Neap:

Trial Examination 2016

VCE Biology Units 3&4

Written Examination

Suggested Solutions

SECTION A – MULTIPLE-CHOICE QUESTIONS

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

Question 1 B

Glycerol is a component of fats and phospholipids, glucagon is a hormone involved in glucose regulation and guanine is one of the five nucleotides. Glycogen is a polysaccharide and is the carbohydrate storage molecule in animals.

Question 2 A

The organelle is a mitochondrion, which is involved in the cell respiration that provides ATP for endergonic activity in all eukaryotic cell types. The products of cell respiration within the mitochondria are CO_2, H_2O and ATP. The inner cristae (not grana) offer a large surface area for cell respiration reactions that have oxygen as a substrate (aerobic respiration).

Question 3 D

Translation is the word used to describe the events occurring at the ribosomes. mRNA moves through the ribosome, the codons along the molecule bind with anticodons on tRNA and an amino acid gets bound to the growing polypeptide. The nucleus is involved in transcription (DNA to mRNA), the chloroplast is involved in photosynthesis and the Golgi apparatus is involved in the secretion of chemicals from the cell (and their modification if needed).

Question 4 C

Phospholipids are a group of lipids that form cell membranes. They are comprised of two hydrophobic fatty acid tails, a glycerol and a hydrophilic phosphate group. With one end hydrophilic and the other end hydrophobic, these biomolecules cluster together in a bilayer and form the basis of a membrane. They are not polymers and are comprised of the elements C, H, O and P. The fluid mosaic model of membrane structure shows they are held within the membrane due to their hydrophobic nature, but they move within it. Cholesterol assists in maintaining this fluidity.

Question 5 B

Students should be able to recognise organelles that are involved in the manufacture, processing and secretion of biomolecules. Q (Golgi), R (mitochondria), S (vesicles) and T (rough endoplasmic reticulum) are the organelles involved in the question. The organelles directly involved in the manufacture and secretion of the signalling molecule based on the information provided would be initially the rough endoplasmic reticulum, to manufacture the signalling molecule (T). Then the Golgi (Q) packages the signalling molecule into vesicles (S) for eventual secretion from the cell. The mitochondria (R) provide energy for these processes but are not directly involved.

Question 6 B

Once the signalling molecule is secreted from the cell (exocytosis) it is in an extracellular environment. From here the signalling molecule would move into the bloodstream to circulate around the body and eventually bind to target cells elsewhere in the body. An action potential triggered the secretion in the first place (making **A** incorrect). The neuroglandular junction is the space between the axon and the cell, similar to a synapse (making **C** incorrect). Some signalling molecules bind to the cell that secreted them, but in this case the secretion is stimulated by a nerve message (making **D** incorrect).

Question 7 C

Hypotheses are generally written in the 'if … then …' format. In this situation the hypothesis could be, 'If the hydrogen peroxide percentage levels increase, then the rate of mass loss will increase'. The thing being changed deliberately – the independent variable (IV) (hydrogen peroxide percentage levels) – should be written first, and the factor being measured – the dependent variable (DV) (rate of mass loss) – follows. The hypothesis should be written before results are achieved, making **D** incorrect.

Question 8 D

The DV is the factor being measured to determine if the IV is having an influence. In this case, the DV is the rate of mass loss in g min^{-1}. The hydrogen peroxide percentage is the IV. The time for each experiment (5 minutes) and the concentration of catalase are referred to as controlled variables because they are the same for each trial.

Question 9 B

If the hydrogen peroxide percentage levels are increased, the amount of substrate available for the reaction is increased. As the concentration of hydrogen peroxide increases, the catalase becomes saturated with hydrogen peroxide. As soon as the active site is empty, more hydrogen peroxide is available to bind and undergo reaction. The rate of formation of oxygen and water (measured by mass loss) now depends on the activity of the catalase itself, and adding more hydrogen peroxide will not affect the rate of the reaction to any significant effect. With a constant amount of catalase this means that the reaction can increase until all of the active sites are occupied all of the time. This occurs at about 8% hydrogen peroxide, where the rate of mass loss levels out at 1.4 g min^{-1}.

Question 10 D

The DNA molecule can be transcribed into mRNA and then the mRNA can be translated into a protein. DNA is the only molecule on the planet that can faithfully replicate, which is important for cell division, but it does not show the functional link between DNA and protein.

