decode:VCE

Decode CSI Diagnostic Tests 2021

Subject: VCE Biology Units 3&4
Area of Study: N/A
Topic: Trial Examination

Model Solutions

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Q	A
1	D
2	C
3	B
4	B
5	A
6	C
7	C
8	B
9	A
10	D

Q	A
11	A
12	C
13	C
14	B
15	C
16	D
17	B
18	B
19	B
20	A

Q	A
21	A
22	C
23	A
24	A
25	C
26	B
27	C
28	D
29	A
30	D

Q	A
31	A
32	B
33	B
34	B
35	D
36	A
37	A
38	C
39	C
40	C

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SECTION B - Short-answer questions

Question 1 (a) **[Difficulty: Foundation]**

Comment	Max
Writes an appropriate definition	1

Solution:

A biological agent, capable of reproducing, that can cause disease in an individual.

Question 1 (b) (i) **[Difficulty: Foundation]**

Comment	Max
Correct answer ("skin" alone is unacceptable)	1

Solution:

Intact skin[a]

[a]A related question was asked in the 2007 VCE Biology exam (Exam 1), and "skin" alone was penalised.

Question 1 (b) (ii) **[Difficulty: Foundation]**

Comment	Max
Gives a non-physical barrier that would be found on the skin	1

Comments:

Examples of acceptable answers include fatty acids on skin, sebum, microbiota/commensal on skin. Additional answers can be accepted at the discretion of the examiner.

Question 1 (c) **[Difficulty: Intermediate]**

Comment	Max
Explains that apoptosis generally does not involve lysis of the cell	1
Explains that in apoptosis the intracellular contents are packaged in vesicles/apoptotic bodies (and are phagocytosed by macrophages) as opposed to being spilled into the extracellular fluid	1

Solution:

In apoptosis, there is no cell lysis unlike in necrosis. Additionally, as opposed to being spilt into the extracellular fluid, in apoptosis the intracellular contents remain intravesicular, being packaged in apoptotic bodies, vesicles containing fragments of molecules and organelles.

Question 1 (d) **[Difficulty: Intermediate]**

Comment	Max
Makes an appropriate comparison of normal helper T cell activation and superantigen-mediated activation	1

Solution:

Helper T cells are usually activated by the presentation of their specific antigen by antigen-presenting cells such as macrophages, whereas superantigens activate helper T cells without antigen-presenting cells (irrespective of T cell receptor/antigen complementarity).

Question 1 (e) **[Difficulty: Intermediate]**

Comment	Max
Correctly identifies that superantigens are not allergens and provides an appropriate reason, with reference to the definition/function of an allergen	1

Solution:

They are not allergens; allergens stimulate the production of IgE antibodies (by plasma cells). Superantigens do not necessarily stimulate IgE production.

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Question 1 (f) [Difficulty: Advanced]

Comment	Max
Identifies blood vessel dilatation as a feature of acute inflammation as well as a cause of septic shock	1
Identifies capillary leakiness as a feature of acute inflammation, **and** that capillary leakiness would cause leakage of fluid into the extracellular fluid	1

Solution:

The cytokine storm leads to the manifestations of acute inflammation, including:

- blood vessel dilatation - a characteristic of septic shock
- capillary leakiness - causing leakage of plasma into the extracellular fluid, contributing to septic shock

Question 2 (a) [Difficulty: Foundation]

Comment	Max
Identifies noradrenaline signalling as being paracrine	1
Identifies thyroxine signalling as being endocrine	1

Solution:

Thyroxine's mode of transmission is endocrine, whereas that of noradrenaline is paracrine.

Question 2 (b) [Difficulty: Foundation]

Comment	Max
Award 2 marks if all three boxes are correctly filled, and 1 mark if 1-2 boxes are correctly filled.	2

Solution:

Stimulus	noradrenaline binds to β_1 adrenergic receptor
Signal transduction (in general terms)	The receptor activates **secondary messengers**, leading to an amplified signal cascade.
Response	Calcium channels open/heart muscle contractile force increases

Question 2 (c) [Difficulty: Advanced]

Comment	Max
Precisely describes the relationship between these three variables; be strict in awarding this mark as this question is designed to differentiate between the top students.	1

Solution:

Increased sympathetic nervous system stimulation increases heart muscle contractility; thyroxine increases the sensitivity of heart muscle contractility to sympathetic nervous system stimulation.

