Neap:

Trial Examination 2015

VCE Biology Units 3&4

Written Examination

Suggested Solutions

SECTION A: MULTIPLE-CHOICE QUESTIONS

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

SECTION A: MULTIPLE-CHOICE QUESTIONS

Question 1 B

P (phospholipid), *Q* (phosphate head), *R* (fatty acid) and *S* (cholesterol) are all integral parts of the membrane. The term hydrophilic literally means water-loving, and it is the phosphate heads of the phospholipid that have this property. The components (fatty acid and cholesterol) in the question are hydrophobic and so do not mix well with water. A whole phospholipid is both hydrophobic and hydrophilic.

Question 2 A

The cholesterol is a steroid (lipid) and, as such, has a high affinity for the fatty acid component of the phospholipid. The function of cholesterol is to help maintain fluidity of the membrane. If the cholesterol level is too high, the membrane is too fluid, and if it is too low, the membrane is not fluid enough. Arctic fish need a high level of cholesterol in their membranes to keep their membranes from crystallising (solidifying) at the low temperatures they are exposed to. Cholesterol is kept within the membrane of the fatty acids due to its generally hydrophobic nature. Apart from helping to maintain membrane fluidity, cholesterol does not play a significant role in the movement of other chemicals across the membrane.

Question 3 B

Textbooks regularly use diagrams to illustrate the structure of various cells and molecules. However, it is easy to lose track of their size differentiation. This question investigates this idea by using two units of measurement (the μm and the nm). Note that there are 1000 nm in 1 μm and 1000 μm in 1 mm. The white blood cell is the biggest, followed by the bacteria, virus and then prion respectively. This means the bacteria is the correct size.

Question 4 D

For the Units 3&4 Biology course, condensation reactions are those where large organic molecules are formed from smaller ones. They are sometimes referred to as condensation polymerisation reactions. ATP breakdown is an example of a hydrolysis reaction, as is the digestion of fat (triglycerides) and the breakdown of polysaccharides, like starch. Glycogen formation from glucose monomers is the only condensation reaction.

Question 5 A

RNA nucleotides, like DNA nucleotides, are comprised of three components. Two of the components are essentially the same, that being a phosphate and a nitrogenous base (A, G, C and U). However, the final component is a 5-carbon ribose sugar. This can be distinguished from a 5-carbon deoxyribose sugar in that there is one less oxygen in the deoxyribose compared to the ribose.

Question 6 A

Anticodons are complementary to codons on mRNA. They are part of a tRNA molecule and carry a specific amino acid within their structure. This means that tRNA play an integral part in the translation of the code in mRNA into a specific order of amino acids (polypeptide). The anticodon binds onto the codon within the ribosome to ensure the correct amino acid is placed in the correct position.

Question 7 A

The natural method students tend to use is to assume the sequence given is mRNA and the amino acids coded for are predicted due to the codons along the strand. This question provides a DNA template which has to be transcribed into mRNA. Then the complementary anticodon needs to be worked out to solve the question. See below for detail.

DNA template: AAA TTT GAG CTC
mRNA code: UUU AAA CUC GAG
tRNA anticodons: AAA UUU GAG CUC

amino acid order: phenylalanine-lysine-leucine-glutamine

Question 8 C

Energy profile diagrams give information about an enzyme-catalysed reaction. They show whether the reaction is anabolic or catabolic, and that the addition of an enzyme lowers the activation energy required for a reaction to proceed. This reaction is catabolic (an energy-releasing reaction), where the activation energy required, with the addition of a catalyst, is about 30 AU (the distance between the reactant level of about 45 AU to about 75 AU). Without a catalyst, the activation is from the energy level of the reactants (45 AU) to the highest peak (105 AU). This makes the E_a = 60 AU.

Question 9 D

The level of understanding required for the enzyme theory is that of the lock-and-key hypothesis. This means the enzyme is the lock and the substrate is the key. More specifically, the active site of the enzyme is the lock and the substrate is the key, which fits perfectly into the active site. It could be stated that the enzyme's active site is complementary to the substrate.