Question 11 D

Steroid hormones are lipids and as a result dissolve through the plasma membrane of cells to bind to intracellular receptors. The general trend with lipid hormones is to activate genes (rather than activate enzymes) because their responses are usually longer lasting; however, unless given specific information about this, it is difficult to make a conclusion. Likewise, conclusions about the number of steps involved in signal transduction also cannot be made.

Question 12 A

The type of signalling molecule in the question, androstenone, is secreted from the saliva of a male pig. This moves through the environment (probably the air or physical contact) and is detected by the olfactory nerves of a female pig, who responds accordingly. This is typical of pheromones.

Question 13 B

Nerve cell A is an axon transporting an electrical message to the synapse, where the message is converted (by signal transduction) into a secretion of neurotransmitters originally enclosed within vesicles (1) via exocytosis (2) into the synaptic cleft (3). The neurotransmitters diffuse across the synapse and bind to receptors on the postsynaptic membrane (4), thus passing the signal to the dendrite of the next nerve (B). Nerve cell A and nerve cell B could either be a sensory/interneuron connection or an interneuron/motor neuron connection.

Question 14 D

For the horticulturist to grow the callus to provide ample plant tissue for further propagation, a solution of equal amounts of auxin and cytokinin would be required. After breaking up the callus into smaller portions, each portion would need to be exposed to an increased level of cytokinin to auxin to stimulate shoot growth.

Question 15 A

One signalling molecule binds to the receptor, triggering the release of (in this case) four G proteins. Once mobile in the membrane, each G protein stimulates the opening of an ion channel (each G protein could stimulate more than one ion channel). This is an example of signal amplification because one signalling molecule can lead to the opening of four ion channels, and each channel can allow many specific ions through. There is not enough information to make a conclusion relating to positive feedback, negative feedback or homeostasis.

Question 16 C

An organism is cellular and has the capacity to reproduce. A virus is non-cellular (sometimes referred to as a pathogenic agent); however, it binds to receptors on cells and 'hijacks' the cell to manufacture more virus. A prion is a protein that in the infective stage is misshapen. When the misshapen protein binds to normal prions it causes a conformational change in shape of the normal protein into the infective shape. Plasmodiums that cause malaria are cellular (protists) and so are pathogenic organisms.

Question 17 D

Physical barriers prevent the entry of pathogens and include cellular layers such as epidermal layers on leaves and the skin. Chemical barriers are secretions such as wax and mucus. These also prevent the entry of pathogens into the internal environment of an organism. The skin needs to be unbroken because if it had a cut in it, pathogens have an easy path into the internal environment.

Question 18 C

The function of T-helper cells is to help activate B cells to secrete antibodies and also help activate cytotoxic T cells to kill infected target cells. They do this by binding with the appropriate B or T cell prior to their proliferation and differentiation. They communicate with a complicated set of signals. First they need to bind to each other (via the MHC-II mechanism) and then the T-helper cell secretes lymphokines (signalling molecule) that stimulate the B or T cell to clone and differentiate. The HIV virus in the blood would normally be removed by a humoral response and the infected helper cells would normally be removed by the cell-mediated response. Both responses will be hindered.

Question 19 A

Allergies have a genetic link and an environmental link. Initially the allergy will occur, but subsequent exposures become more intense (hypersensitive). On first exposure the cells of the innate immune response, known as mast cells (found in parts of the body prone to infection, such as the throat and skin), are activated against the allergen. With a developing allergy, the mast cells become armed with specific antibodies against the allergen and so subsequent exposures become more pronounced. Once the allergen binds to the antibodies, histamines are secreted, leading to inflammation (and the symptoms of an allergic response). Indirectly, B cells are involved to make the antibodies as well as memory cells.

Question 20 B

Immunity can be gained artificially or naturally. Natural immunity would be gained through contracting the disease (chicken pox, for example). The body gets sick, but long-lasting immunity is the consequence (more memory cells). Natural immunity can be gained by obtaining antibodies across the placenta or via breast milk. This confers short-term immunity because memory cells are not produced against the antigen. Artificial immunity can be gained by vaccination (flu, for example), where the immune system is activated against the antigens injected. This confers life-long immunity. Artificial immunity can also be gained with an injection of antibodies (against a toxin, for example) and this is a short-term form of treatment. Monoclonal antibodies are manufactured outside the body and target cancer antigens, so this is a form of artificial passive immunity.