Question 2 (d) (i) [Difficulty: Foundation]

Comment	Max
Identifies that the inner and outer mitochondrial membranes may represent the plasma membrane of the bacterial precursor and the endocytosing cell	1

Solution:

The inner and outer mitochondrial membranes may represent the plasma membrane of the bacterial precursor and the endocytosing host cell.

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Question 2 (d) (ii) [Difficulty: Foundation]

Comment	Max
Writes down **electron transport chain** and identifies **cristae** as the sections	1

Solution:

Electron transport chain; occurs in the cristae.

Question 2 (e) [Difficulty: Intermediate]

Comment	Max
Identifies that the electron transport chain produces almost all the ATP in cellular respiration (or quantifies the amount of ATP produced in each step)	1
Explains that excessive thyroid hormone stimulation, via UCP, minimises the hydronium ion concentration gradient and greatly reduces the amount of ATP produced; makes an appropriate semi-quantitative judgement	1

Solution:

Excessive thyroid hormone stimulation, via UCP, minimises the hydronium ion concentration gradient and reduces ATP production. Given the electron transport chain produces 32-34 out of the 36-38 ATP from cellular respiration, this would dramatically reduce the ATP yield.

Question 2 (f) [Difficulty: Advanced]

Comment	Max
Identifies that the energy produced from cellular respiration is converted to heat rather than ATP	1
Explains that the excessive heat produced can increase body temperature	1

Solution:

A significant amount of energy released in cellular respiration is converted to heat in thyroid hormone excess instead of being used for ATP production. The excessive heat produced leads to an increase in body temperature.

Question 2 (g) [Difficulty: Intermediate]

Comment	Max
Makes a reasonable suggestion involving post-transcriptional (or post-translational) modifications	1

Comments:

Acceptable answers include alternate intron splicing, different post-translational protein modifications (eg. cleavage of a segment of protein product)

Question 3 (a) [Difficulty: Foundation]

Comment	Max
Correctly provides two characteristics	2

Comments:

Acceptable answers include forward facing eyes, nails instead of claws, opposable thumbs, relatively large cranial capacity, ability to circumduct at the shoulder.

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Question 3 (b) **[Difficulty: Foundation]**

Comment	Max
Correct name for the process (allopatric speciation)	1
States that the formation of the Congo river provides a geographic barrier **AND** that this arrests gene flow between the two new popoulations	1
States that the two populations would have encountered different selection pressures and accordingly evolved different traits	1
States that the different traits eventually prevent individuals from the two populations to crossbreed and/or produce viable and fertile offspring	1

Solution:

Allopatric speciation. The formation of the Congo river provides a geographic barrier that arrests gene flow between the two newly formed populations. These populations are subsequently subjected to different selection pressures, leading to the evolution of different sets of traits. The populations eventually evolve traits that prevent interbreeding (eg. via incompatibility in genitalia preventing intercourse) or production of viable or fertile offspring, at which point they are deemed two separate species.

Question 3 (c) **[Difficulty: Intermediate]**

Comment	Max
Identifies that if the ancestor could swim, gene flow between the two populations would have be preserved preventing speciation (or words to that effect)	1

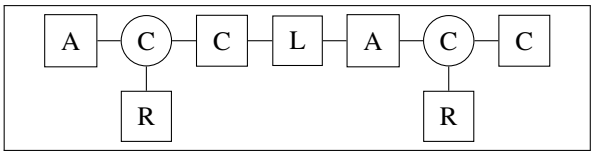
Solution:

Allopatric speciation requires gene flow to be arrested between the two populations; if the common ancestor could swim, the two populations would have been able to swim between sides of the river to interbreed facilitate ongoing gene flow.

