2022 **Sample Examination**

VCE Biology suggested solutions

Section A

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

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

Section B

Question 1a.

Any two of the following (2 marks):

- Saves energy by not producing proteins when not needed
- Prevents the accumulation of proteins when not needed that could cause damage to the cell or interrupt/trigger particular biochemical pathways
- Controls number of proteins (e.g. enzymes) present in cell so there are adequate for cellular requirements (biochemical pathways)
- Allows cells to differentiate and specialise during embryonic development

Question 1b.

In the presence of tryptophan:

- the repressor protein becomes activated (conformational change) enabling it to bind to the **operator** region of the trp operon (1 mark)
- RNA polymerase is unable to bind to the **promoter** region (1 mark)
- this prevents transcription of the five structural genes (1 mark)

In the absence of tryptophan

- the repressor protein remains inactive preventing it from binding to the **operator** region (1 mark)
- this allows RNA polymerase to bind to the **promoter** region and transcribe the five structural genes (1 mark)

Question 1c.

- No, they won't be produced (1 mark)
- When levels of tryptophan are high, the **transcription** and **translation** of the leader region occurs quickly and the leader region forms a **terminator hairpin loop** (1 mark)
- This causes RNA polymerase and the ribosome to detach from the operon and results in no transcription of the structural genes (1 mark)

Question 2a.

CRSIPR Cas9 has the ability to **recognise** foreign viral DNA sequences which it has stored in **spacer regions** upstream of the **PAM sites** (1 mark)

This allows CRISPR Cas9 to bind to the foreign viral DNA at **specific recognition sites**, cut the DNA (phosphodiester bonds) which degrades the viral DNA into smaller pieces (immune response) (1 mark)

Question 2b.

Both of the following:

- The Cas9 will find DNA **complementary** to the sgRNA (1 mark)
- The Cas9 will cut the DNA, which will either repair itself with mistakes (knock out) or allow a new gene/sequence to be inserted (knock in) (1 mark)

Question 2c.

Possible advantages include: (1 mark for each)

- Tomatoes can be produced more quickly (reproductive seasons) throughout the year
- Higher yield of tomato plants grown in a given time (as they produce their fruit quicker and can be removed to then grow more plants)
- Earlier flowering will prevent cross pollination between GM and non-GM plants
- Less time for plants to be damaged by pests which would reduce crop size
- Economically favourable as CRISPR is a cheap GM modification tool

Question 2d.

SlJAZ2 - inserts gene for bacterial resistance – less likely to be affected by bacterial infections increasing tomato plant yield (1 mark)

SlMLO1 - disrupting this gene makes plant less susceptible to powdery mildew –plant won't be attacked by this fungus, increasing tomato plant yield (1 mark)

Question 2e.

Consequence based approach

- aims to achieve maximisation of positive outcomes and minimisation of negative effects (1 mark)
- editing the plant genome can increase plant yields, nutrition and prevent diseases (others) – positive outcomes for producers and consumers of the plants at the cost of 'off-target' mutations and adverse immune responses (1 mark)

Beneficence

- maximising benefit and minimising risks and harm (1 mark)
- benefit the farmers as they get more income and benefits consumers as they get healthier products (1 mark)

Question 3a.

Reduction of photorespiration (1 mark), or

Higher concentration of carbon dioxide to bind to Rubisco, reducing chances of oxygen binding (1 mark)

Question 3b.

Yeast can undergo anaerobic fermentation of the Agave biomass, converting glucose (from cellulose) into ethanol which can be converted into bioethanol (1 mark)

Benefits:

- bioethanol is carbon neutral and so does not increase greenhouse gases (1 mark)
- crops are renewable, while fossil fuels are not a renewable resource (1 mark)

Question 3c.

Developing C4 rice components in C3 rice would be a suitable food source in Australia as the predicted changes to Australian climate below accommodate for greater photosynthetic efficiency (1 mark)

An increase in:

- atmospheric carbon dioxide concentration allows greater interaction with Rubisco (1 mark)
- mean surface air temperature will suit C4 plants increasing photosynthesis at a higher rate (1 mark)

A decrease in:

- seasonal rainfall suits C4 rice better with less water usage (1 mark)

Question 4a.

A possible reason includes: *comparative*

A lack of immunity in the Indigenous population

- Smallpox was frequently contracted during childhood by the British, providing them with active natural immunity.
- For Indigenous populations, however, many individuals encountered smallpox for the first time, and as a consequence, experienced severe disease.
- The Indigenous Australian population had no such immunity for smallpox, meaning they were more likely to contract and experience severe symptoms.

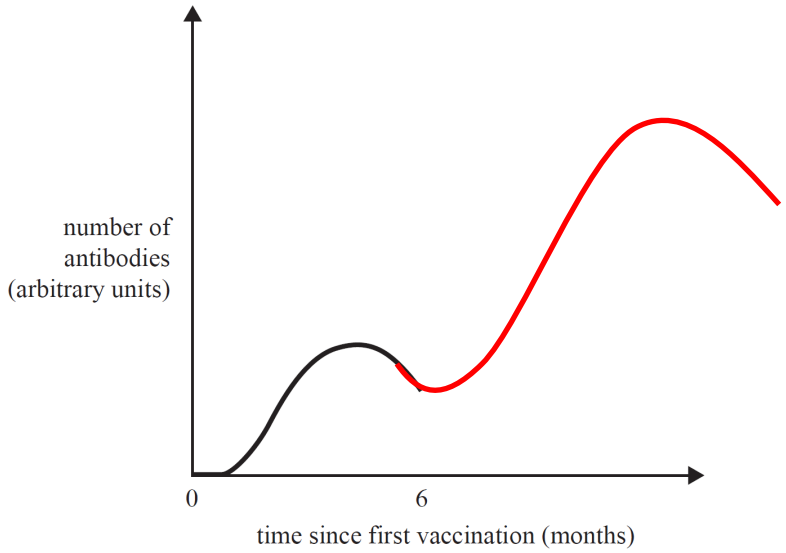
Question 4b.