Question 10 B

To solve this question, a thorough understanding of the metabolic processes within cells is needed. **A** is incorrect because it is the light-dependent reaction, not the light-dependent reaction, occurring in the grana. **C** is incorrect because glycolysis occurs in the cytosol, not the mitochondria. **D** is incorrect because Kreb's cycle occurs in the matrix of the mitochondria, not the stroma of the chloroplast. **B** is correct because ATP hydrolysis (to ADP and Pi) occurs at the ribosome during protein synthesis, as this is an endergonic reaction.

Question 11 A

Nerve responses are faster, shorter in duration, and electrical when compared to hormonal messages. Both messages are directed to target tissue using different mechanisms. Nerves direct messages along neurons to the target effector, and hormonal messages mix into the blood stream and bind to receptors on or in the target cells. Both types of responses can be triggered because of internal or external changes. For example, if a human sees something scary, it may trigger the hormone adrenalin to be secreted. However, if they become dehydrated, the secretion of ADH will occur. Regulation of vasodilation could be due to internal changes in temperature, and the movement of muscles could be due to seeing a threat.

Question 12 C

Students should be able to appreciate how a signalling molecule is able to be converted into a specific response. In the situation presented, *P* refers to the signalling molecule that will bind to *Q*, which is a membrane receptor (complementary to the signal). A second messenger pathway (*R*) then transmits the message that leads to a specific response (*S*). Specific second messenger molecules, like G proteins, cAMP and protein kinases, are not required knowledge. It should also be noted that one signalling molecule bound to a receptor could lead to an amplified response.

Question 13 D

As the signalling molecule is binding to a membrane receptor, it could be concluded that the signal is a protein rather than a steroid. The response in this case is the activation of an enzyme that leads to the conversion of monomers into a polymer. So glucose molecules being converted into glycogen is a likely action. It should be noted that students do not need to know facts about specific hormones such as insulin, testosterone or oestrogen. An understanding of the action of either type of hormone (protein or steroid) is required.

Question 14 B

Signalling molecules fall under four general categories. Animal hormones, plant growth regulators, pheromones and neurotransmitters are the signalling molecules students should be familiar with. **A** is incorrect because hormones are a type of signalling molecule. **C** is incorrect because pheromones are not hormones. **D** is incorrect because neurotransmitters are not a type of plant growth regulator. Students are encouraged to construct a flow chart depicting all the signalling molecules, including examples of each.

Question 15 C

A muscle that is stimulated in this case will be contracted. It would be expected that such a muscle would be contracted when gripping a hot saucepan handle (it should be noted that muscles usually work in pairs to move bones and this question is attempting to simplify this idea). The question does describe that to release the handle, the muscle needs to relax, which is the key to correctly answering the question. If nerve pathways 1, 3 and 5 are inactive and nerve pathways 2 and 4 are active, the saucepan handle would be released quickly and no serious damage would occur. This is part of a typical reflex arc.

Question 16 D

Too often people are prescribed antibiotics when they have a viral infection. The antibiotics are effective against bacteria because they disrupt various aspects of their metabolism with a minimum amount of side effects for the person taking them. They are ineffective against viral diseases because a virus does not metabolise. Viruses hijack cells and generate more viruses within them until they literally burst.

Question 17 C

A chemical barrier (waxes, acids, mucus) can be distinguished from a physical barrier (skin, epidermal layers, ciliated cells), but they both function at the first level of defence. This is a level that a pathogen needs to breach prior to entering the body. The secretion of terpenes is a form of chemical defence, and even though students should not necessarily know about them, they should be able to recognise they are a form of chemical defence.

Question 18 A

The lymphatic system is an important component of the body's capacity to defend itself when faced with the invasion of pathogens. It begins at most body tissues and, like the capillaries, absorbs material from the interstitial fluid surrounding the cells. If there is a pathogen or a toxin in that part of the body, it is then moved to the lymph nodes through the actions of one-way valves. This is where there is a high concentration of lymphocytes and thus a high chance of non-self recognition. The lymphatic ducts then empty into the large veins near the heart. It is a one-way system important for successful body defence.

