



2022 VCE Biology external assessment report

General comments

The 2022 Biology examination was the first one for the new *VCE Biology Study Design 2022–2026* accreditation period.

The multiple-choice Section A provided a variety of styles, formats, amounts of reading and levels of difficulty. In Section B some questions required a name, such as Question 6b.i., while others required students to formulate and set out an extended answer, such as Question 8a., for which six marks were available. Longer-response questions (three to six marks) made up a larger proportion of the examination, and generally required students to formulate and develop their response. Pointers were given within the question (e.g. Questions 4b. and 7c.) and students should have addressed each of these points in their answer.

It was pleasing to see that the length of the examination was suitable and gave students the opportunity to complete the paper in the time available. Students are advised to use the reading time to assess the Section B questions, identify the key requirements and start formulating their answers.

The 'additional space' page at the back of the Question & Answer book provided students with a designated place to continue their answer if they needed to elaborate further or provide a revised response to their original. On many pages there was also blank space with no lines under the question, e.g. Question 7b., which students could also use instead of the space at the back. Notwithstanding size of handwriting, the number of lines under a question gives an indication of the suitable space required to answer it.

The examination papers are scanned in colour and then marked online. It is most important that students put their responses in a form that scans well, especially for Section B. While it is preferable for students to use a pen, if they use a pencil instead it **must** be of a suitable quality to scan.

Specific information

This report provides sample answers, or an indication of what answers may have been included. Unless otherwise stated, these are not intended to be exemplary or complete responses. There were many other answers that were acceptable.

The statistics in this report may be subject to rounding, resulting in a total of more or less than 100 per cent.

Section A

The table below indicates the percentage of students who chose each option. Grey shading indicates the correct answer.

| Question | Correct answer | % A | % B | % C | % D | Comments |
|----------|----------------|-----------|-----------|-----------|-----------|--|
| 1 | C | 4 | 16 | 61 | 19 | |
| 2 | B | 6 | 86 | 2 | 5 | |
| 3 | A | 81 | 12 | 3 | 4 | |
| 4 | A | 77 | 10 | 5 | 9 | |
| 5 | B | 2 | 88 | 6 | 4 | |
| 6 | A | 79 | 6 | 5 | 9 | |
| 7 | C | 1 | 10 | 86 | 3 | |
| 8 | C | 4 | 6 | 89 | 1 | |
| 9 | B | 5 | 75 | 12 | 8 | |
| 10 | C | 12 | 26 | 52 | 10 | |
| 11 | B | 16 | 74 | 3 | 7 | |
| 12 | C | 15 | 10 | 64 | 11 | |
| 13 | D | 10 | 4 | 8 | 79 | |
| 14 | C | 6 | 7 | 72 | 15 | |
| 15 | C | 14 | 9 | 70 | 7 | |
| 16 | B | 18 | 46 | 27 | 9 | The three regions labelled in the diagram, along with the input of glucose, meant the process in question was aerobic cellular respiration. The other input to this process not shown is oxygen and in region 1 this is the final electron acceptor. |
| 17 | C | 9 | 14 | 54 | 23 | |
| 18 | C | 4 | 20 | 57 | 18 | |
| 19 | B | 10 | 78 | 6 | 5 | |
| 20 | A | 60 | 18 | 15 | 6 | |
| 21 | D | 10 | 3 | 25 | 61 | |
| 22 | B | 2 | 90 | 7 | 1 | |
| 23 | B | 2 | 28 | 29 | 42 | The infographic showed the average incubation period for measles to be 14 days. However, the key here was the range, labelled as 7–21 days. This meant that in some cases, an individual could have a 21-day incubation period. As such, this is the minimum |

| Question | Correct answer | % A | % B | % C | % D | Comments |
|----------|----------------|-----|-----|-----|-----|--|
| | | | | | | amount of time required to be certain of no chance of spreading the disease. |
| 24 | D | 7 | 1 | 9 | 82 | |
| 25 | D | 2 | 2 | 6 | 90 | |
| 26 | C | 22 | 11 | 65 | 2 | |
| 27 | D | 18 | 8 | 6 | 68 | |
| 28 | B | 6 | 71 | 6 | 16 | |
| 29 | B | 29 | 64 | 6 | 1 | |
| 30 | C | 4 | 2 | 90 | 4 | |
| 31 | C | 13 | 12 | 71 | 3 | |
| 32 | B | 2 | 85 | 3 | 9 | |
| 33 | D | 8 | 27 | 13 | 52 | |
| 34 | B | 21 | 68 | 3 | 7 | |
| 35 | C | 4 | 4 | 79 | 14 | |
| 36 | D | 2 | 10 | 14 | 74 | |
| 37 | D | 5 | 3 | 28 | 63 | |
| 38 | C | 16 | 10 | 71 | 3 | |
| 39 | A | 65 | 6 | 21 | 7 | |
| 40 | C | 8 | 7 | 71 | 13 | |