- Antigen presenting cells (APCs) will ingest the smallpox virus via phagocytosis (1 mark)
- They present the smallpox antigen on their MHC-II and travel to the lymphatic system (1 mark)
- APCs will present the antigen to Naïve T cells / Helper T cells and clonally select a T cell with a matching T cell receptor, activating the adaptive immune response (1 mark)

Question 4c.

- A body cell infected with an intracellular pathogen will display the antigen of the pathogen on its MHC-I (1 mark)
- This will attract specific Cytotoxic T cells with a matching T cell receptor and bind to the infected body cell (1 mark)
- The Cytotoxic T cell then releases cytotoxins, leading to the destruction of the cell via apoptosis along with the virus within it (1 mark)

Question 5a.



Question 5b.

- The second dose introduces the measles antigen to an already established amount of memory B cells from the first vaccine (1 mark)
- This creates a faster and more vigorous production of antibodies and leaves more memory B cells behind than the first dose (1 mark)

Question 6a.

Either two of:

- Constant region
- Variable region
- Quaternary structure (two heavy and two light chains)
- Disulphide bridge forming a hinge

Question 6b.

Monoclonal antibody	**Mode of action – Stimulating, suppressing or no effect on immune response?**	**Justification for your response**
adalimumab	Suppressing	Prevents TNF causing the inflammatory response in rheumatoid arthritis (autoimmune disease)
alemtuzumab	Stimulating	Sends signals to cells of the immune system to bring about the death to cancer cells

---

Question 7a.

- Damaged cells release inflammatory cytokines and mast cells under the skin release histamines which cause blood vessels to dilate (vasodilation) and become more permeable (1 mark)
- Blood plasma (incl. WBCs and complement proteins) leaks into the infected area leading to swelling and redness (1 mark)

Question 7b.

- When antibiotics (selective pressure) are taken, bacteria that have resistance (due to mutation) can survive and reproduce (1 mark)
- They pass on their favourable alleles (resistance mutation) to their offspring, increasing the population of antibiotic resistant bacteria - natural selection (1 mark)
- Concern is that resistant bacteria cannot be treated with antibiotics (1 marks)

Strategies:

- Limit the prescription (over-prescription) of antibiotics to only those with *S. aureus* infections
- Ensure patients take the full course of antibiotics to completely rid body of *S. aureus* population

---

Question 8a.

- Antigenic shift (1 mark)
- This generates a new human virus (H3N2) which has not been exposed to the human population before, hence, no prior immunity (1 mark)
- Scientists would need time to produce a new vaccine for the new strain (1 mark) or
- Antigenic drift of H2N2 is still fairly similar to original strain and population may still have some immunity (1 mark)

Question 8b.

Any two of the following: (2 marks)

- Same quantity (dose) of vaccine provided to patients
- Same time frame (interval) between vaccine doses/boosters
- Same ranges of age groups for each clinical trial
- No underlying health conditions of the patients (similar health of participants)
- Same ethnic background within each trial

Question 9a.

- *Homo erectus* – migrated out of Africa to Sahul 60,000 years ago – fossils found in area (1 mark)
- Not *Homo floresiensis* as they were considerably shorter in stature, therefore unlikely to be ancestral to Aboriginal Australians, who are taller in stature (1 mark)
- Not *Homo denisova* - Aboriginal Australians would have more DNA in common (only 4-6%) if they were descendants, this indicates interbreeding rather than direct lineage (1 mark)

Question 9b.

- Physical separation (large distances) restricted **gene flow** between the two populations (1 mark)
- Over time, exposure to different **selection pressures** (climate, disease, colonialism) and **mutations** to **mtDNA** gathered, creating the differences in genomes of the different populations (1 mark)

Question 9ci.

Any two of the following: (2 marks)

- Primitive tools for hunting
- Primitive tools for agriculture
- Fire pit residue
- Cooking tools and utensils
- Cave paintings/art
- Primitive jewellery

Question 9cii.

- Differences in regions of mtDNA are called a haplotype passed down from maternal line (1 mark)
- Like members of the same haplotype share the same haplogroup and descend from the same lineage (1 mark)
- Discrete geographic areas show unique haplogroups, providing evidence of relatedness and the continuous presence of Aboriginal populations (1 mark)

Question 10a.

If the % of oxygen supplied to the wheat seeds is greater, then the concentration of carbon dioxide produced as a result of respiration will be greater (1 mark)

Question 10b.

- No, as there is no data provided on the amount of glucose (1 mark)
- Although the same number of wheat seeds were present in each container, each seed may have had varying glucose concentration, so not controlled (1 mark)

Question 10c.

- As the concentration of oxygen increases, so does the rate of carbon dioxide produced, indicating cellular respiration was increasing (1 mark)
- The rate of carbon dioxide increases quickly between 10 and 20% oxygen levels (~22-60 ppm/min), then begins to slow down between 25-30% (~70-75 ppm/min) (1 mark)
- The slowing down of carbon dioxide production would be due to another limiting factor such as enzyme or glucose availability (1 mark)

Question 10d.

- At very low oxygen levels, the seed will undergo anaerobic respiration (1 mark)
- This process is faster than aerobic respiration and would show a consistent and high level of carbon dioxide because (1 mark)
- carbon dioxide is a product of anaerobic respiration (1 mark)
- After a period of time, the rate of carbon dioxide production would slow, as the by-products of anaerobic respiration may be toxic - in this case the production of ethanol (1 mark)