Question 19 C

Immunosuppressant medication that is given to patients who are the recipients of transplanted organs is designed to stop the T cell response from rejecting the organ. The T cell response generally acts against cells (viral-infected cells, fungi) and the B cell response is generally against smaller particles (virus, toxins). The immune response is more effective if both the B and the T cell responses are active; however, if the B cell response remains active, some degree of immunity will still occur. **A** and **D** are both incorrect because they are cells causing the problem. **B** is incorrect because a virus' life cycle includes a cellular stage. A spider bite would only include toxins that the B cell response should be effective against.

Question 20 B

Mast cells are active in parts of the body where infection is likely to occur (skin, gut, lungs). It is part of the second line of defence; however, the action of some mast cells can be a 'learned' response; for example, an allergic response. The components of the mast cell include antibody receptor sites (*J*), antibodies (*H*), histamines that trigger inflammation (*I*), histamines within a vesicle prior to secretion (*G*) and an allergen that is involved in the secretory action of the mast cell (*K*).

Question 21 B

During mitosis the chromosomes, once visible, are said to be in prophase. The chromosomes then align across the equator, with the spindle fibres attaching to them at the centromeres during metaphase. The sister chromatids are pulled apart during anaphase and get further away from each other until the cell starts to pinch in half during telophase and cytokinesis. The graph shows sister chromatids being separated apart from approximately 13 minutes until approximately 20 minutes.

Question 22 D

The data table shows organism, genome size and haploid number. There is no correlation between haploid number and genome size, making **A** incorrect. Just because different organisms have the same haploid number does not mean the genes along them are the same, making **B** incorrect (note that the dog and chicken have vastly different genome sizes). The table gives no information relating to genome size and the number of genes, making **C** incorrect. An onion's diploid number would be 16, which is the same as the haploid number of the yeast, making **D** correct.

Question 23 D

The chromosomes in the diagram are homologous due to their similarity in size and position of the centromere. The inner chromatids are crossing over in two locations. This indicates that the cell these chromosomes are inside of is undergoing meiosis (which does not occur in binary fission) and, more specifically, the first division of meiosis. This is the part of meiosis where independent assortment of chromosome pairs occurs (metaphase I).

Question 24 C

The karyotype clearly shows twenty-two pairs of autosomes and three sex chromosomes. There are two X chromosomes and one Y chromosome, indicating a male (due to the presence of the Y chromosome). There are two copies of each gene present apart from the Y chromosome. The chromosomes are found within cells that are undergoing mitosis from the amniotic fluid the baby is floating in. The chromosomes have two chromatids each and one centromere.

Question 25 D

The baby would be diagnosed with Klinefelter's syndrome (XXY) and it would occur as a result of nondisjunction during meiosis. **A** is incorrect because nondisjunction could occur in the father (where the X and Y chromosomes end up in a gamete) as well as an X from the mother. **B** cannot be correct because if nondisjunction occurred during meiosis II of a male, there would be either two X or two Y chromosomes in a gamete, and either combination could not lead to XXY. The scenario in **C** would lead to four sex chromosomes in a karyotype, which is incorrect. **D** is correct because nondisjunction in the mother would lead to gametes with an XX combination. This could combine with a Y from the male to produce XXY.

Question 26 C

Based on the information in the table, I^Ai would be blood type A, Rr would be rhesus positive and L^ML^N would be type MN.

Question 27 D

There are many genotypes possible. With respect to the ABO blood-typing gene, there are six possible genotypes (I^AI^A, I^Ai, I^AI^B, I^BI^B, I^Bi and ii). With respect to the rhesus factor gene, there are three possible genotypes (RR, Rr and rr). With respect to the MNS gene, there are also three genotypes (L^ML^M, L^ML^N, L^NL^N). To work out the possible number of genotypes, the number of the genotypes for each gene are multiplied by each other. This is $6 \times 3 \times 3 = 54$.

Question 28 A

The problem can be treated like two monohybrid crosses. The chance of a type A child from two type AB parents would be $\frac{1}{4}$. The chance of a Rhesus negative child from heterozygous parents (Rr) would also be $\frac{1}{4}$. The collective probability of a type A negative is $\frac{1}{4} \times \frac{1}{4} = \frac{1}{16}$. The other method that could be used is to construct a dihybrid punnet square of 16 grids (see below).

