

# 2021 VCE Biology external assessment report

## General comments

Section A provided a variety of styles, formats, amount of reading and level of difficulty. In Section B some questions required a name, such as Question 5b, while others required students to formulate and set out an extended answer, such as Question 4a., for which five marks were available.

Students are always advised to use the reading time to assess the Section B questions, identify the key requirements and start to formulate their answers.

The examination papers are scanned and then marked online. Students must make every attempt to write their responses in the spaces provided. It is suitable to continue under the question or elsewhere, if necessary, but this can sometimes be avoided if an answer is formulated before being written.

It is most important that students put their responses to Section B in a form that scans easily. Pencil is suitable for responding to multiple choice questions, labelling diagrams and drawing.

## 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.

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

## Section A

Question	Correct answer	% A	% B	% C	% D	Comments
1	B	8	84	6	2	
2	C	18	27	44	10	mRNA is comprised of a ribose-phosphate backbone as distinct from DNA, which contains a deoxyribose sugar. To form mRNA, nucleotides must be joined together forming a nucleotide chain.
3	A	36	17	23	24	The mRNA is stated as being used to produce a new type of molecule. mRNA is used in protein synthesis to produce proteins. In translation, mRNA must bind to the ribosome, which is comprised of rRNA and associated proteins.
4	D	3	7	53	37	The probe is labelled as a DNA probe in the diagram provided. In this question, it is complementary to the mRNA molecule with the target sequence. As a DNA strand, thymine will be the complementary base pair for the adenine in the mRNA molecule.
5	D	6	17	8	69	
6	C	6	3	86	6	
7	B	20	47	16	16	Given that ribulose 1, 5-biphosphate can react with either carbon dioxide or oxygen, increasing the concentration of oxygen will allow the rate of reaction 1 using oxygen to increase and decrease the rate of reaction 2.
8	C	3	1	92	3	
9	A	96	2	1	2	
10	D	6	9	14	70	
11	D	16	14	20	50	
12	A	71	5	18	6	
13	C	20	5	69	6	
14	B	3	57	24	16	
15	B	12	69	7	12	
16	C	10	8	79	3	
17	C	15	5	70	9	
18	A	59	15	9	17	
19	B	3	63	11	22	
20	B	15	77	4	3	
21	D	4	48	4	44	Mammals appeared approximately 210 million years ago (mya) while flowering plants appeared approximately 130 mya.
22	C	5	4	88	3	
23	A	68	21	4	7	

Question	Correct answer	% A	% B	% C	% D	Comments
24	D	6	8	14	72	
25	C	8	17	64	11	
26	D	5	4	3	88	
27	B	12	77	10	2	
28	A	72	11	6	11	
29	D	2	4	15	79	
30	D	10	13	31	46	Step 2 is polymerase chain reaction (PCR), which requires two primers for the amplification of DNA. Step 1 is the isolation of mtDNA, which is not present in the nucleus.
31	A	43	28	10	20	A valid experiment must measure what it states it will measure. Therefore, the correct locus must be chosen for the experiment to be valid.
32	C	35	9	51	5	
33	B	2	90	4	5	
34	B	5	75	14	5	
35	D	9	1	2	88	
36	A	93	3	1	2	
37	B	3	86	6	4	
38	C	11	7	72	10	
39	A	15	49	11	25	The independent variable is the plant hormone, or plant hormone combination added to the detergent solution and applied to the seedlings. Therefore, treatment for the control group would be the buffered detergent solution, with no plant hormone added. This would enable the scientists to see if the plant hormones were responsible for the effects seen rather than the detergent itself.
40	D	35	7	11	47	BA in low concentrations showed a shorter stem length, and therefore less elongation, than the control group and therefore does not promote stem elongation. TIBA in high concentrations (50) can be seen on the graph to have lower stem length than the control but a much higher number of lateral shoots.

## Section B

### Question 1a.

Mark	0	1	2	Average
%	47	36	17	0.7

Students were required to write a description of an example of a situation, rather than a general description of the movement of a substance.