Section B

Question 1a.

| Mark | 0 | 1 | Average |
|------|----|----|---------|
| % | 38 | 62 | 0.6 |

The amino acids trp and met are both coded for by only one codon or the codes for trp and met are not degenerate or redundant.

Question 1b.

| Mark | 0 | 1 | 2 | 3 | Average |
|------|----|----|----|----|---------|
| % | 13 | 13 | 16 | 58 | 2.2 |

Next triplet: A C C

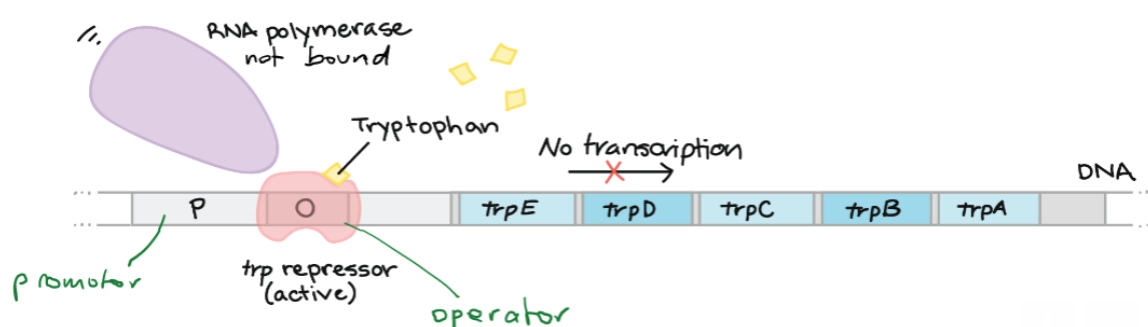
Corresponding mRNA strand: A U G A A G C C G A G U C A U U G G

Amino acid sequence: met/Start lys pro ser his trp

Students were able to gain consequential marks here. For example, if a mistake was made in the transcription, but the student then correctly used the table to translate, they were able to gain this mark.

Question 1c.

| Mark | 0 | 1 | 2 | 3 | Average |
|------|----|----|----|----|---------|
| % | 20 | 13 | 10 | 57 | 2.1 |



Question 2ai.

| Mark | 0 | 1 | Average |
|------|----|----|---------|
| % | 37 | 63 | 0.7 |

DNA which is double stranded is replicated in PCR OR. The enzyme required for amplification acts on DNA.

Question 2aii.

| Mark | 0 | 1 | Average |
|------|----|----|---------|
| % | 35 | 65 | 0.7 |

PCR makes multiple identical copies and therefore a large enough sample to be analysed.

Question 2b.

| 3 | 0 | 1 | 2 | 3 | Average |
|---|----|----|----|----|---------|
| % | 23 | 12 | 12 | 53 | 2.0 |

The stages are:

- Stage 1: denaturation occurs at e.g. 94°C; DNA strands separate
- Stage 2: annealing occurs at e.g. 55°C to allow the primers to join
- Stage 3: extension occurs at e.g. 72°C; optimal temperature of Taq polymerase and adding of nucleotides occurs.

Students provided very clear answers to this question.

Question 2c.

| Mark | 0 | 1 | 2 | Average |
|------|----|----|----|---------|
| % | 45 | 43 | 13 | 0.7 |

Two reasons why RT-PCR cannot be used on all viruses included:

- a suitable probe may not be available or a complementary probe has not been produced
- not all viruses are made of RNA, or the nucleotide sequence in a virus may not be unique enough.

Students who were able to apply their knowledge of complementary sequences to this unfamiliar situation provided suitable reasons.

Question 3a.

| Mark | 0 | 1 | 2 | 3 | 4 | 5 | Average |
|------|---|---|---|---|----|----|---------|
| % | 2 | 1 | 1 | 2 | 24 | 70 | 4.6 |

It's a C4 plant because:

- the temperature falls in the same range
- the pathway to fix CO₂ is the same
- stomata are open during the day unlike CAM plants
- low photorespiration rate unlike C3 plants
- moderate amount of water loss.

