2025 VCE Biology (NHT) external assessment report

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

Section A – Multiple-choice questions

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

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

Section B

Question 1a

When *E. coli* are in an environment with low levels of *trp*, the repressor protein is inactive OR not bound to the operator.

When *E. coli* are in an environment with high levels of *trp*, two *trp* amino acids bind to the repressor protein, changing its shape so it then binds to the operator, blocking RNA polymerase from binding to the promoter to initiate transcription.

Students were required to refer to the activity of the repressor protein in environments with low and high levels of *trp*.

Question 1b

The function of mRNA in the production of proteins includes:

- coding for proteins/enzymes involved in the synthesis of *trp*
- carrying a copy of the genetic code to the ribosome for translation OR to be read by tRNA after binding to the ribosome.

The function of *trp* in the production of proteins includes:

- being an amino acid/monomer for proteins
- contributing to the growing polypeptide chain OR overall 3D functional shape of proteins.

Students were required to describe at least one function for both mRNA and *trp* in the production of proteins.

Question 2a

Similarities between the biochemical pathways of fermentation in human and yeast cells include:

- no oxygen is used
- both produce ATP/energy
- glycolysis occurs OR glucose is converted to pyruvate OR pyruvate is produced
- the same enzymes are used in glycolysis.

Differences between the biochemical pathways of fermentation in human and yeast cells include:

- different products are produced – lactic acid in humans compared to ethanol and carbon dioxide in yeast
- different enzymes are involved in the conversion of pyruvate to final products.

As this was a ‘compare’ question, students could provide similarities and differences or a combination of both.

Question 2b

The general role of coenzymes in biochemical pathways includes:

- assisting enzymes in catalysing reactions OR lowering activation energy
- cycling between loaded and unloaded forms
- carrying energy (e.g. ATP)
- carrying protons/hydrogen (ions) and/or electrons (e.g. NADH, $FADH_2$, NADPH).

Students should be careful not to confuse the role of coenzymes with that of enzymes. Coenzymes do not catalyse reactions; instead, they assist enzymes in their role as protein catalysts.

Question 3a

The RGA2 gene is incorporated into a bacterial plasmid through:

- cutting the plasmid with a specific endonuclease
- cutting the RGA2 gene using the same endonuclease used to produce the sticky ends for the plasmid
- DNA ligase joining the phosphodiester bonds between the RGA2 gene and the plasmid.

Students could also mention that the RGA2 gene is isolated using a specific endonuclease or that the overhanging bases / sticky ends form hydrogen bonds between complementary base pairs.

Students should note that DNA ligase joins the phosphodiester bonds between the gene and plasmid, not hydrogen bonds, which exist between complementary base pairs of the two DNA strands.

Question 3b.i

The TR4-resistant Cavendish bananas are genetically modified, as the RGA2 gene came from the same species / *M. acuminata*.

A transgenic organism has had genes from a different species inserted.

Question 3b.ii

Reasons why there are no plans for Australian farmers to grow TR4-resistant Cavendish bananas on a large scale or sell them to consumers include:

- Cavendish bananas not being in short supply OR still growing in Australia, as only nine farms were infected with the TR4 disease *(economic implication)*
- TR4-resistant plants needing to be labelled as genetically modified (GM) *(legal implication)*
- the cost or time required to upscale research and grow new banana varieties OR the cost to consumers *(economic/political implication)*
- the education required for farmers/consumers OR the marketing campaigns required for consumers *(social implication)*
- consumers being deterred by GM labels OR not guaranteed to purchase GM products *(social implication)*.

Other appropriate reasons were also accepted.

For this type of question, students are encouraged to apply their knowledge and skills of ethical understanding (see page 12 of the Study Design). Specifically, students should be able to apply the VCE Biology Units 1–4 key science skill regarding '… the influence of social, economic, legal and political factors relevant to the selected issue'.

Question 4a

A case study is an appropriate methodology for the World Health Organization (WHO) to monitor both animal and human cases of swine flu around the world because:

- it contains a real-world situation / real-world data, which informs health bodies/scientists
- analysis of the causes and consequences of current and/or past outbreaks can lead to plausible/timely recommendations to help manage future outbreaks.