Name of small substance	Hydrophilic or hydrophobic	Example of situation
One of: <ul style="list-style-type: none"> <li>water</li> <li>ethanol</li> </ul>	hydrophilic	<ul style="list-style-type: none"> <li>Water diffuses into a plant cell during photosynthesis OR diffuses out of cell during respiration.</li> <li>Ethanol diffuses out of yeast or bacterial cell that is anaerobically respiring.</li> </ul>
One of: <ul style="list-style-type: none"> <li>carbon dioxide</li> <li>steroid hormones</li> </ul>	hydrophobic	<ul style="list-style-type: none"> <li>Carbon dioxide diffuses into a photosynthetic plant cell OR diffuses out of cell that is aerobically respiring.</li> <li>The steroid or steroid hormone diffuses into a cell and binds to a receptor.</li> </ul>

A common incorrect response was water moving by osmosis with no example of a situation described.

### Question 1b.

Mark	0	1	2	3	Average
%	23	22	32	23	1.6

If the student selected 'into a cell', they needed to name one of the following:

- endocytosis
- phagocytosis
- pinocytosis.

The plasma membrane surrounds the large substance and a vesicle forms around the substance. Some suitable examples are:

- protein
- antigen or virus or bacteria.

If the student selected 'out of a cell', they needed to refer to one of the following:

- exocytosis
- bulk transport
- requires ATP.

A vesicle containing the large particle fuses with the plasma membrane and the contents are released from the cell. Some suitable examples are:

- protein or a named protein such as peptide hormone
- neurotransmitter
- enzyme
- antibodies.

## Question 2a.

Mark	0	1	2	3	Average
%	49	17	20	14	1.0

An acceptable answer was one of the following types of proteins with the explanation.

Enzyme: If there is a change in substrate concentration, then more or less enzyme may be produced to conserve ATP

OR

Structural protein: repair or synthesis of organelles if organelles are damaged due to increased or decreased temperature

OR

Regulatory/repressor protein: more or less repressor protein is required to inhibit or promote a reaction when there is a change in substrate availability

OR

Transcription factors: more or less is required for transcription if environmental conditions result in increased or decreased need for protein synthesis.

## Question 2b.

Mark	0	1	2	Average
%	37	30	33	1.0

Acceptable responses were as follows.

Cellular activity	Immediate end product
transcription	pre-mRNA
RNA processing	mRNA
translation	polypeptide
breakdown of protein	amino acids

## Question 2c.

Mark	0	1	2	Average
%	33	37	30	1.0

The correct response was ADR1 and GCN4. Both of their gene products regulate, for example, transcription.

Many students were able to identify the regulatory genes. However, it was common for students to repeat the function of the gene product information given in the table, which was not an acceptable justification.

## Question 2d.

Mark	0	1	2	Average
%	66	15	19	0.6

The correct answer was exons, with a suitable function such as:

- code for a protein
- be translated into a protein
- code for mRNA
- be transcribed into mRNA.

## Question 3a.

Mark	0	1	2	Average
%	34	41	26	0.9

A suitable answer was that glucose is used in aerobic respiration and ATP is produced from glucose for metabolism.

## Question 3b.

Mark	0	1	2	3	4	Average
%	5	43	31	11	10	1.8

Students were required to identify what the glucose uptake would be and then to justify their answer. All uptake comparisons were justifiable, and examples of each justification are given below.

Higher uptake

- With less oxygen the cell would not respire aerobically producing less ATP for each glucose molecule.
- The cell would take up more glucose to get the same amount of energy.

OR

Lower uptake

- With less oxygen the cell would respire anaerobically and produce toxic products that could cause damage to cells.

OR

Same uptake

- Oxygen is not required for the breakdown of glucose, so glycolysis still occurs and produces less ATP and less energy for the cell.

Students were expected to correctly refer to the types or stages of cellular respiration.