Question 3b.

| Mark | 0 | 1 | 2 | 3 | Average |
|------|----|----|----|---|---------|
| % | 37 | 41 | 19 | 3 | 0.9 |

- Determine if Calvin cycle or Rubisco is present in bundle sheath or if any specific substrates or enzymes for this cycle are present.
- The unknown plant could have physical or genetic comparisons made to other known plants.
- The sample size could be increased, reducing effect of outliers.
- Other originally controlled variables could be altered then measure the effect of growth, photosynthetic or photorespiration rate.

Many students were not able to provide extensions beyond what was already tested and included in the data within the stem of the question.

Question 4a.

| Mark | 0 | 1 | 2 | 3 | Average |
|------|----|----|----|----|---------|
| % | 29 | 12 | 17 | 42 | 1.7 |

The role of organelles involved in the export of ovalbumin include:

- Rough endoplasmic reticulum transports protein to Golgi, which packages it into vesicles.
- Vesicles move to and fuse with the plasma membrane.
- Content is released by exocytosis.
- Mitochondria provide energy.

Question 4b.

| Mark | 0 | 1 | 2 | 3 | 4 | Average |
|------|----|----|----|----|----|---------|
| % | 14 | 12 | 22 | 32 | 21 | 2.4 |

Students were required to discuss the ethical concern, its cause and effect. They had to identify an ethical concept or approach and provide a solution.

Following are two possible answers

1. Ethical concern: intensive farming methods – welfare of the chickens

- Cause: Chickens living in cramped conditions are unable to behave naturally and become stressed.
- Effect: Increased disease, or chickens may peck at one another and cause injury or early death of chickens.

Plus:

- Ethical concept: respect/non-maleficence/beneficence/justice.
- Solution: Providing areas for the chickens to roam during the day. / Providing better diet for the chickens. / Regulations to ensure chickens are looked after.

or

- Ethical approach: consequences-based
- Solution: Ensuring that the positives of increased ovalbumin for humans outweigh the negative impacts on chickens by improving the housing of chickens.

or

- Ethical concept: integrity; Ethical approach: duty- and/or rule-based / virtues-based
- Solution: Chicken farmers follow the guidelines for looking after chickens' welfare. / Farmers do not cut corners. / Farmers act with good intentions.

2. Ethical concern: the use of recombinant technology

- Cause: Protein produced is not natural. / People uncomfortable consuming products made by modified DNA.
- Effect: Causes harm to humans. / Will ovalbumin be available to everyone?

Plus:

- Ethical concept: beneficence/non-maleficence; Ethical approach: Duty- and/or rules-based
- Solution: Ensuring all laboratories transferring the plasmids are accredited so chance of plasmids being transferred to another organism is small / not likely.

or

- Ethical concept: respect
- Solution: providing information to the general public on the benefits of changing the genome of bacteria / transparent labelling of recombinant ovalbumin

Question 5a.

| Mark | 0 | 1 | 2 | 3 | Average |
|------|----|----|----|----|---------|
| % | 30 | 22 | 25 | 24 | 1.4 |

Scientists identify a gene that acts as a template and create a complementary sgRNA strand that binds with Cas9. sgRNA then guides Cas9 to the target gene.

The study design requires students to understand the difference between the action of CRISPR naturally found in bacteria compared with CRISPR used for gene editing in plant cells.

Question 5b.

| Mark | 0 | 1 | 2 | 3 | Average |
|------|----|----|----|----|---------|
| % | 38 | 23 | 22 | 17 | 1.2 |

The codon sequence changes, leading to amino acid sequence changes and an early stop codon or a non-functional protein produced.

Students needed to realise that both an insertion or deletion of nucleotides would cause a frameshift mutation. Some students confused their answers with a discussion of block mutations, which affect more than one gene.

Question 5c.

| Mark | 0 | 1 | 2 | Average |
|------|----|----|----|---------|
| % | 31 | 19 | 50 | 1.2 |

The manufacture of bioethanol arises from the production of ethanol through anaerobic fermentation. This process involves the breakdown of glucose into ethanol in the absence of oxygen.

Question 6a.

| Mark | 0 | 1 | 2 | 3 | 4 | Average |
|------|----|----|----|----|----|---------|
| % | 22 | 20 | 12 | 16 | 30 | 2.2 |

Both cells recognise virally infected cells displaying antigen on their MHC-I marker, resulting in cell death or apoptosis.