Students could also support their answer to this question by assessing why another methodology may not be appropriate, including by explaining that:

- fieldwork would require the WHO/scientists to have contact with the virus, which would potentially be unsafe
- a controlled experiment may be difficult, as there are many unknown variables OR it may be perceived as unethical to infect / test on patients
- a correlational study is not required, as the WHO already understands the relationships or associations between animal and human cases of swine flu.

This question proved challenging for students. Therefore, they are encouraged to review the various forms of scientific investigation methodologies outlined in the Study Design on pages 9–10.

Question 4b

The function of the MHC Class I marker on cells infected with the swine flu virus is that it allows:

- the immune system to distinguish the cells' self-antigens from non-self antigens
- infected cells to display swine flu antigens to activate natural killer OR cytotoxic T cells.

Question 4c

The role of dendritic cell A, which has a high amount of MHC Class II markers and low production of interferons, would be to engulf the pathogen OR present the foreign antigen fragments to helper T cells, allowing the pathogen to be removed from the body.

The role of dendritic cell B, which has a low amount of MHC Class II markers and high production of interferons, would be to alert uninfected cells of potential infection to produce defences to the pathogen before they are infected OR attract other immune cells to the infected area to slow the spread/replication of the pathogen, allowing a faster recovery.

Question 5a

The roles played by helper T cells in the adaptive immune response include:

- activation when presented with antigens of *C. burnetiid* by an antigen-presenting cell
- release of cytokines
- formation of memory T helper cells
- activation of cytotoxic T cells
- activation of B cells.

Students should note that helper T cells do not collect or present the antigen fragments themselves.

Question 5b

Polymerase chain reaction (PCR) is used to amplify the pathogen DNA to identify or analyse it further through gel electrophoresis.

Students may have also answered this question by referring to the use of primers to anneal to bacterial DNA OR the use of *Taq* DNA polymerase to synthesise new bacterial DNA OR heating up DNA to separate DNA strands so specific regions can be amplified.

Question 5c

Examples of reasons why 90% of Q fever cases are not identified include:

- people not being tested
- testing early in the onset of disease OR months after the onset of disease when antibody levels are not high enough to display in the test
- a low proportion of the population being infected
- a long incubation period, meaning people are not aware they are infected
- the expense associated with collecting and analysing blood samples from individuals.

Question 5d

Examples of a strategy that could be implemented by the Australian Government to control the spread of Q fever include:

- isolation OR quarantine of infected individuals
- use of existing vaccination
- mandatory reporting of cases
- education or disinfection protocols for individuals working with animals
- prevention of movement of animals OR screening of animals OR culling of infected animals.

Question 5e

Reasons why the National Immunisation Program (NIP) does not provide free vaccination against Q fever, but does for many other infectious diseases, include:

- person-to-person spread is unlikely
- a specific population is at risk of infection (those working with animals), so herd immunity is not required OR vaccination is only effective for those working with animals
- the cost to vaccinate everyone is high when the number infected is so low.

Question 6a

Population	Prediction (increase, decrease, stay the same)	Justification
St Kilda	decrease	Examples of justifications accepted include: • small gene pool • reduced gene flow • exposed to harsh living conditions so only favourable alleles continued to be passed on • population arose from a genetic bottleneck • alleles removed from the gene pool as migration to mainland occurred.
Lord Howe Island	increase	Examples of justifications accepted include: • increased gene flow or introduction of new alleles into the population from different regions • larger gene pool from favourable environmental conditions.

For this question, one mark was assigned to each correct population prediction for their change in genetic diversity, and one mark for a correct justification for each predicted change.

Question 6b

The cause of the outbreak was virus particles present on the dead man's clothing, which was handled by community members.

Examples of the impact this had on the St Kilda population include:

- individuals became infected
- the infection spread rapidly in the small island community
- individuals lacked immunity or herd immunity against smallpox
- the population had a small gene pool OR limited genetic diversity, so smallpox significantly decreased the population, as most individuals were similarly affected.

