Neap

Trial Examination 2021

VCE Biology Units 3&4

Written Examination

Suggested Solutions

SECTION A – MULTIPLE-CHOICE QUESTIONS

1	A	**B**	C	D	15	A	B	C	**D**	29	A	B	**C**	D					
2	A	B	**C**	D	16	A	B	**C**	D	30	A	**B**	C	D					
3	A	**B**	C	D	17	A	B	C	**D**	31	A	**B**	C	D					
4	A	B	C	**D**	18	A	**B**	C	D	32	A	B	**C**	D					
5	A	**B**	C	D	19	**A**	B	C	D	33	A	**B**	C	D					
6	A	B	C	**D**	20	**A**	B	C	D	34	**A**	B	C	D					
7	A	B	C	**D**	21	A	**B**	C	D	35	**A**	B	C	D					
8	A	B	**C**	D	22	A	**B**	C	D	36	A	**B**	C	D					
9	A	B	**C**	D	23	A	B	**C**	D	37	A	**B**	C	D					
10	**A**	B	C	D	24	A	**B**	C	D	38	A	B	C	**D**					
11	A	B	C	**D**	25	A	B	C	**D**	39	A	B	**C**	D					
12	A	**B**	C	D	26	A	B	**C**	D	40	**A**	B	C	D					
13	A	B	**C**	D	27	A	B	**C**	D										
14	**A**	B	C	D	28	A	B	C	**D**										

Question 1 B

B is correct. A plasma membrane is a phospholipid bilayer with the phosphate component facing towards both the inside and outside of the cell. The phosphate component is hydrophilic and so is stable in that configuration. The hydrophobic fatty acid tails face towards each other thus providing the basic structure of a membrane. While a light microscope shows a single line, the electron microscope provides evidence for this arrangement by showing the layer as two lines, each line being the phosphate heads and the gap between being the fatty acid tails. **A**, **C** and **D** are incorrect. In the given example, the electron microscope does not provide evidence for the fluid mosaic model, variation in plasma membrane structure or the fact that plasma membranes consist of two membranes.

Question 2 C

C is correct. Over time the cell is manufacturing, transporting, packaging and secreting the polypeptide (the radioactive amino acids in this example), and so different organelles would be active at different times.

- Ribosomes manufacture proteins.
- The endoplasmic reticulum then transports proteins into the *cis* vesicles of the Golgi apparatus.
- The Golgi apparatus, having packaged the protein, transports it out through the *trans* vesicles.
- Finally, secretory vesicles receive the protein and enable exocytosis.

A, **B** and **D** are incorrect. The mitochondria and nucleus are not directly involved in the manufacture or transport of the polypeptide.

Question 3 B

B is correct. Condensation reactions are those that produce a molecule of water when building a larger polymer from smaller monomers. Even though phospholipids are not polymers, the fatty acid components are still joined to glycerol by a condensation reaction. **A** is incorrect. Nucleotides are smaller components of nucleic acids. **C** is incorrect. Amino acids are smaller components of proteins. **D** is incorrect. A carbon dioxide molecule is smaller than a glucose molecule (this is anaerobic respiration).

Question 4 D

D is correct. Transcription is the process whereby mRNA is formed from DNA. From the diagram, O is the template strand that the RNA polymerase (Q) is moving along to produce mRNA (P). The other components are the coding strand (N), which is complementary to the template strand. It makes sense that there is a termination point (R) for the whole process, otherwise transcription would continue along the strand. **A** and **C** are incorrect. The process begins with the template strand. **B** is incorrect. DNA polymerase is not used to produce mRNA.

Question 5 B

B is correct. The coding strand is the polynucleotide strand that the template strand is complementary to. In the sequence of the complementary mRNA derived from this strand, the T from the coding strand is replaced with U in the complementary strand. **A** and **D** are incorrect. Thymine is part of DNA, not RNA. **C** is incorrect. The complementary mRNA strand will not completely complement the coding strand.

Question 6 D

D is correct. Hypotheses are written in a format that makes a prediction, as well as including the independent and dependent variables (average time for a colour change and temperature respectively). **A** is incorrect. This option does not include the dependent variable. **B** is incorrect. Based on knowledge of enzyme function, the time taken should increase and not decrease. **C** is incorrect. Based on knowledge of enzyme function, it would be expected that the optimal temperature for lipase would be body temperature (37°C) rather than 20°C.