Natural killer cells are innate or act early in the second line of defence and are non-specific, whereas cytotoxic T cells are adaptive or act later in the third line of defence and are specific.

The comparison could have included highlighting the similarities or differences, or a combination of both between the two cell types. Students may also have spoken about the chemicals involved in the action of these cells leading to cell death. Many students incorrectly referred to these cells as destroying the pathogen itself directly rather than the infected cell.

Question 6bi.

| Mark | 0 | 1 | Average |
|------|----|----|---------|
| % | 31 | 69 | 0.7 |

Mutation.

Question 6bii.

| Mark | 0 | 1 | 2 | Average |
|------|----|----|----|---------|
| % | 34 | 34 | 33 | 1.0 |

Possible answers included:

- Vaccines contain new antigens resulting in the production of new antibodies OR memory cells specific to the antigen
- Memory cells allow for a faster OR larger immune response
- Any existing memory cells specific to the previous antigens would no longer be effective.

Question 7a.

| Mark | 0 | 1 | Average |
|------|----|----|---------|
| % | 37 | 63 | 0.7 |

Natural, active immunity.

Question 7b.

| Mark | 0 | 1 | 2 | Average |
|------|----|----|----|---------|
| % | 16 | 57 | 27 | 1.1 |

Possible answers were any two of the following:

- virus enters and is detected
- memory cells present
- rapid antibody production / Antibodies are produced in large numbers
- virus is neutralised

Question 7c.

| Mark | 0 | 1 | 2 | 3 | Average |
|------|---|----|----|----|---------|
| % | 6 | 11 | 47 | 36 | 2.2 |

Childhood immunity existed in colonists due to previous exposure prior to arrival in Australia. No immunity existed for the Aboriginal Australian population due to no previous exposure.

Aboriginal children became mildly ill when exposed and became immune; this led to the increase of population numbers over 30 years, from 1790–1810.

Question 8a.

| Mark | 0 | 1 | 2 | 3 | 4 | 5 | 6 | Average |
|------|----|---|----|----|----|----|----|---------|
| % | 11 | 9 | 12 | 15 | 17 | 18 | 17 | 3.4 |

Allopatric speciation was caused by the geographical separation of groups of finches preventing gene flow between them. Due to the difference in diet or habitat on different islands, some finches' beak or body type provided a selective advantage, enabling them to survive and pass on favourable alleles to offspring. Over time, different genetic mutations also accumulated in each population.

There were a number of different aspects required for this question, and students needed to address the type of speciation and selection pressure specifically within their response. Sympatric speciation was an incorrect answer, although students were still awarded marks if other explanatory points for speciation were included. Many students concluded their answer by outlining why the species were classified as being different, which was not required as the question asked for 'how' speciation occurred as opposed to 'why' they are different species.

Question 8b.

| Mark | 0 | 1 | Average |
|------|----|----|---------|
| % | 12 | 88 | 0.9 |

Geospiza fuliginosa (G. fuliginosa)

Question 8c.

| Mark | 0 | 1 | 2 | Average |
|------|----|----|----|---------|
| % | 19 | 50 | 31 | 1.1 |

Suitable responses included:

- No sightings or fossil remains of finch species have been found on islands.
- No other evidence such as DNA or feathers or nests or their common food source are present.

Many students misinterpreted this question as asking for reasons that would lead to extinction as opposed to evidence confirming that the species are already extinct.

Question 9a.

| Mark | 0 | 1 | 2 | Average |
|------|----|----|----|---------|
| % | 17 | 38 | 45 | 1.3 |

- Brain size: increasing from most ancient to recent
- Limb structure: longer leg to arm ratio or more angled legs in recent species compared to ancient ones.

Suitable responses had to refer to brain size and limb structure. Skull features such as position of foramen magnum were unacceptable.

Question 9bi.

| Mark | 0 | 1 | 2 | Average |
|------|---|----|----|---------|
| % | 7 | 17 | 76 | 1.7 |

There were many pairs, including any two of the following:

- A. anamensis and A. afarensis
- A. africanus and H. habilis
- H. habilis and H. rudolfensis
- H. erectus and H. rudolfensis

Question 9bii.

| Mark | 0 | 1 | 2 | Average |
|------|----|----|----|---------|
| % | 29 | 46 | 25 | 1.0 |

Some suitable limitations are:

- specific locations are not given so geographic overlapping may not have occurred over migration paths
- molecular evidence not available or considered and fossil finds of humans are very scarce or incomplete.