	I^AR	I^Ar	I^BR	I^Br
I^AR	I^AI^ARR	I^AI^ARr	I^AI^BRR	I^AI^BRr
I^Ar	I^AI^ARr	I^AI^Arr	I^AI^BRr	I^AI^Brr
I^BR	I^AI^BRR	I^AI^BRr	I^BI^BRR	I^BI^BRr
I^Br	I^AI^BRr	I^AI^Brr	I^BI^BRr	I^BI^Brr

Question 29 B

Protein synthesis has been heavily assessed over the past few years, particularly in the short-answer section. A clear understanding of the steps and chemicals involved is required. Initially the DNA must be transcribed (step *M*) and the pre-mRNA (chemical *N*) needs to be modified. This modification removes introns, and the smaller mRNA (chemical *O*) is comprised of only exons. The mRNA leaves the nucleus and is fed through a ribosome to be translated (step *Q*) into a protein (chemical *P*).

Question 30 D

The DNA sequence illustrated has several binding sites that the restriction enzymes in the data table will bind to and cut the DNA. All of the binding sites are highlighted and italicised.

AACTTTAGC*CCCGGG*AGCAC*GAATTC*GGATGCTTGC*TCGA*TAGCAACGTC
TTGAAATCG*GGGCCC*TCGAG*CTTAAG*CCTACGAACG*AGCT*ATCGTTGCAG

This means the DNA would be cut in three locations, making four smaller strands.

Question 31 B

Mutations are generally a random phenomenon that occurs at a set rate in an unchanging environment. This set rate can be increased in an environment with mutagens (UV light or X-rays). Because the genome is so large and the proportion of a genome that relates to genes is so small, the chance of a mutation occurring within a gene is low. Due to the redundancy of the genetic code, a mutation may have no effect on the primary structure of a protein. However, occasionally a change would occur which would usually place the organism carrying the mutation at a disadvantage. That being said, all organisms are full of 'good' mutations, because the mutations have offered some type of advantage in a changing environment.

Question 32 A

The stem of the question illustrates that the northern elephant seals have reduced genetic variation due to the population dropping to twenty individuals (presumably as a result of hunting). All of the 30 000 now in existence would have descended from those twenty. This explains the reduced genetic variety compared to the southern elephant seals. The phenomenon being case studied here is called a population bottleneck.

Question 33 A

The map shows the distribution of the larger land masses in the world. Students should be aware that marsupials are mainly endemic to Australia, but there are some distributed elsewhere also (South America). They are mainly terrestrial animals that would be unable to swim the very large distances between Australia and South America. The only explanation that fits the information relates to biogeography. Marsupials evolved when Australia and South America were on the same land mass that was called Gondwana(land). When the continents separated, marsupials were left in both.

Question 34 A

Stratigraphic correlation enables the relative age of fossils within various layers to be calculated. In one area, the deeper the layer, the older the fossils within that layer are. If similar fossils are located in two areas, they can be used as a reference to determine the relative ages of fossils above and below them. They are sometimes referred to as index fossils. Using the index fossils in *A4* and *B7*, it can be concluded that layers *A5* to *A7* are the oldest layers (making area *A* have the oldest strata). Using the index fossils in layers *A1* and *B4*, it can be concluded that area *B* contains the youngest fossils.

Question 35 B

The two organisms illustrated are unrelated, yet carry the same phenotype with respect to flight. This is a clear example of convergent evolution, which states that unrelated organisms develop similar phenotypes due to being exposed to similar environmental conditions. The form of the wings are different and so would be regarded as analogous. It should be noted that students are regularly attracted to **C**-type answers, which are Lamarckian statements. Organisms do not change to suit their environment; the best variant survives to breed more successfully.

Question 36 B

Radioisotopic dating can be used to determine the absolute age of rocks or fossils. Different isotopes have different uses, and in this case, old volcanic rock with potassium in it is being used to calculate the oldest rocks on the planet. The isotopes decay at a set rate and they also have a known half-life (the amount of time it takes for a given sample to lose half the mass of a particular isotope). Using the graph, for a sample of rock to be 4.6 billion years old, it would need about 8% of the original potassium present compared to 'fresh' rock.

Question 37 C

Cladograms illustrate the evolutionary relationships that different related organisms have. This can be done based on morphology, biochemistry, or both. There is a scale at the bottom of the cladogram that can be used to determine times of divergence between different groups. Mice and rats diverged about 17 million years ago, compared to the orangutans and gorillas that diverged about 15 million years ago, making them more closely related.