Question 7 D

D is correct. The temperature of 30°C is below the optimum temperature based on the data. It would be expected that there would be fewer collisions between lipase and triglyceride, increasing the time taken for the indicator to change colour. **A** is incorrect. The kinetic energy at 30°C is lower than that at 37°C. **B** is incorrect. Lower temperatures do not denature enzymes. **C** is incorrect. Temperature is not an irreversible inhibitor, which is a chemical that binds to the active site and alters the functioning of the enzyme.

Question 8 C

C is correct. The results of the experiment, which were repeated and replicated, do show a clear trend of a reduction in enzyme activity with increasing temperature over the optimum. The 60°C data does look imprecise due to some of the data being omitted. However, the omitted data could still have been within the expected result due to the time frames used, so both students are making a reasonable argument. **A** is incorrect. The average result is higher than the other temperatures even with the outlying data being omitted, which is the expected result. **B** is incorrect. It is difficult to make a comment about precision in this case when two results are included in the final average and two results are not. **D** is incorrect. The only independent variable tested was temperature.

Question 9 C

C is correct. An isotonic solution would mean the mitochondria can be functional on their own. To function optimally, the mitochondria would need to be provided with pyruvic acid (for the Krebs cycle) as well as oxygen (for the electron transport chain). **A** and **D** are incorrect. Carbon dioxide is an output of the Krebs cycle. **B** is incorrect. Glucose needs to be converted into pyruvic acid during glycolysis, which will not occur in these isolated mitochondria.

Question 10 A

A is correct. The cellular combustion of glucose in the absence of oxygen in plants or yeast is referred to as anaerobic respiration or fermentation. The products from the sugar cane are ethanol as well as carbon dioxide. **B**, **C** and **D** are incorrect. None of these processes can be used to produce ethanol.

Question 11 D

D is correct. As the respiration is anaerobic, the process of glycolysis occurs in the cytosol. **A** is incorrect. The mitochondria are involved in aerobic respiration, not anaerobic respiration. **B** and **C** are incorrect. The nucleus and Golgi apparatus are not directly involved in respiration.

Question 12 B

B is correct. Any chemical that is secreted into the external environment of the organism and is absorbed by other members of the same species to change their behavior is referred to as a pheromone. **A** is incorrect. Animal hormones act within the same organism that secretes them. **C** is incorrect. Neurotransmitters convey messages between neurons. **D** is incorrect. Cytokines convey messages between white blood cells.

Question 13 C

C is correct. Signaling molecules that bind to extracellular receptors are unable to dissolve through the cell membrane due to their size as well as their polarity. They are polar molecules and can also be referred to as lipophobic or hydrophilic. **A**, **B** and **D** are incorrect. Signaling molecules that pass across a cell membrane are water insoluble, lipophilic or hydrophobic.

Question 14 A

A is correct and **B** is incorrect. Cancer is an uncontrolled cell division that chemotherapy can act against. In a fully grown individual, the balance between apoptosis and cell replacement is roughly equal. Treating cancer with chemotherapy involves destroying the uncontrollably dividing cells with minimal side effects. A higher survival rate of patients using IP chemotherapy means that cell division destruction (apoptosis) has been more effective than patients using IV chemotherapy. **C** is incorrect. A greater rate of cell reproduction with IP therapy would lead to more cancerous cells. **D** is incorrect. In a sample of 800 patients, a 17% difference in effectiveness is significant.

Question 15 D

D is correct. Viruses, bacteria and pathogens with nuclei within their cells all contain nucleic acid, which gives them the capacity to replicate given appropriate conditions. **A** is incorrect. Viruses, such as swine flu, are described as non-cellular pathogens. **B** is incorrect. Cholera is a caused by a prokaryote, not a eukaryote. **C** is incorrect. *Plasmodium malariae* is nucleated and so is eukaryotic.

Question 16 C

C is correct. Physical barriers to infection form a layer that prevents or reduces the chance of pathogens entering the internal environment of the body, and a layer of mucus will act in this way. **A** and **D** are incorrect. They are chemicals within fluids that serve as a form of protection, and so are not a physical barrier. **B** is incorrect. While they are a physical barrier, tears protect the eyes and not the bloodstream.