### Question 4a.

Marks	0	1	2	3	4	5	Average
%	15	17	11	14	14	30	2.9

A suitable answer was that the vaccine is taken up by, for example, macrophages and antigen presented on the surface of the cell. The antigen presenting cell moves into the lymphatic system and is taken to the lymph node. Helper T cell stimulates naïve B cells. Each B cell divides to produce plasma cells, which produce specific antibodies. B memory and or T memory cells are produced for long-term immunity

This was very well answered. Many students presented clear logical answers and demonstrated a sound understanding of how long-term immunity is achieved.

### Question 4b.

Mark	0	1	2	Average
%	18	37	45	1.3

The first dose leads to the activation of B cells and development of a small number of memory cells. The second dose increases the number of memory cells for a much faster response to subsequent infection and greater antibody production.

Most students also understood the advantages of a second dose.

### Question 4c.

Mark	0	1	2	3	Average
%	19	16	25	40	1.9

Both types of immunity result in antibodies in the person and offer protection against the pathogen. Active immunity produces antibodies and memory cells and provides long-lasting immunity, for example by vaccination, whereas passive immunity results in short-term immediate immunity, for example via breast milk.

Some students confused their answers with discussion of natural and artificial types of immunity.

### Question 5a.

Mark	0	1	2	Average
%	41	42	17	0.8

A suitable answer was transmission of a signal to or within a cell by a signalling molecule. This involves reception and a response in the cell receiving the signal.

## Question 5b.

Mark	0	1	2	Average
%	38	30	32	1.0

Acceptable responses included the following.

Mode of cell signalling	Example of signalling molecule	Example of target cell
X	One of: <ul style="list-style-type: none"> <li>cytokine</li> <li>interferon</li> <li>histamine</li> <li>death ligand</li> <li>named hormone</li> </ul>	<ul style="list-style-type: none"> <li>phagocyte OR T cell OR B cell</li> <li>cell near virus infected cell</li> <li>phagocyte or any appropriate cell type</li> <li>cell to undergo apoptosis</li> <li>name of relevant target cell</li> </ul>
Y	<ul style="list-style-type: none"> <li>neurotransmitter</li> <li>neurohormone</li> </ul>	<ul style="list-style-type: none"> <li>neuron OR muscle OR gland</li> <li>neuron OR endocrine cells OR immune cells</li> </ul>

Some students correctly named a specific neurotransmitter.

Naming the target cell for the neurotransmitter as 'dendritic cell' instead of 'neuron' was a common error.

## Question 5c.

Mark	0	1	2	Average
%	12	21	67	1.6

The correct answer was pheromone. Guard bees fan their wings to move the secretion/pheromone.

This question was well answered, with many students providing detailed responses.

## Question 6a.

Mark	0	1	2	3	4	Average
%	21	22	23	19	15	1.9

The two groups are geographically isolated and as a consequence there is no gene flow. There would be different selecting pressures or environmental factors acting upon each population. The result of different mutations in each population and their accumulation over many generations is that they would be regarded as two different species.

The question asked students to describe the process that led to the formation of the two species. Some students explained why they were classed as different species, which did not answer the question. There was no mark for stating the inability to produce viable fertile offspring.

## Question 6b.

Mark	0	1	2	Average
%	41	35	24	0.9

The populations share a relatively recent common ancestor and interbreeding can still occur between the two populations. There may also be similar selection pressures in the two different regions.

The question specifically asked for an account between the populations; unfortunately, some answers focused on variation within the population.

## Question 7a.

Mark	0	1	2	Average
%	34	43	22	0.9

Suitable examples were:

- prehensile or grasping hands NOT five digits
- opposable thumb(s) or large toe(s)
- forward-facing eyes NOT stereoscopic vision
- relatively large brain volume to body NOT large brain volume
- nails instead of claws.

Common errors were to give non-structural features or features unique either to hominins or mammals.