Question 38 C

To determine if seeds display a particular phenotype due to genetics alone, those seeds, when fully grown plants, should show a similar phenotype to the plants they were removed from. **A** does not show whether height is genetic or environmental. **D** would provide information that could not possibly be compared. **B** would occur if the expression of height was only environmental.

Question 39 D

An understanding of *hominins* and their place in the evolution of *Homo sapiens* is required for the last part of the Units 3&4 course. Prolific tool use was associated with *Homo habilis*, the first use of fire was associated with *Homo erectus*, and coexistence with *Homo sapiens* was associated with *Homo neanderthalensis*. There are many other features that each of these *hominins* displayed which show a line leading towards modern humans.

Question 40 D

Gene therapy is a form of technology at the pinnacle of biotechnology. It is going to hopefully lead to the cure of genetic diseases, such as cystic fibrosis. Gene therapy can be somatic (where normal functioning genes are inserted into somatic cells) or germ line (where normal functioning genes are inserted into gametes). Somatic therapy would cure the individual, but the alteration is not heritable, whereas germ line therapy would include the alteration in every cell descended from the one with the original alteration. It should be noted that gene therapy is not yet commercially available.

SECTION B: SHORT-ANSWER QUESTIONS

Question 1 (7 marks)

a. *D*, *B*, *C*, *A*, *E*, *F* 1 mark

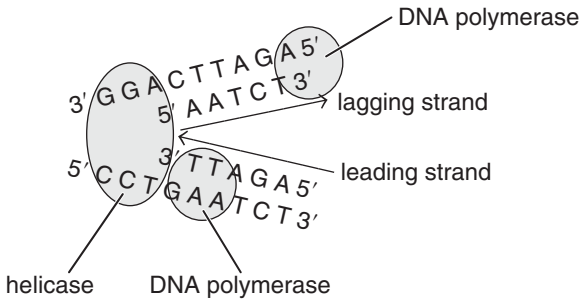
b. **i.** 3′ G G A C T T A G A 5′
5′ C C T G A A T C T 3′ 1 mark

Both the correct sequence and the orientation of the nucleotides is expected.

ii. Within the diagram, students should show that the new strands form along each strand once the H-bonds are broken. 1 mark

Within the diagram, they should illustrate that enzymes are involved in the helicase and DNA polymerase processes. 1 mark

The diagram should show that the DNA is replicated in opposite directions (leading and lagging strand), with the new strands forming along the template strand in the 5′ to 3′ direction. 1 mark



*Students must use the strands from part **i.** and include both enzymes for full marks.*

c. *Any one of the following:*

- Structure/function: cell respiration
  How: DNA codes for the production of enzymes that control the process.
- Structure/function: production of ribosomes
  How: DNA codes for the production of rRNA and the proteins making up the ribosome subunits.
- Structure/function: movement across the membrane
  How: DNA codes for the production of protein channels that will be embedded within the membrane.

2 marks
1 mark for listing appropriate structure/function
1 mark for explanation of how the genome controls the structure/function

Question 2 (5 marks)

a. Leaf discs floating are not a product of photosynthesis. Oxygen gas is the (direct) product of photosynthesis that accumulates within the disc, causing the leaf discs to float (indirect). 1 mark

Note: Students should be able to visualise the experiments outlined in examinations.

b. At low temperatures (15°C) the enzymes which catalyse photosynthesis and the substrates slow down their (kinetic) movement. This leads to fewer collisions between substrates and enzymes, meaning it will take more time for oxygen gas to accumulate in the leaf, lengthening the timeit takes for the leaves to float. 1 mark

At high temperatures (60°C) the enzymes which catalyse photosynthesis start to denature (change their three-dimensional shape). Even though the movement of chemicals will be faster due to the increased heat, there will be less effective collisions between substrates and the (denatured) enzymes, meaning it will take more time for oxygen gas to accumulate in the leaf, lengthening the time it takes for the leaves to float. 1 mark

c. **i.** the bicarbonate ions: As a source of carbon (CO_2), they are involved in carbon fixation (the Calvin cycle) within the stroma of the chloroplast. The products are glucose (water, ADP, Pi, NADP). 1 mark

ii. water: This is split during the light-dependent part of photosynthesis. The products of this process are O_2, H (NADPH) and ATP. 1 mark

Note: The information in brackets could be included, but is not essential for marks.