Question 4 (a) **[Difficulty: Foundation]**

Comment	Max
Correctly depicts the peptide linkage binding the two amino acids	1
Correctly draws the rest of the structure	1

Solution:



Question 4 (b) (i) **[Difficulty: Foundation]**

Comment	Max
Correctly describes the secondary structure	1
Correctly identifies the interactions as hydrogen bonds	1

Solution:

Localised coiling and folding of segments of the polypeptide chain, held together by hydrogen bonds [between nearby peptide linkages].

Question 4 (b) (ii) **[Difficulty: Foundation]**

Comment	Max
Correctly names the secondary structure	1

Solution:

Alpha helix/helices

Question 4 (b) (iii) **[Difficulty: Foundation]**

Comment	Max
Correct name with appropriate explanation	1

Solution:

Quaternary structure; SAA is composed of multiple (6) identical polypeptide chains.

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Question 5 (a) (i) **[Difficulty: Intermediate]**

Comment	Max
Writes down a reasonable hypothesis	1

Comments:

Example answer: Invertase activity is highest at a particular optimal pH, and decreases as pH deviates from this optimal pH.

Question 5 (a) (ii) **[Difficulty: Intermediate]**

Comment	Max
Provides either a partial explanation (1 mark out of 2) or complete explanation (2 marks out of 2).	2

Comments:

Example answer based on the answer to part **i.**: Ionic interactions in the tertiary structure are altered as the pH deviates from optimal. This would affect the shape of the active site and inhibit its ability to bind to its substrate.

Question 5 (b) (i) **[Difficulty: Intermediate]**

Comment	Max
Correct answer	1

Solution:

Independent variable – pH
Dependent variable – invertase activity

Question 5 (b) (ii) **[Difficulty: Intermediate]**

Comment	Max
Provides two variables	1

Comments:

Acceptable answers include temperature, invertase concentration, time of incubation.

Question 5 (c) (i) **[Difficulty: Intermediate]**

Comment	Max
Provides an appropriate explanation with reference to the test tubes' role as a negative control	1

Comments:

Negative control/to attribute the absorbance in the invertase-containing test tubes to the presence of invertase

Question 5 (c) (ii) **[Difficulty: Intermediate]**

Comment	Max
Provides an appropriate explanation with reference to the test tubes' role as a positive control	1

Comments:

Positive control/to indicate the expected absorbance if 100% of the sucrose was broken down/to verify that the presence of glucose and fructose (exclusively) gives rise to a high absorbance

Question 5 (d) **[Difficulty: Intermediate]**

Comment	Max
Provides an appropriate suggestion	1

Comments:

Example answers: experiment repeated with multiple sets of invertase-containing samples across the same pH range; same experiment repeated in tandem by multiple individuals (or VCE Biology classes).

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Question 5 (e) [Difficulty: Advanced]

Comment	Max
Makes an appropriate comparison between pH 8 and pH 2, 4, 6, 10 and 12 based on the provided data (that pH 8 is the optimal among these options)	1
Identifies that the optimal pH may lie in between the pH values that have been tested	1

Solution:

The absorbance is highest at the pH 8 sample compared to those of pH 2, 4, 6, 10 and 12, suggesting that pH 8 is associated with the highest glucose and fructose content and hence highest invertase activity. However, this does not exclude other, untested pHs giving rise to higher invertase activities (eg. a pH between 6-10 excluding 8) and one of those pHs hence being the optimal.

Question 5 (f) [Difficulty: Advanced]

Comment	Max
Identifies that the 95°C temperature would denature the invertase enzyme (by breaking hydrogen bonds)	1
Explains that this would prevent any meaningful sucrose breakdown/lead to near-zero absorbances in all solutions (which would prevent the aim from being achieved)	1

Solution:

The incubation at 95°C would denature the invertase. Therefore, at all pH levels, the absorbances of all developed solutions would be near-zero, as there would be no meaningful glucose and fructose production. This would lead to the results being uninterpretable.

Question 6 (a) [Difficulty: Foundation]

Comment	Max
Highlights the differences between the two terms	1

Solution:

An epidemic is where a communicable disease infects a large number of people within population/region, but not necessarily multiple countries or continents; a pandemic involves multiple countries or continents.