Question 6c

Students were able to use any one of the five bioethical concepts to answer this question. They were required to include each of the following in their response:

- name OR definition of bioethical concept
- explanation of how the concept relates to the article/decision
- the ethical justification for relocation.

Examples of responses include:

- non-maleficence / avoidance of the causations of harm
- harsh environmental conditions / poor nutrition / high disease vulnerability was causing significant harm to the St Kilda population
- prevention of further suffering / potential loss of life

- justice / moral obligation to ensure there is no unfair burden on a particular group
- unsustainable existence of St Kilda population under harsh conditions / unequal access to resources and/or healthcare compared to mainland population
- relocation to mainland, where there is better access to healthcare and/or resources

- integrity / honest reporting of information, whether favourable or unfavourable
- government informs population about why they are being relocated / provides them with pros and cons
- best interests for population / better livelihood / experience less harm

- beneficence / commitment to maximising benefits and minimising risks and harms
- resources/healthcare available on the mainland
- ensuring long-term health and survival of population / population will experience less harm

- respect / regard for the welfare, autonomy, beliefs, customs, cultural heritage and so on of the St Kilda population
- population was consulted/informed / evacuation was not imposed
- respecting their right to make informed choices about their future / better livelihood

While students could recall the different types of bioethical concepts, as listed in the Study Design on page 16, many did not clearly relate these concepts to the correct context of the question, which was the relocation of the human population from St Kilda.

Question 6d

Antigenic shift results in the emergence of a new viral strain OR existing antibodies/memory cells/vaccines may not recognise the virus antigen.

Some examples of how this could pose a current public health threat on Lord Howe Island include:

- the small population could experience a rapid transmission of the virus due to close contact among residents/visitors
- if a tourist became infected before containment, this could lead to an epidemic/pandemic
- the limited healthcare infrastructure, due to isolation from the mainland, might create challenges in receiving vaccines / medical supplies / treatments
- if no treatment existed OR current treatment was no longer effective, it would take time to develop antivirals
- the efficacy of current vaccines varies, as some individuals could mount a stronger immune response than others.

Students were required to make specific reference to the Lord Howe Island context in their response to be awarded full marks.

Question 7a.i

Hominin cranial capacity / brain size has increased over time.

Students were required to include any **two** correct data points of comparison, for example, from 678 cm^3 in *H. habilis* to 1464 cm^3 in *H. sapiens* (300 000 to 129 000 ya).

Question 7a.ii

Examples of advantages of the change in hominin brain size over time include:

- more developed regions or folding of the brain / allowed for more complex thinking or problem-solving
- more likely to survive and reproduce / communicate / manipulate environment.

Question 7b

Homo sapiens cranial capacity / brain size decreased over time OR is the opposite of the increasing trends in earlier hominin species.

Students were required to include any **two** correct data points of comparison, for example, from 1464 cm^3 in *H. sapiens* (300 000 to 129 000 ya) to 1304 cm^3 in *H. sapiens* (present).

Question 7c

Some examples of possible recommendations to extend the investigation to improve the study include:

- analysing other hominin data (e.g. height) to determine a ratio for comparison that would improve the validity/accuracy of results
- determining if cranial capacity measurements were from adults or children, or had gender differences that would improve the validity/accuracy of results
- determining how cranial capacities were measured to remove outliers
- considering other ways of taking measurements to remove systematic or random errors, improving accuracy or precision, respectively
- collecting more data from modern humans to improve the validity of results.

Students were required to connect their answers to a correct Biology Unit 1–4 key science skill. Students should be familiar with the 'Key science skills' and 'Data and measurement' sections in the Study Design on pages 7–8 and 14–15, respectively.

Question 8a

Examples of the useful information scientists were able to determine about the plants of vegetable crops by measuring the reflected light wavelengths include:

- wavelength(s) of light absorbed for photosynthesis / favourable for growth of the plant
- amount of light absorbed by the plant
- amount or type of chlorophyll
- health of the plant
- if the crop is being produced or flowering / not flowering.