Question 21 C

Each chromosome is comprised of two identical chromatids (1) and a single centromere (2). The chromosomes are visible during the mitotic phase of the cell cycle, particularly during prophase, and then the chromatids separate during anaphase of mitosis. The chromosomes are compacted strands of DNA and protein (histone), which is a convenient way to distribute DNA accurately during cell division. Chromatin is the term used for the DNA within the nucleus that is bound to protein. Telomeres are the ends of the DNA strands; DNA in eukaryotic cells is linear and sometimes the telomeres 'wear out', which some hypothesise is a measure of the aging of cells.

Question 22 D

The cell cycle begins with interphase, where the DNA is not compacted as chromosomes and the nuclear membrane surrounds the DNA (5). Once the DNA replicates, it compacts into visible chromosomes within a membrane-bound nucleus; however, the cell cytosol is beginning to change appearance (4). The spindle fibres form and poles are visible at either end of the cell. Chromosomes are visible in the middle of the cell, attached to the spindles (2). The sister chromatids separate from each chromosome and are pulled to opposite poles by the contracting spindle fibres, which are anchored to the poles (1). A cell plate starts to form across the middle of the cell, which eventually separates the original cell into two cells (3). So the order is 5, 4, 2, 1, 3.

Question 23 D

Location 1 shows four chromosomes in anaphase, where the sister chromatids are about to separate. The chromosomes appear as two pairs and so this must be a mitotic division within somatic tissue (such as bone marrow or skin). Location 2 shows the chromosome pairs lined up next to each other (independent assortment) and the pairs are about to separate. This occurs during meiosis (metaphase I) and would occur in gonads (testes or ovary).

Question 24 A

The haploid number refers to the number of chromosomes in the sex cells of each organism. This is half the diploid number, making human 23, chimp 24 and monkey 21. The sex chromosome pattern of inheritance is the same for all primates with two sex chromosomes (XX in females and XY in males). Homologous chromosomes are paired chromosomes that carry the same genes. The non-sex chromosomes are homologous, and the females carry homologous sex chromosomes as well. The autosomes are those non-sex chromosomes remaining, and because the diploid numbers are different, each individual would have a different number of autosomes. The human has 44 autosomes, a chimp has 46 autosomes and a monkey has 40 autosomes.

Question 25 C

When DNA replicates the hydrogen bonds holding the complimentary strands together are broken by a helicase enzyme. This forms a replication fork from which two single strands emerge, each being a template for a new strand. DNA is antiparallel and the replication enzyme, DNA polymerase, moves along the template strand in the 3′ to 5′ direction, synthesising a new strand in the 5′ to 3′ direction. So the strand with the 3′ on the end is referred to as the leading strand and is continuously replicated in the same direction as the strand is being unwound. The other strand is more complex; it is referred to as the lagging strand and is copied in small sections, but in the opposite direction (Okazaki fragments). The process is more complicated as a result of this, but it is beyond the scope of VCE Biology.

Question 26 A

A test cross is a breeding situation where an individual of an unknown genotype is crossed with one that is expressing the recessive phenotype, in this case aabbcc. For the dog to be of pure breeding it would have to be homozygous dominant for all three genes in question, in this case AABBCC.

Question 27 A

Mitochondrial DNA is inherited along the maternal line. If an individual carries a genetic mitochondrial DNA disease, it would have been inherited from their mother (unless it was a mutation), who inherited her mitochondria from her mother, who is the maternal grandmother of the individual.

Question 28 B

Individual III-1 is female and not expressing the sex-linked trait. Her father does not express the trait and so he carries the normal allele on his X chromosome. Her mother must be heterozygous. There is no chance she could express the trait because her father only carries a dominant allele. However, there is a 50% chance she would inherit a recessive allele from her mother, so this means she has a 50% chance of being heterozygous.

Question 29 A

The trait is sex-linked recessive and the individual highlighted is a male expressing the trait. All males have an X and Y chromosome, and the X chromosome would have the recessive allele in the locus for this particular gene, making the genotype X^bY.

Question 30 B

All crosses were between yellow mice. It would be reasonable to conclude that their genotypes could be YY or Yy. However, all crosses produce yellow and wild type offspring, so the parents all have to be heterozygous. It would be expected that with these types of crosses and a large number of offspring, the ratio of yellow to wild type offspring would be 3 : 1. The collective result is 36 : 18, which is 2 : 1. This result is consistent with each of the crosses, so the best explanation would be that the YY genotype is lethal. This would generate a ratio of 2 yellow (all heterozygous) to 1 wild type. The punnet square below illustrates this.