## Question 7b.

Mark	0	1	2	Average
%	45	27	28	0.9

Suitable examples were:

- there are many more copies of mtDNA in each cell
- mtDNA has a predictable rate of mutation
- mtDNA mutations accumulate or are not repaired
- all changes in nucleotides are a result of mutations rather than recombination
- mtDNA inherited from mother only allowing for a more direct line of relationships to be established.

## Question 7c.

Mark	0	1	2	Average
%	21	28	51	1.3

*Lemur catta*, *Eulemur coronatus* and *Eulemur flavifrons* share a common ancestor approximately 20 mya and *Eulemur coronatus* and *Eulemur flavifrons* have a more recent common ancestor approximately 9 mya.

This was generally well answered; however, some students had difficulty interpreting the scale.

## Question 7d.

Mark	0	1	2	3	4	Average
%	30	9	11	17	33	2.2

The main steps are:

- isolate single DNA strands from lemur species by heating, for example to 94 °C
- mix the single stranded DNA from both species together and allow these strands to cool
- similar strands of DNA with complementary bases from different species reform. This hybrid DNA is reheated and the melting temperature is determined.

The more closely related two species are, the higher the melting temperature is.

This part was very well answered and again the student's responses showed a clear understanding of the process.

A common incorrect response was a description of polymerase chain reaction.

## Question 8a.

Mark	0	1	2	Average
%	29	56	15	0.9

Any two of the following were acceptable:

- cave drawings show passing of information through generations
- cave drawings become more complex over time
- cave drawings show evidence of change in cultural practices
- evidence of complex thought OR evidence of symbolic representations.

## Question 8b.

Mark	0	1	2	Average
%	48	15	37	0.9

The drawings must be older than 65,000 years as the mineral layer is on top of the ancient drawings.

Some students accurately identified that the transparent layer was on top of the ancient drawings, but then stated the drawings must therefore be younger than that layer.

## Question 8c.

Mark	0	1	2	Average
%	18	26	56	1.4

Acceptable answers:

- *H. sapiens* first appeared in Europe 45,000 years ago and the drawings are older than 65,000 years and therefore *H. sapiens* could not have been the first to make cave drawings.

OR any two of the following:

- *H. neanderthalensis* not *H. sapiens* drew the art.
- *H. sapiens* could have drawn the art but fossils of that age have not been found yet OR dating methods used were unreliable.
- *H. sapiens* first appeared in Europe 45,000 years ago and the drawings are older than 65,000 years.

This question was answered well with many students providing detailed explanations.

## Question 9a.

Mark	0	1	Average
%	26	74	0.8

An acceptable answer was one of the following:

- genetically modified (GM) cotton is transgenic as it contains genes from other species OR bacteria.
- GM canola is transgenic as it contains genes from other species OR bacteria.
- GM safflower is not transgenic as it does not contain genes from another species.

## Question 9b.

Mark	0	1	Average
%	37	63	0.7

An acceptable answer was one of the following:

- use a different herbicide that the GM canola is not resistant to
- remove by mowing
- pick the GM canola growing by the side of the road by hand
- use controlled burning.

## Question 9c.

Mark	0	1	2	3	4	Average
%	15	21	30	20	14	2.0

Social implication

The correct answer was any one of the following:

- Farmers who grow non-GM canola may sell more canola and the farmer may have an improved quality of life OR may sell less canola and have a decreased quality of life.
- Improved nutrition for consumers and therefore less demand on the health system.

- More people have access to better nutrition as GM canola is cheaper OR more accessible than fish.
- There could be a decreased consumption of fish, which results in fish farmers making less money and having a lower quality of life.
- Consumers may not want to consume GM food. This could lead to consumers not buying enough GM canola and farmers having a lower quality of life.

Biological implication

Accepted responses included any one of the following:

- Possible crossbreeding with non-GM canola crops leading to a change in genome of the crops.
- Potential lack of genetic variation within the GM canola crop. All GM canola plants could then die if there is a change in a selection pressure.
- Consumers may not want to eat or purchase any GM products as these consumers are concerned it is not safe to eat.
- Less fish consumed reduces overfishing, leading to an increase in the fish population.
- Improved nutrition for consumers improves health outcomes for consumers.