Question 6 (b) (i) [Difficulty: Foundation]

Comment	Max
Correct answer	1

Solution:

polymerase chain reaction

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Question 6 (b) (ii) **[Difficulty: Foundation]**

Comment	Max
Describes the denaturation step	1
Describes the annealing step	1
Describes the elongation step	1
States that these steps are repeated multiple times	1

Solution:

Denaturation: the DNA sample is heated to over 90°C to break the hydrogen bonds and dissociate the DNA strands[a].
Annealing: specific single-stranded DNA primers are added, and the mixture is cooled (to 55°C) to enable annealing of primers to complementary sequences within the DNA.
Elongation: DNA nucleotides and a *Taq* DNA polymerase are added, and the DNA heated to 72°C to enable new complementary DNA strands to form from the primers.
The above steps are repeated many times.

[a]The 2007 VCE Biology Examination 2 (Section B Question 2b.) had a similar question; the wording here is similar to that quoted in the Assessment Report.

Question 6 (b) (iii) **[Difficulty: Advanced]**

Comment	Max
Provides an appropriate explanation	1

Solution:

The use of primers with base sequence complementary to complementary DNA regions unique for the SARS-CoV-2 virus would ensure that only SARS-CoV-2 derived complementary DNA would be amplified.

Question 6 (c) **[Difficulty: Foundation]**

Comment	Max
Writes down an appropriate definition	1

Solution:

The set of all proteins that are produced by a cell, organism or virus at a particular timepoint.

Question 6 (d) **[Difficulty: Intermediate]**

Comment	Max
Writes an appropriate explanation with reference to identifying a biomolecule (M^{pro}) whose activity/function could be modulated to effect a specific therapeutic biological outcome (inhibition of viral synthesis/replication) as opposed to a "trial and error" approach	1

Solution:

This approach identifies a biomolecule integral to the development of COVID-19 (M^{pro}) and tries to determine how to inhibit its function, to achieve a specific therapeutic outcome (inhibition of viral replication and hence aid in treating COVID-19).

Question 6 (e) **[Difficulty: Intermediate]**

Comment	Max
Correct answer	1

Solution:

Charge

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Question 6 (f) **[Difficulty: Intermediate]**

Comment	Max
Identifies that there is a time delay between vaccine administration and the development of immunity	1
Identifies that treatment of COVID-19 infection requires a modality that works immediately	1

Solution:

No, as there is a time delay (of approximately 1-2 weeks) between vaccination and the development of immunity. Patients already infected with COVID-19 require treatment that has immediate efficacy.

Question 6 (g) **[Difficulty: Foundation]**

Comment	Max
Correct answer	1

Solution:

Autoimmune disease

Question 7 (a) (i) **[Difficulty: Foundation]**

Comment	Max
Correct answer	1

Solution:

divergent evolution

Question 7 (a) (ii) **[Difficulty: Foundation]**

Comment	Max
Correct answer	1

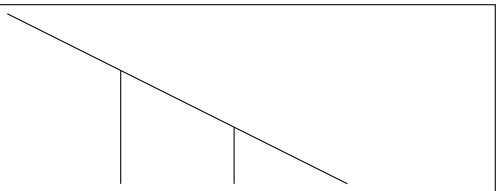
Solution:

analogous structures

Question 7 (b) **[Difficulty: Foundation]**

Comment	Max
Draws appropriate phylogenetic tree	1

Solution:



Question 7 (c) **[Difficulty: Foundation]**

Comment	Max
Makes appropriate reference to the association between cetaceans, water and ease of fossilisation	1

Solution:

The aquatic conditions are conducive to the fossilisation of cetaceans via rapid underwater burial.

Question 7 (d) **[Difficulty: Foundation]**

Comment	Max
Writes an appropriate definition	1

Solution:

A fossil containing anatomical features common to an ancestral species and its descendant lineages.