Question 3 (6 marks)

a. **i.** trials 2 and 5 1 mark

ii. As the hydrogen peroxide concentration increases, the rate of mass loss increases (up to a point, then levels off). 1 mark

iii. 0.9 ± 0.05 g/min 1 mark

b. Get fifty cultures of kidney cell lines mixed with *Streptococcus* bacteria and divide the cultures into two groups.

- Group 1: Expose the kidney cell culture to all the conditions needed for effective growth as well as 0.1% hydrogen peroxide.
- Group 2: Expose the kidney cell culture to all the conditions needed for effective growth as well as 0.05% hydrogen peroxide.

This means that the variable of hydrogen peroxide is the independent variable. 1 mark

The conditions for effective growth would include temperature (about 37°C), pH (about 7) and the volumes of culture media (small volumes). These are referred to as the controlled conditions. 1 mark

Note: There are many controlled conditions – students should make reference to two.

After some time (two days) the cultures are examined for the presence of bacteria, by counting them in small volumes of the culture media (using a microscope). The number of bacteria would be the dependent variable. 1 mark

Note: There are a variety of methods that could be used to determine bacterial populations.

Question 4 (7 marks)

a. The GA has the same shape as a signalling molecule and would bind to receptors on cells that have the same complementary shape. The second messenger within the cells could lead to a different end result; 1 mark
for example, the activation of a gene to produce and secrete amylase in a germinating seed, or the activation of the gene that leads to the production of 'growth' proteins in a stem. 1 mark

Note: Specifics are not required here, but students should be able to show how the second message can lead to a different response.

b. **i.** 67.5 ± 2% 1 mark

ii. There would probably be too much GA present, so the cultivator could reduce the amount of GA provided to the plants. 1 mark

Note: This is the most obvious answer, but students could discuss availability of water and light as well as the amount of GA. Arguably there may be a small amount of GA, but not enough water or light.

c. Step 2: The second messenger activates the gene controlling amylase synthesis. 1 mark

Step 3: The RER is studded with ribosomes that will produce the amylase and place it within the lumen of the ER for transport towards the Golgi. 1 mark

d. Amylase activates starch, meaning it converts it into glucose monomers. The glucose can then be respired to generate the energy (ATP) needed for growth. 1 mark

Question 5 (5 marks)

a. **i.** apoptosis 1 mark

ii. Extracellular factors or intracellular factors provide the signal for apoptosis. This could be due to the cell becoming internally damaged (intrinsic factors released), or externally, the cell may be in the wrong location (extrinsic factors released). 1 mark

A signal cascade is induced, where only a few signalling molecules lead to a massive response. The cell's response is for its cytoskeleton to break down. The cell can no longer hold itself together, and it breaks apart. 1 mark

b. The **drug** could bind to the **receptor** (could be called a repressor), causing a conformational change that keeps the receptor bound to the operator region of the FGFR-1 gene. This would prevent the **RNA polymerase** from transcribing the gene, thus switching the gene off. 2 marks

1 mark for two terms correctly used
Full marks for all three terms correctly used

Question 6 (4 marks)

a. An antigen is a foreign substance (often a protein) that stimulates an immune response within the individual exposed to it. 1 mark

b. The more people protected, the smaller the reservoir of environments in which the pathogen can proliferate. This leads to less individuals within the group (unvaccinated infants) being exposed to the pathogen. 1 mark

c. The memory B cells within the vaccinated individual will have a large chance of coming in contact with the active H1N1 strain before it enters a cell. 1 mark

The B memory cells will rapidly clone and differentiate into plasma cells that produce antibodies against the antigens on the surface of the H1N1 virus, leading to its destruction. After the immune response, more memory cells will remain. 1 mark

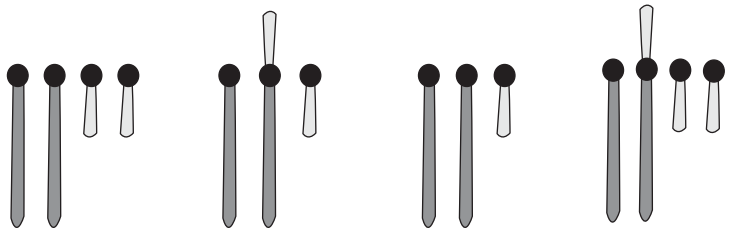
Note: Students could discuss the response relating to T cells or T_h cells. The T_h cell controls the response and the T cell response destroys the viral-infected cells.