	Y	**y**
Y	YY	Yy
y	Yy	yy

Question 31 D

The height distribution for the past 2000 years illustrates a continuous distribution of the height phenotype. This infers that height is a polygenic trait influenced by many genes as well the environment (making **A** incorrect). The graph showing a steady decline in height as the number of years ago increases illustrates that the environment could have had an impact on this human feature (diet, for example). Quantitative measurement of the influence of genetics and the environment is difficult but some work has been done using identical twins. Since genetics is a new science, it would not have provided potential answers and a means to increase height from 200 years ago (making **B** incorrect). If natural selection (rather than diet) was the major factor in leading to taller humans, then the gene pool would have had more 'short' alleles rather than fewer (making **C** incorrect).

Question 32 C

The first result (**A**) has had one crossover, leaving a single recombinant section on the end of the two inner chromatids. The second result (**B**) has had four crossover points, leaving two recombinant sections within each of the two inner chromatids. The third result (**C**) has had two crossover points, leaving one recombinant section within each of the two inner chromatids. The fourth result (**D**) has had three crossover points, leaving one recombinant section within and one recombinant section on the end of the two inner chromatids.

Question 33 A

In a population of 100 beetles, with respect to a single gene with two alleles (B and b), there are a total of 200 alleles in the population. The allele to represent brown is b, and if 26% of the 100 beetles have this phenotype, then there must be 52 b alleles within that group. The hazel beetles are heterozygous (Bb), and if 44% of the 100 beetles have this phenotype, there must be 44 b alleles within the group. This gives a total of 96 b alleles in the population.

Question 34 D

A selective advantage for the green beetles would place an advantage on the beetles with the BB genotype. The brown and hazel beetles would be at a selective disadvantage (those with genotype Bb or bb). This would lead to more B alleles in the population and fewer b alleles.

Question 35 B

The three subspecies of Burrowing bettongs belong to the same species, but as a result of living in separate groups, they would have distinct phenotypes (not unlike different races of humans); however, they would be able to successfully breed between subspecies. Gene flow would occur across the subspecies, which is the transfer of alleles or genes from one population to another, a distinct possibility if the populations are released near each other. Genetic drift is the change in the proportion of a particular variant within a population, and even though this may happen as a result of gene flow, there is no concrete evidence to support this. The founder effect is a special form of genetic drift occurring when small groups are relocated. The question is referring to the possibility of breeding. It is not discussing allele frequencies.

Question 36 D

When different organisms evolve a similar phenotype – in this case, wings for flight – the type of evolution is referred to as convergent evolution. This is when differently related organisms develop similar phenotypes due to a similar environmental pressure, which favours the similar phenotype.

Question 37 B

The larger the zygomatic arch, the more work the jaws would do, which means organism 1 did more chewing than organism 2. Organism 2 has a more central foramen magnum, which means it was bipedal. The foramen magnum being further back in organism 1 means that it was more likely to be a knuckle-walker.

Question 38 C

Students should be aware of the main groups of hominins, the order within the hominin evolutionary tree, their time of existence and major events they are credited with.

1. *Australopithecus afarensis* (3–4 million years ago): clearly bipedal
2. *Australopithecus africanus* (2–3 million years ago): ancestor to the *Homo* genus
3. *Homo habilis* (1.5 million years ago): prolific tool user
4. *Homo erectus* (1 million years ago): discovered fire
5. *Homo neanderthalensis* (200 000–20 000 years ago): buried their dead
6. *Homo sapiens* (200 000 years to present): us

Question 39 B

The context of the question gives specific information about the pressure the Pyrenean ibex was under. It was initially due to hunting, and then there were not enough Pyrenean ibex to sustain a viable population.

Question 40 C

With one individual to clone it would be unlikely a thriving population could eventuate. Celia was a female and so all the clones would also be that gender and genetically identical. This would mean there was no genetic variety in the population of Pyrenean ibex. Since the clones are not representative of the original population, it would be difficult to truly gain data relating to their impact on the environment. We originally hunted them to extinction anyway!