Question 10ai.

| Mark | 0 | 1 | 2 | Average |
|------|---|----|----|---------|
| % | 6 | 31 | 63 | 1.6 |

The conventional vaccines contained the dead or inactivated version of the pathogen. This resulted in the production of memory cells or faster and larger antibody production.

Many students were able to draw information from the article but were not able to apply this to an appropriate immune response.

Question 10aii.

| Mark | 0 | 1 | 2 | Average |
|------|----|----|----|---------|
| % | 15 | 19 | 67 | 1.5 |

mRNA vaccines contain mRNA, allowing the individual to create the antigen.

Question 10b.

| Mark | 0 | 1 | 2 | 3 | 4 | Average |
|------|----|----|----|----|----|---------|
| % | 14 | 15 | 25 | 27 | 18 | 2.2 |

mRNA vaccines can be quickly produced in order to treat different cancers, resulting in the production of antibodies specific to cancer and not to other cells.

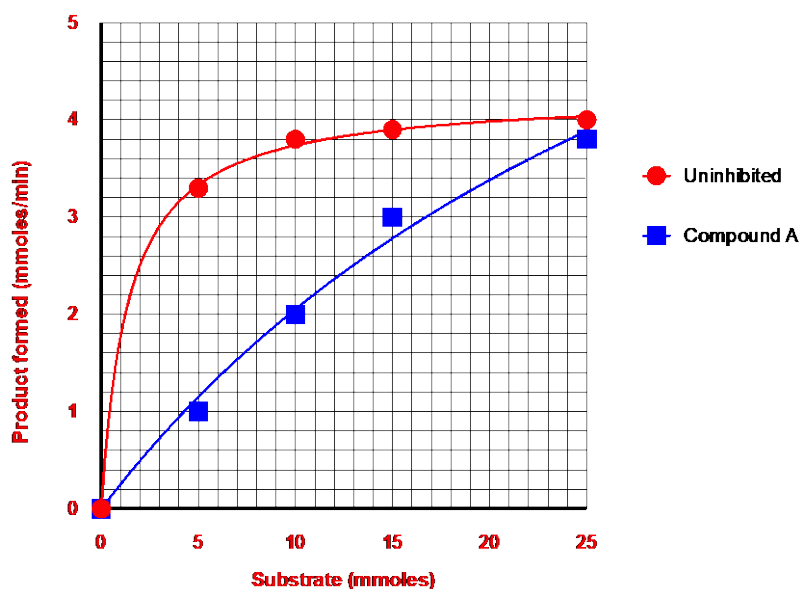
Any one of the following ethical concepts:

- justice: vaccine needs to be available to everyone; may be too expensive to make for just one person or type of cancer
- integrity: researchers should ensure the honest communication of all results from the vaccine trials
- non-maleficence: to ensure the mRNA vaccine does not cause harm to trial participants
- beneficence: to ensure benefits of mRNA vaccine outweigh any potential harm to individual trial participants
- respect: by considering the needs of trial participants and gaining informed consent before commencing vaccine trials.

While students could recall the different types of ethical concepts, they struggled to outline these concepts in the correct context of the question which was the development of vaccines.

Question 11a.

| Mark | 0 | 1 | 2 | 3 | Average |
|------|----|----|----|----|---------|
| % | 13 | 15 | 40 | 32 | 1.9 |



Students were required to use units on both axes. The x-axis needed to be an even scale (some students did not include 20). A key or suitable way to identify each graph was also required.

Question 11b.

| Mark | 0 | 1 | 2 | Average |
|------|----|----|----|---------|
| % | 27 | 15 | 58 | 1.3 |

Possible answers were any two of the following:

- Competitive inhibitors are complementary to the active site or the same shape as a substrate
- They compete with the substrate
- They bind to the enzyme's active site
- They prevent the substrate from binding.

Question 11c.

| Mark | 0 | 1 | 2 | Average |
|------|----|----|----|---------|
| % | 27 | 27 | 46 | 1.2 |

Possible answers were any two of the following:

- The amount of product formed could be less than that seen at 37°C, which is the optimum temperature for enzyme activity.
- Enzyme activity or reaction rate reduces at lower temperatures.
- At lower temperatures, less collisions will occur between the enzyme and substrate.