## Question 10a.

Mark	0	1	Average
%	77	23	0.3

Human DNA is incorporated with bacterial DNA.

This question was not well answered, and it appeared the concept of recombination was not well understood in this context.

## Question 10b.

Mark	0	1	2	Average
%	80	11	10	0.3

Researchers would work backwards from the amino acid sequence to determine the possible mRNA or DNA. The DNA sequence might differ due to the code being redundant or degenerate OR the natural gene would include introns.

## Question 10c.

Mark	0	1	2	3	Average
%	38	20	22	19	1.2

A suitable answer was that the steps to clone and express the gene in bacteria are as follows.

- Isolate human insulin gene from human or artificially synthesise human insulin gene from known sequence.
- Insulin gene inserted into plasmid using restriction enzymes to cut and ligases to join to form recombinant plasmid, which are then placed back into bacteria. These bacteria are then grown in culture.

## Question 10d.

Mark	0	1	Average
%	58	42	0.4

Some suitable ethical responses were:

- Researchers should stop the clinical trial and people who are being given the animal insulin should be offered the more effective recombinant version of the insulin.
- Stop production of insulin from animals to protect their welfare.
- Release information to public to increase informed decision.

## Question 11a.

Mark	0	1	2	Average
%	15	27	58	1.4

Examples of suitable responses included two of the following:

- volume of *E. coli* first applied to plates
- type of nutrient agar used
- size of plates used
- batch or source of ampicillin
- incubation duration
- incubation temperature
- exposure time to each concentration of ampicillin.

## Question 11b.

Mark	0	1	2	Average
%	35	50	15	0.8

If *E. coli* is exposed to low OR 1 µg/ml concentration of ampicillin, then there will be more growth of *E. coli* when exposed to increasingly higher levels of ampicillin.

That *E. coli* exposed to a low OR 1 µg/ml concentration of ampicillin will show more growth after exposure to increasingly higher concentrations of ampicillin.

Students were often unable to correctly identify the independent variable in the experiment and wrote in general terms about the effect of ampicillin on *E. coli*.

## Question 11ci.

Mark	0	1	2	3	Average
%	18	25	30	27	1.7

An acceptable answer included three of the following:

- On Day 0 more *E. coli* grew when no ampicillin was present.
- 2 µg/mL concentration of ampicillin did not affect bacterial growth.
- On Day 2/3 fewer colonies were present on plates for both groups.
- Higher ampicillin concentration (4 µg/mL / 6 µg/mL) killed many *E. coli* OR there was a significant effect on *E. coli* growth.
- There was more growth than predicted for all plates.
- By the end of the experiment more ampicillin-resistant bacteria were present on the experimental plate.
- Initial exposure of *E. coli* to 1 µg/mL concentration of ampicillin resulted in a greater number of resistant *E. coli*.

## Question 11cii.

Mark	0	1	2	Average
%	22	51	27	1.0

If the student wrote that the experimental results did not support the predicted results, then:

- there was *E. coli* still present on both plates on Day 3
- this shows exposing *E. coli* to 1 µg/ml ampicillin does not increase its resistance to ampicillin OR
- R resistant *E. coli* grew regardless of initial exposure to ampicillin.

If the student wrote that the experimental results did support the predicted results, then any two of the following:

- The results showed that the number of colonies in both groups decreased over time.
- More *E. coli* developed ampicillin resistance in the experimental group.
- There were more colonies in the experimental group than in the control group on Day 3.
- Yes, but there were more colonies than expected as ampicillin concentration increased.
- Yes, although a difference is that no growth was expected at the end of Day 3 for the control group.

It was common, and acceptable, for students to explain that the experimental results neither supported nor refuted the predicted results and then provide one explanation for each viewpoint.