Question 17 D

D is correct. The arrow illustrates the direction of a secretion (cytokine), which is typical of a cytotoxic cell causing apoptosis in the target cell. The target cell carries antigens (small triangles) that provide a binding site for specific receptors on the surface of the cytotoxic cell, so the response is specific. **A** is incorrect. Cell X is the cytotoxic cell and cell Y is the target cell. **B** is incorrect. The differentiation into a cytotoxic cell occurs in the lymph nodes after the antigen encounters the receptor, not in the thymus gland. **C** is incorrect. Each specific response is unique and depends on the specific antigen that activates it.

Question 18 B

B is correct. The horse's immune system will develop antibodies against the snake venom. Regular injections of the venom will hypersensitise the horse so that large quantities of antibodies can be extracted. **A** is incorrect. Any animal needs to be treated with appropriate ethical consideration; the reason that horses are used for this process instead of sheep is because they are larger animals and are at less risk from the process due to the quantities of snake venom involved. **C** is incorrect. The immune system responds more vigorously over time. **D** is incorrect. Antibody response is a humoral response relating to B cells, not to T cells.

Question 19 A

A is correct. When a horse is injected with small amounts of snake venom, it is injected with antigens to promote a specific immune response. For this reason, the immunity is active and artificial. **B** and **D** are incorrect. The immunity gained is not natural, as there is interference by biotechnology. **C** is incorrect. A human who has the antibodies administered would have an artificial and passive response.

Question 20 A

A is correct. When small sections of chromatids appear on non-homologous chromatids due to crossover, it is referred to as a translocation mutation. **B** is incorrect. For an inversion mutation to occur, the section of DNA exchanged would need to be reattached upside down, which is not specified by the question. **C** is incorrect. A deletion mutation is where the DNA material is missing. **D** is incorrect. Aneuploidy refers to entire chromosomes being carried over into a cell via an error in meiosis, not sections of chromatids.

Question 21 B

B is correct and **C** is incorrect. As mutations are random, it is less likely that they will occur at exons, which only represent 1% of the genome, and comparatively more likely to occur at intron, which represent 25% of the genome. However, since about 75% of the genome is 'junk' DNA, mutations are most likely to affect these regions. **A** is incorrect. Mutations are not likely to change the amino acid sequence of a protein due to the redundancy of the genetic code. **D** is incorrect. Mutagens only speed up mutation rate; they do not target specific sections of the genome for mutation.

Question 22 B

B is correct. The domestication of animals parallels the development of farming. The animals with the most desirable traits (such as producing the best milk yield or the most wool) were chosen to breed together. The offspring of these animals were more likely to express those desired features compared to random breeding between any members of the species. Over generations this compounds and the descendants will appear to be very different from their ancestors. This human-driven process is a form of artificial, or selective, breeding. **A** is incorrect. Speciation does not explain the different appearances of the different domesticated animals. **C** is incorrect. Domestication would not directly lead to aneuploidy. **D** is incorrect. Gene flow is how alleles move between populations; however, domestication prevents free gene flow.

Question 23 C

C is correct. Flowering plants appear in the fossil record approximately 125 million years ago. **A**, **B** and **D** are incorrect. The fossil record gives evidence for a number of major evolutionary events such as the development of multicellularity (600 million years ago), the emergence of animals on land (450 million years ago), the emergence of mammals (200 million years ago) and the emergence of flowering plants (125 million years ago).

Question 24 B

B is correct. The independent evolution of a similar feature in two separate species is referred to as convergent evolution. The two species did not inherit the patagium from the common ancestor; they were placed under similar environmental pressures and thus evolved to showcase similar traits. **A** is incorrect. Divergent evolution is when a single ancestor forms two different linages. **C** is incorrect. Homologous structures are features in organisms that appear to be different but in fact evolved from the same ancestor, such as the wing of a bat and the wing of a bird. **D** is incorrect. Molecular analogy is different sections of DNA taking on a similar sequence, which is unlikely due to the randomness of mutation.

Question 25 D

D is correct. The timeline can be used to determine the timing of events in the evolution of organisms in the phylogenetic tree. The more closely related individuals have a more recent branch. The tree is based on fossil evidence as well as molecular homology. From the evidence available, no evidence is recorded of the platypus from before 50 million years ago, and so this is the most reasonable answer. **A** is incorrect. More recently branched species would have more homology than species that branched less recently. **B** is incorrect. The common ancestor of all four species diverged about 220 million years ago, not 200 million years ago. **C** is incorrect. Placental mammals and marsupials diverged about 130 million years ago, not 150 million years ago.