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Question 7 (e) **[Difficulty: Foundation]**

Comment	Max
Identifies the pre-existing presence of variation in the *Mesonyx* limb morphologies that is (partly) genetic	1
Explains how selection pressures (giving at least one relevant example) cause relatively higher fecundities among organisms with favoured traits	1
Explains how the above mechanism (across many generations) leads to the evolution of the dolphin fin	1

Solution:

Genetic variation in the morphologies of the limbs within the precursor species (originally *Mesonyx*) is continually generated as a result of germline mutations. As the populations became increasingly aquatic, individuals possessing limb morphologies conducive to mobility in water to (for example) escape predation would be more fecund; hence, these limb morphologies, and its associated alleles, would be over-represented in the next generation. There would be an increasing number and degree of fin-like limbs over successive generations as this process repeats, with the final outcome being dolphin species monomorphic for fins as opposed to limbs.

Question 8 (a) **[Difficulty: Intermediate]**

Comment	Max
Correct answer with explanation	1

Solution:

Yes, as the rice plant cells possess genes from other species (bacteria and daffodil species) within their genome, fitting the definition of a transgenic organism.

Question 8 (b) **[Difficulty: Intermediate]**

Comment	Max
Describes two social or ethical issues (1 mark each)	2

Comments:

There are a large number of reasonable answers. Examples include (in brief, should be elaborated on in student answer):

- social - equitable access to Golden Rice seeds vs profits, social class divisions, power imbalances between Golden Rice producers and government officials in developing countries and farmers
- ethical - loss of autonomy (due to increasing dependence on Golden Rice seeds), inadvertent cross-pollination of rice plants of non-GMO varieties affecting consumers' right to choose non-GMO options, profiteering off countries with "desperate" health situations

Question 8 (c) **[Difficulty: Intermediate]**

Comment	Max
Explains why it is biologically implausible for consumption of GMO foods to cause modifications in consumers' DNA	1
Provides a reasonable judgement as to the possible carcinogenic properties of GMO foods	1

Solution:

It is the genome of the plant that produces the GMO food that is edited, not that of the consumer. The GMO food, like any other food, would be chemically digested and GMO DNA broken down into its constituent nucleotides prior to absorption in the gut. Any effect on the risk of developing cancers by GMO foods is uncertain and would require studies with follow-up over many decades; in any case, even if there were carcinogenic properties, it would not be by the mechanism described in the social media post.

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Question 9 (a) (i) **[Difficulty: Intermediate]**

Comment	Max
Identifies the **larger** size of the zygomatic arch as the feature	1
Correlates the above with larger and stronger jaw muscles capable of chewing hard seeds and tough plant matter	1

Comments:

Large zygomatic arch; this suggests that *Australopithecus* possessed large and strong jaw muscles (eg. masseter muscles that attach to the zygomatic arch) providing the ability to chew and crush tough plant material and hard seeds.

Question 9 (a) (ii) **[Difficulty: Foundation]**

Comment	Max
Provides one other difference (aside from large zygomatic arch)	1

Comments:

Acceptable answers include:

- sloping forehead
- prominent jaw
- prominent brow ridge

Question 9 (b) **[Difficulty: Advanced]**

Comment	Max
Provides a thorough explanation of how the switch to carnivorous behaviour removed a previously existing selection pressure favouring larger teeth, but does not actively favour smaller teeth	1
Provides a sophisticated discussion of the relationship between the traits of teeth size, jaw size, and cranial capacity, and the relative selection pressures acting on each trait, to explain the outcome of smaller teeth	1

Solution:

The first paradigm is partially accurate. A diet consisting of hard seeds and tough plant matter would actively select for larger teeth; the switch to the softer meat would remove this selection pressure, but would itself not actively select for larger or smaller teeth.
The second paradigm explains the active selection for smaller teeth. Larger brain frontal lobes providing executive function abilities and requiring high cranial capacities are likely to have been strongly selected for, with the side effect being a shortening of the jaw, crowding of the teeth and dental infections. This should ordinarily provide an selection pressure that favours larger jaws or smaller teeth. However, it is likely that the overwhelming positive selection for larger cranial capacities prevents larger jaws being selected for, and hence the trait of smaller teeth is favoured as there is a lower risk of dental infections and high cranial capacity is retained.

Enquiries

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