Question 7 (5 marks)

a. without the translocation: 46
with the translocation: 45

1 mark

b.



2 marks

1 mark for two correct arrangements
Full marks for four correct arrangements

c. There would be a 25% chance of conceiving a baby with Down's syndrome. This is due to the presence of three copies of chromosome 21 in the cells (even though one is attached to a longer chromosome).

2 marks

1 mark for identifying percentage chance of Down's syndrome
1 mark for identifying the chromosomal arrangement
Note: Students may say that one of the arrangements is unviable, making the chance of a Down's syndrome child 33% rather than 25%. This is likely, but no information is given in the question to make this conclusion.

Question 8 (5 marks)

a. 4 (2 b alleles and 2 d alleles) 1 mark

b. The breeder would use any of the ten cats with lilac points
AND
the breeder would use any of the six cats with seal points. 1 mark

c. phenotype: lilac seal
genotype: bbdd BBDD

Offspring: If the seal cat was homozygous (BBDD), all the offspring would have a seal phenotype but would be heterozygous (BbDd), and so the original lilac cat could be used for breeding. 1 mark

Then the process is repeated with the other lilac cats (of opposite gender) until the same result is obtained. The breeder would have two cats of opposite gender with a genotype of BBDD. 1 mark

d. Chocolate cats have the genotype of B–dd, lilac cats have the genotype of bbdd, and blue cats have the genotype of bbD–.

There is no chance of a blue cat because parent cats are homozygous recessive for pigment dilution, and a blue cat needs a dominant form of that gene to be that phenotype. 1 mark

Question 9 (6 marks)

a. **i.** The presence of the *BRCA1* allele gives a greater risk of breast cancer, not a 100% chance, even though it is dominant.
OR
Individual II2 may not have developed breast cancer yet. 1 mark

ii. She has a 50% chance of having inherited the *BRCA1* mutation and, as such, she has a much higher chance of developing breast cancer compared to an individual without the mutation. 1 mark

b. DNA which is both transcribed and translated 1 mark

c. III4 is heterozygous. 1 mark

He has two bands, where the higher band represents the normal exon of 1050 base pairs. The lower band is the faulty exon that is 244 base pairs shorter. 1 mark

d. Women who are diagnosed with the *BRCA1* mutation may get depressed/have a mastectomy; however, it is not guaranteed that they will develop breast cancer. 1 mark

Note: There may be other disadvantages. These should relate to the presence of the mutation and this only being a predisposition. Students who discuss the cost or accuracy are not necessarily using the context of the question to formulate their answer.

Question 10 (8 marks)

a. No more living members of the species are present. This would normally need to be substantiated with no sightings or other evidence for a certain period of time. 1 mark

b. **i.** The discovery of an 18-million-year-old bandicoot fossil that shows evidence of most of the descendants, and 1 mark
the discovery of other fossils that are more recent and show a clear distinction that leads phenotypically towards the modern bandicoots, would be required. 1 mark

ii. DNA mutates at a set rate and DNA hybridisation measures the difference in particular nucleotide sequences between individuals. 1 mark

The number of DNA differences in the loci of modern bandicoots would be less than expected for an 18-million-year-old ancestor. 1 mark

c. The original population carried genetic variation and was split in two groups geographically. 1 mark

Each group was exposed to different environments and so different features were selected for, making each group more different to the other over time. 1 mark