Question 26 C

C is correct. The sequences are all compared to a human, not to each other. The greater the percentage homology, the closer the evolutionary relationship with humans. Multiple alignments would need to occur for a complete picture to emerge, but it is reasonable to suggest that humans are more closely related to mice than they are to mosquitos from this information. **A** is incorrect. The alignment search tool compares the differences in the proteins that the EFHC1 gene codes for against humans, so it is not reasonable to make a judgement on how mice and mosquitos relate to each other from this information. **B** is incorrect. The 1% difference is compared to humans, not compared to other chimpanzees. **D** is incorrect. Most genes carry the same sequence of amino acids.

Question 27 C

C is correct. The BMP4 gene is a master regulator gene that controls the activity of other structural genes. If the gene is active for longer during embryological development, the amount of keratin that is formed for the beak is greater. This leads to thicker and larger beaks more suited to breaking open seeds. **A**, **B** and **D** are incorrect. They state or imply that the resultant beak will be small and thin.

Question 28 D

D is correct. *Australopithecines* are an ancestral human that showed clear evidence of bipedalism but small cranial capacity. They exist along the hominin line between the ancestor of chimpanzees and humans. **A**, **B** and **C** are incorrect. *Australopithecines* would be classified as primates (all monkeys, apes and hominids), hominids (all tailless apes) and hominins (humans and bipedal ancestors).

Question 29 C

C is correct. mtDNA can be used as a molecular clock to determine ancestry. Mutations, while random, will, on average and over the long term, occur at a set rate. The more differences, the longer it has taken for the differences to accumulate. It would therefore be expected that there would be fewer mtDNA differences between different indigenous peoples in South America compared to the differences between different indigenous peoples in Australia. **A** is incorrect. Indigenous peoples in Africa have existed for longer than indigenous peoples in Australia and so should have more differences. **B** is incorrect. This option relates to evidence from migration between Australia and New Zealand, which is not supported by any of the mtDNA information given. **D** is incorrect. The differences are measured between more than two individuals, and so the average difference between two individuals would be expected be 180 differences, but this cannot be predicted in a specific case.

Question 30 B

B is correct. Bipedalism evolved in *Australopithecines,* and the increase in cranial capacity developed afterwards as illustrated by the fossil record. A bigger brain would enable better problem-solving strategies, which includes the stone tool manufacture seen in *Homo habilis.* **A**, **C** and **D** are incorrect. These options are all evidence of bipedalism.

Question 31 B

B is correct. Restriction enzymes bind to specific cutting sites and the DNA is cleaved at that site. Different restriction enzymes bind to different sites, and so knowing the sequence of the target alleles is important for genetic tests such as the one in this question. **A** is incorrect. The normal form allele is the one the mutation must occur within. **C** is incorrect. The restriction enzyme cuts rather than holds the allele together. **D** is incorrect. The diagram shows that two unequally sized fragments are formed.

Question 32 C

C is correct. The child with sickle cell disease would carry two alleles that have not been cut with the restriction enzyme, leaving two long fragments. This should leave one band on the gel close to the wells.
A is incorrect. Lane 3 does not show a band and so the profile only shows the results of two children.
B is incorrect. The gel shows four different sized bands, whereas this test should only show three.
D is incorrect. There are two children with sickle cell disease in this genetic profile.

Question 33 B

B is correct. There are several parameters that enable DNA fragments to be pushed through a gel. These include:

- the size of the fragments (smaller ones move faster)
- the voltage applied (higher voltage pushes fragments faster)
- the concentration of the buffer solution (higher concentration increases electricity flow)
- the duration that the gel is run (a longer time means the DNA gets pushed further).

A, **C** and **D** are incorrect. These options will all push the DNA fragments more slowly.

Question 34 A

A is correct. Plasmids are small circular strands of double-stranded DNA located in bacteria. They are routinely used in biotechnology. **B** is incorrect. Plasmids are circular and not linear. **C** is incorrect. Plasmids are found in prokaryotes and not eukaryotes. **D** is incorrect. Plasmids are double-stranded sequences of DNA and not single-stranded.

Question 35 A

A is correct. A pandemic relates to a pathogen that has become a world-wide problem. A very contractable disease with relatively high mortality rate such as COVID-19 meets this definition. **B** is incorrect. An epidemic is localised to one or two areas, but is contained within them and has not spread further.
C is incorrect. Sporadic refers to irregular bursts and does not describe a disease such as COVID-19.
D is incorrect. Endemic refers to something confined to a single particular area.

