent reaction / less glucose formation / less photosynthesis / less energy for growth.

Question 4b.

This gene might code for an accessory pigment OR code for a protein that enables more light to be absorbed.

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This will increase the plant leaf cells' ability to absorb those wavelengths of sunlight that chlorophyll does not absorb, especially in the green light part of the visible light spectrum.

Students should note that inserting genes to increase the action of the Calvin cycle will not increase glucose formation unless the plant is able to increase the output of the light-dependent reaction.

Question 4c.

C3 plants would not have grown well.

C3 plants are affected by photorespiration as oxygen competes with carbon dioxide to bind to Rubisco and, as a result, the light independent stage / photosynthesis / formation of glucose is less.

Question 5a.

- Complement proteins form membrane attack complexes (MACs) on B cells' plasma membranes and cause the lysis of B cells.
- Opsonisation occurs when complement proteins coat the B cells and induce phagocytosis of the B cells.
- Complement proteins can also recruit other inflammatory cells that destroy the B cells.

Question 5b.

If the B cells are destroyed, then fewer autoantibodies are produced. Fewer nerve cells are damaged, which leads to a reduction in the symptoms of MS.

Question 5c.

Both cells have the same antigen (CD52) and as alemtuzumab has variable regions / antigen-binding sites complementary to CD52, it can bind to either cell type.

Question 6a.

- The benefit of treatment 1 is that it results in the production of memory cells, which provide long-term immunity.
- The benefit of treatment 2 is that it gives immediate protection as the antibodies can bind to the pathogen and the person is likely to have less rabies symptoms.

Question 6b.

Memory cells and antibodies decline in number over time. A booster will trigger an immune response, leading to the production of more antibodies and more memory cells. The person can then mount a faster and larger immune response if infected again, so is less likely to have rabies symptoms.

Question 7a.

Examples of approaches to help reduce or control the spread of the chikungunya virus include:

- isolating infected people
- providing information to the public about control and avoidance of infection
- removing mosquito breeding grounds
- vaccinating people in the community, which may lead to herd immunity.

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Question 7b.

- An endemic disease is always present in a population, but the number of people affected is limited / under control.
- An epidemic disease may be in a population for a short time and more people are affected within this short time.

Question 7c.

An animal (typically a mouse) is injected with an antigen in order to produce antigen-specific plasma cells. The plasma cells are removed from the mouse and fused (hybridised) with tumour cells that are capable of endless divisions (i.e. an immortal cell line). The resulting hybridoma cell is capable of synthesising large quantities of monoclonal antibodies that can then be isolated for use.

Question 8a.

Both involve changes in the nucleic acid / antigen / protein of the virus.

- In antigenic shift, viruses swap whole sections of their genomes, leading to widespread changes in surface proteins, whereas in antigenic drift there may be a small change in one protein due to a point mutation.
- Antigenic shift can produce entirely new virus strains whereas antigenic drift will result in a closely related strain.
- Antigenic shift may result in the infection of a new species whereas antigenic drift will more likely result in infection in the same species.

Question 8b.

The original vaccine or exposure to influenza will have enabled a person to produce antibodies / memory cells against the antigens (proteins) on the surface of the virus. When the antigen shape changes, the person's antibodies may not be complementary / able to bind at all to the new virus antigen. This results in the loss of immunity to the virus.

Question 9a.

A. anamensis evolved to become *A. afarensis.*

Question 9b.

There are limited fossils finds / the fossil record is incomplete, so some species may be missing from the record. Some samples may only be a small part of the organism (e.g. finger bone), making it difficult to compare species. Closely related *Homo* species may not show any great differences in physical structure so it is harder to determine their relatedness.

Question 9c.

Trends observable in the diagram include:

- increase in cranial size
- reduction in size of brow ridges
- reduction in jaw size
- face becomes flatter
- longer leg-to-arm ratio.

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Question 10a.

Modern genomes of people from the islands of South-East Asia have 3% to 5% of their DNA traced to Denisovan ancestors. The amount of DNA found in different populations can be used to ascertain when groups interbred or split from common ancestors.

Question 10b.

D1 separated from D0 around 283 000 years ago, and experienced different selection pressures, which led to significant changes from the original population. D2 and D0 split around 363 000 years ago, and could accumulate only small changes in their genomes over time if the selection pressures were similar.

Question 10c.

There is no evidence of Denisovans in Australia. But Aboriginal people have been in Australia for 65 000 years and their genomes contain Denisovan DNA, so they must have interbred earlier than 30 000 years ago.

Question 10d.

The fossil record is incomplete. Different fossils may be found in new areas. It is possible that Denisovan DNA in Australian Indigenous populations may be explained by other factors, such as interbreeding within Australia.

Question 11a.

Thirty cycles of PCR are required to sufficiently amplify the DNA fragments so that the DNA can be identified as a band using gel electrophoresis.

Question 11b.

DNA

Question 11ci.

Variables to be controlled include:

- same concentration of agarose gel
- same person loading the DNA into the gel
- same volume of DNA loaded into the same gel
- DNA run in gel for the same amount of time
- same dye used.

Question 11cii.

Tumour	Tumour identification
T1	D2
T2	D1
T3	D1

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Question 11ciii.

Validity is ensuring the data is consistent with what is being measured. The tumour DNA is compared with known tumour DNA samples.

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