Students should understand that the wavelengths of light that are reflected are not as well absorbed by the plant. Therefore, responses could link to the light-dependent stage of photosynthesis or pigments (such as chlorophyll) involved in light absorption.

Question 8b

Examples of two pieces of data, other than reflected wavelength, that the scientists collected to determine vegetable crop suitability include:

- biomass
- size / plant height
- leaf characteristics
- heat resistance OR flooding
- growth rate
- variable crop yield
- overall plant health.

Question 8c

Examples of two advantages of the scanner over data collection by fieldworkers include:

- reduced labour OR a smaller team managing plant care / harvest
- easier / more accurate identification of plant varieties that could be grown in certain environments
- increased data / traits of plants collected
- easier identification of desired traits so farmers can produce more crops or improve their livelihood
- faster collection of data, improving the accuracy/quality of data.

Student responses were required to focus specifically on the advantages of the scanner, compared to fieldworkers, in terms of data collection.

Question 8d

Similarities between the photosynthetic pathways in C3 and CAM plants include:

- Rubisco fixes carbon dioxide in the Calvin cycle
- photosynthesis occurs in the same cell type (mesophyll cells)
- the light-dependent stage is identical OR it occurs before the light-independent stage.

Differences between the photosynthetic pathways in C3 and CAM plants include:

- in CAM plants, a different enzyme (PEP carboxylase) fixes carbon dioxide first
- CAM plants have two stages of carbon fixation, whereas C3 plants only have one stage of carbon fixation
- CAM plants fix carbon dioxide at night, whereas C3 plants fix carbon dioxide during the day
- in CAM plants, carbon dioxide is stored in a C4 compound (malate), whereas C3 plants use carbon dioxide immediately
- in CAM plants, the stomata are typically closed during the day, whereas stomata in C3 plants are usually open during the day.

The adaptations in CAM plants that enable them to survive in hot, arid environments include:

- minimising photorespiration at high temperatures
- closing stomata during the day to reduce water loss.

Since this was a ‘compare’ question, as part of their response students were required to compare the photosynthetic pathways by providing at least two differences between the C3 and CAM plants. This meant they could also compare the two types of plants by providing one or more similarities between them. Responses then needed to explain either one or two of the adaptations in CAM plants that assist them to survive.

Question 9a

Blackbutt / *E. pilularis* is the tree species most effective at capturing carbon dioxide.

Examples of justifications for this include:

- the Blackbutt showed the highest predicted biomass compared to other species
- as its trunk diameter increased, biomass also increased
- it fixed/stored more carbon dioxide, resulting in more photosynthesis
- appropriate use of data from the graph (e.g. at a trunk diameter of 50 cm, Blackbutt’s predicted biomass was approximately 1900 kg).

Question 9b

Examples of limitations of the method used by students include:

- only using the diameter to provide information about the tree's trunk
- no data was collected about the overall height or shape of tree / root mass / number of leaves/branches, etc.
- it assumes the tree trunk is circular OR there may have been irregularities in the trunk shape
- a limited number of species for comparison of predicted biomass
- no indication of repeatability OR how many trees should be measured
- no indication of how the tree was identified for reproducibility.

Question 9c

Examples of safety precautions that should be followed by the students include:

- avoid tripping hazards or uneven ground
- wear protective clothing (e.g. gloves, boots, hard hat)
- avoid standing under large branches that could fall.

Examples of ethical guidelines that should be followed by the students include:

- no material should be removed during measurements
- living organisms OR the ecosystem should not be disturbed or damaged OR should be respected
- approval must be granted by the park/forest to conduct fieldwork.

Students could provide two different examples of safety precautions, two different examples of ethical guidelines, or a combination of one safety precaution and one ethical guideline that should be followed.

Question 9d

CRISPR-Cas9 technology could improve the efficiency of photosynthesis through either:

- altering the gene for chlorophyll production so a greater rate of photosynthesis / light absorption occurs
- altering the gene for an enzyme (e.g. Rubisco) so more photosynthesis / a light-independent stage occurs OR less photorespiration occurs.