Question 36 B

B is correct. Relenza binds onto the neuraminidase protein on the surface of the virus, preventing the virus from severing its link with the hijacked cell. It is then unable to spread. Relenza is only useful for a short time after infection while the number of infected cells in the body is low. **A** and **C** are incorrect. Hemagglutinin does allow viral entry but is not the target of Relenza. **D** is incorrect. Neuraminidase allows viral exit from a cell, not entry into a cell.

Question 37 B

B is correct. Antibiotics are an effective treatment against bacterial infections. The agar plate demonstrates that the largest zone of no growth was around the tetracycline disc. **A**, **C** and **D** are incorrect. The other antibiotics have less effect against the bacteria than tetracycline.

Question 38 D

D is correct. The incorrect method of using the electronic scale means the mass of yeast will include the mass of the plastic weighing dish. This means the amount of yeast present will be less for each trial, leading to fewer enzymes available to combust the glucose. The error is systematic because all results deviate from the actual result by the same amount. **A** is incorrect. Random errors lead to individual results being incorrect, so it would be unlikely for random errors to produce consistency in their results as is shown in the graph. **B** is incorrect. Experimental bias is the result of a flaw made in the experiment that could affect the quality of the data. **C** is incorrect. Poor methodology has led to lower results, but it is more accurate to say the error is systematic than to say it is an experimental error.

Question 39 C

C is correct. The control in an experiment is identical in all factors and does not include the independent variable. In this case, the trial that did not have the inhibitor added is the control because the effect of the addition of the inhibitor can then be compared to an experiment that was not affected by the independent variable. **A** is incorrect. The same amount of sugar is a controlled variable. **B** is incorrect. This option identifies the wrong sample; it is the experiment with no inhibitor that is the control. **D** is incorrect. The experimental data collected using the correct method is not the control, as errors are not planned for in an experimental method.

Question 40 A

A is correct. Sandra's survey is measuring people's choices, and therefore percentage of the preference for each type of vaccine is the dependent variable. **B** is incorrect. The type of vaccine is the independent variable. **C** is incorrect. A high number of people will make the data more reliable, but this is not the dependent variable. **D** is incorrect. The proportion of people not getting the vaccine is a subset of the data, not the dependent variable.

SECTION B

Question 1 (8 marks)

a. **i.** A, B, C and D 1 mark

ii. E 1 mark

iii. A, C, D, F and G 1 mark

b. Selectively permeable means that only certain chemicals can pass through a membrane, which relates to chemical polarity and size. 1 mark

Component F is a protein channel. It has a shape in the middle that allows a chemical, usually a specific chemical, to move through and will prevent other chemicals from doing so. 1 mark

Note: Accept responses that use the example of a lipophilic substance dissolving across the membrane.

c. The hydrophilic heads of phospholipids on the vesicle will fuse with the hydrophilic phosphate heads of the cell membrane. 1 mark

The hydrophobic tails of the vesicle membrane will fuse with the hydrophobic tails of the cell membrane, enabling the protein enclosed to be secreted. 1 mark

The movement of the vesicle towards the membrane requires energy in the form of ATP to carry out the process. 1 mark

Question 2 (6 marks)

a. **R:** poly A tail

S: mRNA

U: polypeptide (chain)

W: tRNA

2 marks

Award 1 mark for two or three correctly named structures.

b. In the ribosome, there is an area (Z) where a group of three mRNA nucleotides called a codon (T) binds to an anticodon (X), which is a group of three RNA nucleotides on a tRNA molecule. 2 marks

1 mark for correct description of both structures and area.
1 mark for correct description of the interaction between both structures and area.

c. Structure V is tRNA that does not have an amino acid attached, and structure W is tRNA that has an amino acid attached. 1 mark

Structure W binds to a specific amino acid, thus providing all the different types of tRNA (structure V) required for the process occurring in the ribosome (structure Y). 1 mark

Question 3 (8 marks)

a. **i.** protein 1 mark

ii. Rubisco has a specific three-dimensional shape that contains an active site. 1 mark

The active site is complementary to the substrates ribulose biphosphate and carbon dioxide. 1 mark

iii. One ribulose biphosphate molecule (5-carbon) combines with one carbon dioxide molecule (1-carbon) to form two phosphoglycerate molecules (3-carbon). 1 mark

b. **i.** Precision relates the range of the repeated results for each trial, with results that are close to each other resulting in high precision. 1 mark

