2023 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 | B |
| 2 | D |
| 3 | A |
| 4 | C |
| 5 | B |
| 6 | D |
| 7 | D |
| 8 | C |
| 9 | A |
| 10 | A |
| 11 | B |
| 12 | D |
| 13 | A |
| 14 | A |
| 15 | D |
| 16 | C |
| 17 | B |
| 18 | D |
| 19 | B |
| 20 | B |
| 21 | B |
| 22 | D |
| 23 | A |
| 24 | B |
| 25 | A |
| 26 | C |
| 27 | B |
| 28 | C |
| 29 | D |
| 30 | A |
| 31 | A |
| 32 | C |
| 33 | D |
| 34 | C |
| 35 | D |
| 36 | B |
| 37 | D |
| 38 | B |
| 39 | A |
| 40 | C |

Section B

Question 1a.

DNA is found in the nucleus or mitochondria. RNA is found in the nucleus, cytosol, ribosome or mitochondria.

Question 1b.

|  |  |  |
| --- | --- | --- |
| Nucleic Acid | DNA | RNA |
| Number of nucleotide strands | 2 | 1 |
| Type of pentose sugar present | Deoxyribose | Ribose |
| Names of bases present | Adenine, Cytosine, Guanine, Thymine | Adenine, Cytosine, Guanine, Uracil |

Question 1ci.

Molecule X is DNA.

Molecule Y is pre-mRNA.

Molecule Z is mRNA.

Question 1cii.

Component P (is an intron and) does not code for protein or is not translated, whereas component Q (is an exon and) codes for protein or is translated.

Question 2a.

The role of the Golgi apparatus is to modify or package the enzymes (polypeptides/proteins) into vesicles.

Question 2b**.**

In addition to its primary structure, RNA polymerase is composed of:

* Secondary: alpha helices or beta-pleated sheets, which are regions of the polypeptide chain
* Tertiary: single structural 3D folded polypeptide chain
* Quaternary: more than one polypeptide chain.

Question 3a

The CRISPR array provides prokaryotes with a memory of prior viral infections.

The origin of the spacers is the viral DNA from these prior viral infections or bacterial plasmids.

If a prokaryote is reinfected with the same virus, then guide RNA (gRNA) is produced and attaches to complementary viral DNA sequences or gRNA directs cas9 endonuclease to cut viral DNA preventing it from infecting the prokaryote.

Question 3bi.

An sgRNA sequence complementary to DNA, such as GAU UGU CAA CGA AAA UAG UG

Students were not penalised if this was not complementary to the opposite strand to the PAM site.

Question 3bii.

The PAM sequence acts as the binding site for the cas9 endonuclease and can act as the target for designing sgRNA upstream of this sequence or allowing cas9 to cut the DNA sequence.

Question 3c.

Examples of ethical concepts and their justification for continuing treatment in new patients include:

* beneficence as the benefits of the (genetically modified stem cell) treatment outweigh the adverse effects
* integrity when all results are reported, so patients have the choice of receiving the (genetically modified stem cell) treatment, or not
* respect when patients are informed of possibilities of any adverse effects of receiving the (genetically modified stem cell) treatment
* non-maleficence, as long as they remove adverse effects associated with receiving the (genetically modified stem cell) treatment.

Question 4a.

A non-competitive inhibitor binds to a site on the enzyme away from the active site causing a change to the active site. This results in the substrate no longer binding to the enzyme, or the rate of product formation is lower, or the enzyme cannot catalyse the reaction as efficiently.

Question 4bi.

Glucose consumption at 35 ºC is 4 mmoles/24 hours.

Lactate production at 35 °C is 6 mmoles/24 hours.

Question 4bii.

Students were required to recognise that glucose is consumed in both the presence and absence of oxygen and were then required to account for the results both in terms of presence and absence of oxygen.

When there is no oxygen, glucose/pyruvate is converted into only lactate. Double the amount of lactate is produced for every one glucose consumed through glycolysis and fermentation or more glucose will need to be consumed as less ATP/energy is produced. When oxygen is present, glucose/pyruvate can also be converted into water and carbon dioxide. This leads to a smaller ratio of lactate formed compared to glucose consumed, or a greater amount of ATP/energy is produced through aerobic cellular respiration, to meet its energy requirements.

Question 4c.

At 45 °C, enzymes involved in biochemical processes begin to denature resulting in a decreased rate of reaction compared to when there is optimal glucose consumption and lactate production at 35 °C.

Question 5

The plant is likely either a C3 or C4 plant.

Students may have provided a number of justifications dependent on their selection. For C3 this may include: the quantity of glucose production being higher at 25 °C, or when a higher percentage of carbon dioxide or humidity was present. Higher temperatures increase the affinity of Rubisco for oxygen, leading to an increased rate of photorespiration. For C4 this may include that they are adapted to hot/sunny/tropical environments at temperatures 25 °C or above.

It cannot be a CAM plant as these are adapted to hot/dry/desert conditions with greater glucose production at 40 °C temperatures and above OR low humidity, which was not observed from the scientists’ results.

Question 6

The diagram demonstrated an interaction between a Dendritic cell (Cell B) and a Helper T cell (Cell A) where antigen presentation is shown. Students may have identified the following suitable points in their explanation.

* The Helper T cell activates the B cell through the release of cytokines.
* The B cell then undergoes clonal expansion producing plasma cells and memory B cells.
* Plasma cells produce specific antibodies that bind with antigens on pathogens causing agglutination.
* Memory B and T cells are also produced for long-term immunity.

The Helper T cells may also activate cytotoxic T cells, which then destroy cells displaying the antigen on their MHC-I marker.