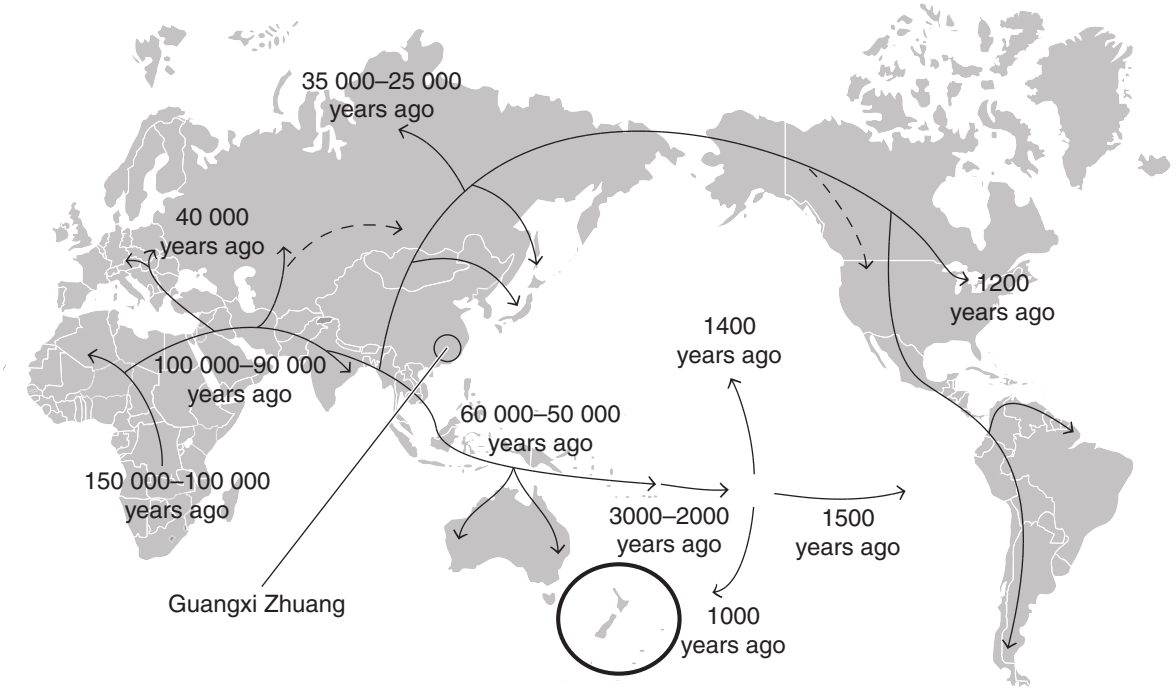
Over time, if the two groups physically interact with each other, there is no prospect of breeding to form fertile offspring. 1 mark

Question 11 (7 marks)

a. **i.** *Hominins* include modern humans and all their bipedal ancestors, as well as any other individual leading to modern humans. 1 mark

ii. *Homo sapiens* evolved in Africa and migrated out of Africa after this event. 1 mark

b.



1 mark

mtDNA mutates at a set rate, and so the more recent the existence of the modern human group, the more similarity would be expected in their mtDNA, as the mutations have not been able to accumulate for as long as more ancient groups of modern humans (such as in Europe). 1 mark

c. Radioisotopes have a known half-life, which means that in a given sample of matter, it takes a known amount of time for one half of the isotope in the matter to decay. 1 mark

By working out the amount of that isotope present in the sample compared to the amount of isotope that would originally be present in the sample, the actual age of the sample can be measured. 1 mark

d. Modern humans were there 130 000 years ago, but this is the first time evidence has been discovered.
OR
The tooth was carried from Africa by the humans that migrated to China. 1 mark

Note: Any logical answer that could explain the tooth's existence would be reasonable.

Question 12 (5 marks)

a. The proteomes would be different because the combination of proteins active within a cardiac cell is different to the combination of proteins active in a skin cell. 1 mark

b. Students could mount an ethical argument saying the use of embryonic stem cells wastes a life, whereas the use of adult stem cells does not.
OR
If the recipients own stem cells are used, rejection of the tissue will not occur, whereas this would occur if embryonic stem cells were used. 1 mark

Note: Students must make the comparison between adult and embryonic stem cells, as well as showing how it could be beneficial.

c. **i.** mitosis 1 mark

ii. The **genomes** of all the cardiac cells are the same. 1 mark

The position on the framework provides a signal for the cardiac stem cells to **differentiate** into the different types of cells needed to make specialised heart cells. 1 mark