The most precise light intensity is 50 lux, with two arbitrary units between the four results, whereas the other light intensities have more than two arbitrary units between the results gained for them. 1 mark

ii. As light intensity increased, the action of rubisco was not affected. 1 mark

At a light intensity of zero, the level of phosphoglycerate was approximately 39–40 arbitrary units, and this average did not significantly change with increasing light intensity. 1 mark

Question 4 (7 marks)

a. *Any one of:*

- a thick (waxy) cuticle
- thick cell walls

1 mark

b. **i.** As the elicitor molecule binds to an external receptor, it is hydrophilic in nature. 1 mark

Note: Accept responses that identify the molecule as water-soluble .

ii. The steps involved are as follows:

– reception *(Elicitor molecules bind to the receptor.)*

– transduction *(Second messengers lead to a cascade of reactions.)*

– response *(Jasmonate is formed.)*

1 mark

Note: Only the names of the steps are required for full marks.

c. Jasmonate binds to JAZ, releasing a transcription factor that binds to a gene to express the protease inhibitor and activate the gene. 1 mark

For bacteria that possess the *lac* operon, lactose can bind to a repressor, changing its shape so it will no longer bind to the operator. This allows the expression of the *lac* operon genes. 1 mark

d. The presence of a protease inhibitor within the leaf will be a form of chemical defence against future attacks by a caterpillar. 1 mark

If another caterpillar consumes the leaf, the protease inhibitor will bind to the protease enzymes within the caterpillar, stopping it from digesting protein. The caterpillar will then gain no benefit from consuming the plant and it will starve. 1 mark

Question 5 (8 marks)

a. A vaccine introduces antigens into the body so that an active immune response (production of memory cells) is stimulated without inducing the disease. 1 mark

b. Antigens meet a naive B cell with complementary receptors in the lymph nodes (clonal selection). 1 mark

The selected B cell undergoes cell division as well as differentiation into plasma B cells and memory B cells (clonal expansion). 1 mark

The plasma cells secrete antibodies that bind to the antigens injected to neutralise them. The memory cells remain in the system for a more rapid response to a future exposure to the antigen. 1 mark

Note: Discussion of T helper cells is not required for full marks.

c. A trial vaccination program should obtain a large number of healthy volunteers (including a range of ages, genders and ethnicities) who are then divided into two groups; a group that receives the vaccine and a control group that receives a placebo. 1 mark

Both groups should be permitted to move through the community in a normal fashion, where both will naturally be exposed to the disease. 1 mark

After a certain time, both groups should be tested for the presence of the disease. If a significantly larger population from the vaccinated group did not contract the disease when compared to the group given the placebo, members of the general population could be confident in the vaccine's efficacy. 1 mark

The whole program should be repeated for a greater level of confidence. 1 mark

Question 6 (7 marks)

a. autoimmune 1 mark

b. myelin sheath 1 mark

c. Surface proteins on the myelin sheath are recognised by the immune system as non-self. 1 mark

Antibodies bind to the myelin sheath and the immune system starts to destroy this part of the neuron. 1 mark

Any one of:

- Difficulty walking: Motor nerve degeneration leads to a lack of control of the leg muscles.
- Blurred vision: Sensory neurons to the eyes degenerate, leading to blurred vision.
- Speech difficulty: Motor neurons controlling the tongue lose function.
- Body tremors: Muscles can contract uncontrollably as the myelin is no longer able to control them.

1 mark

d. The diagnosed individual should be advised to relocate to the northern part of Australia. They should be encouraged to spend more time in the sun each day, as well as take vitamin D tablets daily. 2 marks

Note: Award 1 mark only if 1–2 of the factors are addressed.

Question 7 (7 marks)

a. allopatric speciation 1 mark

There was genetic variation within the ancestral group of squirrels. 1 mark

A geographic barrier formed between members of the ancestral group, in this case the formation of the Grand Canyon. 1 mark

Each group was exposed to different selection pressures over time. 1 mark

Speciation has occurred when the different populations are unable to produce viable offspring if they breed with each other. 1 mark

b. Evolution is defined as change over time through the accumulation of alleles within a population. 1 mark

It has taken 10 000 years for the speciation to occur according to the evidence, and so the change over time in the two groups of squirrels could be regarded as evolution. 1 mark

Question 8 (8 marks)

a. *Any one of:*

- Use comparative anatomy with modern organisms.
- Use the mass of living bone and compare this to the volume of bone in the *Mamenchisaurus.*
- Use the mass of living tissue over bones for comparison.