Question 7a.

The disease has a persistent presence or is localised to a particular region.

Question 7b.

To control the spread of mpox from Africa to other continents, suitable responses included:

* quarantine or isolation before departure / on arrival for a period of 21 days
* checking individuals for symptoms before departure and not allowing them to leave the country if they display symptoms
* vaccinating individuals
* burning contaminated bedding and materials or wearing gloves to avoid direct skin contact.

Question 7c.

**ACAM2000 could be administered as this is very effective and only requires four weeks to achieve maximum immune response and therefore will achieve herd immunity more quickly.**

**JYNNEOS could also be administered as it leads to fewer side effects even though it requires 10 weeks to achieve maximum immunity. This will allow more members of the population to be inoculated without causing negative press.**

Question 8a.

Monoclonal antibodies bind to PD-L1 antigens on cancer cells stimulating Tc cells or NK cells to target cancer cells. They can also be designed to deliver radioactive compounds to only the cancer cells or to block cancer cells from receiving growth factor signals or spreading.

Question 8b.

The advantage of using antibody-drug conjugate monoclonal antibodies is that, specifically cancer cells and not health cells, are targeted, resulting in fewer side effects or less chemotherapy required.

Question 9a.

Key differences between the information gained from mtDNA compared to whole genome analysis are:

* mtDNA is inherited from mother only, whereas nuclear DNA is inherited from both parents
* mtDNA has fewer bases compared to nuclear DNA
* no recombination in mtDNA compared to nuclear DNA
* mtDNA used for lineage/migration compared to nuclear DNA for parentage/relationship between species
* mtDNA has a faster mutation rate / less conserved compared to nuclear DNA.

Advantages for using mtDNA include:

* faster to sequence
* differences due to mutation only and not due to recombination
* high copy number (number of mitochondria) per cell, so only a small sample is required
* less likely to degrade
* known or constant rate of mutation
* used for determining lineage.

Advantages for using nuclear DNA include:

* more bases and therefore information available
* DNA from both parents can determine if interbreeding occurred
* presence of introns can reveal more inherited mutations.

Question 9b.

Examples of the types of evidence that could be found include:

* cave or rock shelter paintings
* trace fossils
* agricultural tools
* charred animal bones or evidence of a fire pit.

Question 9c.

The *2022–2026 Biology Study Design* requires students to understand the shared characteristics between hominin species and to be able to identify trends in hominin evolution in terms of changes in brain size and limb structure.

Differences between the skeletons of *H. erectus* and *H. sapiens* include, but are not limited to:

* *H. erectus* has smaller cranial capacity
* *H. erectus* has a smaller angle/slant between leg bones.

Similarities between the skeletons of *H. erectus* and *H. sapiens* include, but are not limited to:

* long leg to arm ratio
* bowl-shaped/shallow pelvis
* a central foramen magnum
* angled leg bones
* arched foot or toes in line.

Question 9d.

Reasons for DNA evidence not being found include:

* DNA degrades too quickly to be available from a fossil this old
* DNA evidence from a *H. erectus* fossil is needed to compare sequences to those in present day *H. sapiens*
* low chance that a fossil of an interbred individual will be found.

Reasons for DNA evidence being found include:

* could find H. erectus DNA in H. sapiens
* DNA has been obtained from older hominin fossils
* other hominin sequences have been shown to be present in different hominin species’ genomes, suggesting interbreeding occurred.

Question 10a.

Examples of evidence with appropriate supporting examples from the article include:

* individuals from different populations cannot produce viable/fertile offspring, such as Euhadra snails, which cannot mate successfully (due to genital openings not aligning) or the difference in sexual maturity between *R. pomenella* species occurring at different times
* DNA differences large enough to classify them as different species, such as Alpheus species, which diverged 3-9 mya or the presence of a beneficial allele for one population that is harmful to another in *R. pomenella* during the seasons
* morphological differences large enough to classify them as different species, such as the different direction of spiral in Euhadra species or the different body shape in Gambusia populations leading to a mating preference.

Question 10b.

|  |  |  |
| --- | --- | --- |
| Example | Type of speciation shown by example | Justification/reason(s) for choosing this type of speciation |
| 1. Snapping shrimpAlpheus | Allopatric | Geographical isolation of populations by isthmus |
| 2. Japanese land snail Euhadra | Sympatric | Reproductive isolation through misaligned genital openings  |
| 3.Mosquito fishGambusia | Allopatric | Geographical isolation of land between ponds that once were connected |
| 4.Apple maggot flyRhagoletis | Sympatric | Reproductive isolation where hawthorn and apple fruit trees coexist in same area or the flies’ maturation at different times |

Question 11a.

The two dependent variables are the height of the plant and the grain yield. These are measured by the experimenter as a result of change in the rice variety.

Question 11bi.

A decreased height and the grain yield increasing in modified rice varieties. More glucose would be produced, resulting in an increased photosynthetic efficiency.

Question 11bii.

Other factors that could be measured by the scientists include:

* light absorption or wavelength of light absorbed
* carbon dioxide consumed
* oxygen production
* glucose production
* concentration of starch
* amount of chlorophyll
* water production.

Question 11c.

The independent variable is the different concentration of carbon dioxide applied to each plant.

The dependent variable is the average grain yield measured.

The controlled variables include the same wavelength of light / temperature / humidity / pH of soil / number of seeds for each plant / the volume of water applied to plants.

The control group would consist of a plant exposed to normal atmospheric carbon dioxide concentration.

A large sample size for each carbon dioxide concentration is tested.