1 mark

b. **i.** No older fossils (than 160 million years ago) of this type have been found and no younger fossils (than 145 million years ago) have been found. 1 mark

ii. A sample of volcanic rock would be located above and below (or nearest to) the fossils and the amount of uranium in each sample would be determined. 1 mark

By calculating the amount of half-lives that have elapsed in both samples, a time period could be determined. *(For example, if about 0.03 of a half-life has elapsed, the fossil would be 135 million years ago and if 0.04 of a half-life had elapsed, the fossil would be 180 million years ago).* 1 mark

Note: Calculations of half lives are not required for full marks.

c. Anatomical homologies would need to exist that demonstrate each specimen belongs to the same genus. 1 mark

For example, vertebrae from each specimen would need to have similarities in size, shape, positioning and placement. 1 mark

Inference can link skulls and limbs if the vertebrae of two specimens clearly fit together. 1 mark

Differently sized and shaped vertebrae between specimens would support the argument that the fossils do not belong to members of the same species. 1 mark

Question 9 (8 marks)

a. *For example:*

A social implication is that the modified canola oil is cheaper to produce than coconut oil. 1 mark

An ethical implication is that the modified canola has not yet been permitted to be sold for human consumption, meaning there could be unknown side effects from the genetically modified plant. 1 mark

Note: There are other acceptable responses. The implications must relate to the information provided in the question for full marks.

b. Both a plasmid from a bacterium exposed to a restriction enzyme and a purified *Laurate thioesterase* gene are exposed to the same restriction enzyme so that complementary sticky ends are exposed. 1 mark

The plasmid and gene are added together with ligase so that a recombinant plasmid is formed. 1 mark

Untransformed bacteria and the plasmid are added together to form transformed bacterium, which are selected and extracted from the culture. 1 mark

Transformed bacteria are added to canola cells so that the plasmids are inserted into them. The canola cells are then allowed to grow and divide, containing the new genetic information. 1 mark

c. The genetically modified canola plant is both a genetically modified organism and a transgenic organism. 1 mark

Genes from a California bay laurel as well as a gene from a coconut plant have been incorporated into the genome; if the canola plant were only genetically modified, it would only have alterations of its own genome. 1 mark

Question 10 (13 marks)

a. If the temperature of the DNA mixture of primer and *Taq* polymerase is increased, then the Tm will increase as the mixture deviates from the optimum temperature. 1 mark

b. *Any two of:*

- volume of DNA solution added to each tube
- incubation times and temperatures *(90°C for 60 seconds and 60°C for 30 seconds)*
- volume of Taq polymerase and primer added to each tube
- time of exposure of each tube to the independent variable *(60 seconds)*
- final heating time and temperature *(90°C for 60 seconds)*

2 marks

1 mark for each correct controlled variable identified.
Descriptions of how the variables were controlled are not required.

c. The Tm is a measure of how well the DNA complementary base pairs break (denature). G–C bonds require more energy to break than T–A bonds, and so if the sequence and length varied, the amount of heat needed to break the bonds would vary. 1 mark

DNA with different sequences and lengths would act as a confounding variable for the experiment, which would invalidate any results drawn from the experiment. 1 mark

d. **i.**

Tube Number	Temperature that the mixture was heated to (°C)	DNA melted (%)
A	**60**	**67**
B	**85**	**70**
C	**70**	**73**
D	**78**	**77**
E	**75**	**81**

4 marks

Award 1 mark for two complete, correct rows.
Award 2 marks for three complete, correct rows.
Award 3 marks for four complete, correct rows.
Award 4 marks for five complete, correct rows.

ii. The optimum temperature is the temperature where there are maximum collisions between enzyme and substrate (from 65–75°C, the Tm production increased from 65% to 90%), 1 mark
but also where the three-dimensional shape of the active site can remain intact (from 75–85°C the Tm production decreases from 90% to 75%). 1 mark

e. **i.** Repeatability means the same experiment is conducted more than once by the same experimenter using the same equipment and similar results were obtained. 1 mark

ii. Reproducibility means that the same experiment can be conducted by different experimenters using different equipment and similar results were obtained. 1 mark