SECTION B – SHORT-ANSWER QUESTIONS

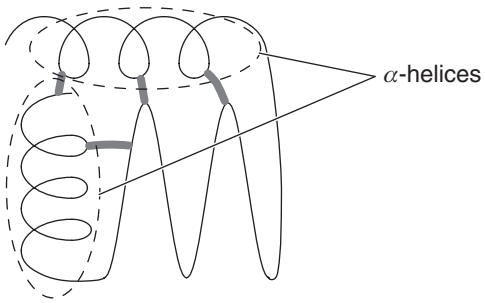
Question 1 (6 marks)

a. **i.** protein (polypeptide) 1 mark

ii. DNA (accept nucleic acid) 1 mark

b. four 1 mark

c. **biomacromolecule 1**



1 mark

Both α-helices must be labelled.

d. carbon, hydrogen, oxygen, nitrogen and phosphorous 1 mark

All elements are required. Accept C, H, O, N and P.

e. The disulphide bonds are covalent links within the polypeptide chain that hold the three-dimensional shape (tertiary structure) of the polypeptide together. 1 mark

Question 2 (7 marks)

a. Both organelles are small packages of chemicals that maintain their shape within the cell. The cell's environment would have a certain concentration of solutes within it that is isotonic to the mitochondria or chloroplast. If the external environment was hypotonic (free of solutes), the mitochondria and chloroplast would gain water via osmosis and burst. 1 mark

b.

	Input(s)	Output(s)
Chloroplast	oxygen, water, light energy	carbon dioxide, glucose
Mitochondria	pyruvic acid, oxygen (ADP, Pi)	carbon dioxide, water (ATP)

4 marks

1 mark for each box correctly filled in.
All inputs and/or outputs for each process should be included for each mark.
There is room to give a penalty, for example, if one input/output is missing from each section, students could achieve 2 marks.

c. **Chloroplast:** Electrons from split water move through a series of protein channels in the thylakoid membrane and become available for the production (reduction) of NADP and H on the stroma side of the membrane. This maintains a hydrogen gradient, so that ATP can be formed when H moves from the grana into the stroma through ATPase. 1 mark

Mitochondria: Electrons from NADH are transported through a series of proteins on the cristae and are available for the production of water. The hydrogen is removed from the NADH and moves into the intermembrane space, which forms a gradient, allowing the hydrogen ions to flow through ATPase back into the matrix of the mitochondria. This forms ATP. The hydrogen in the matrix combines with oxygen and the electrons to maintain hydrogen flow through the cristae. 1 mark

The key here is for students to recognise the electron transport proteins are there to maintain proton (hydrogen) flow. Some recognition of the differences should be given.

Question 3 (6 marks)

a. Essential amino acids must be included in the diet because they cannot be synthesised by the body, whereas non-essential amino acids can be synthesised by the body and so do not need to be included in the diet. 1 mark

b. Tyrosinase catalyses the conversion of tyrosine (substrate) into melanin (product). 1 mark

c. Transaminase and hydroxyphenylpyruvic acid oxidase are both enzymes involved in the metabolism of phenylalanine. The functional difference is that transaminase catalyses the conversion of tyrosine into hydroxyphenylpyruvic acid, and hydroxyphenylpyruvic acid oxidase catalyses the conversion of hydroxyphenylpyruvic acid into homogentisic acid. 1 mark

The structural difference is that each enzyme would have a differently shaped active site because they have different substrates. 1 mark

d. **i.** If the enzyme phenylalanine oxidase is missing from the metabolic pathway, one effect would be a build-up of phenylalanine. 1 mark

Students should not say a drop in tyrosine as that amino acid is non-essential (so no marks awarded); however, if they discuss that consuming tyrosine would replace it, then they could score the full mark.

ii. Phenylalanine is an essential amino acid so to reduce its build-up, individuals with PKU should not eat food (protein) that contains that amino acid. 1 mark

Question 4 (4 marks)

a. The two amino acids have different shapes 1 mark
and so bind to different receptors on different target cells within the body. 1 mark

b. More axons would mean more connections between neurons, leading to more nerve messages for better control of health. 1 mark

c. Theanine and glutamate have a similar shape and so when both are present in the synapse they will 'compete' to bind to the glutamate receptors. A response will only be triggered when glutamate binds; no response will be triggered when theanine binds. This means the glutamate-triggered response will be reduced (less stress). 1 mark

Question 5 (4 marks)

a. Insulin is a protein that is complimentary to the insulin receptor located on the surface of the cell. 1 mark

b. The secondary messenger activated as a part of pathway 2 may lead to the activation of different proteins involved in responses 3 to 5. Both activated proteins may have the same-shaped binding site for the receptor. 1 mark

c.

Response	How response specifically lowers the blood glucose levels
3	Gated protein channel opens, allowing glucose to move from the extracellular environment.
5	Enzymes involved in glycolysis are activated, removing glucose from within the cell and thus maintaining a lower concentration within the cell, which allows glucose to move into the cell by facilitated diffusion.

2 marks
Specific changes are required for full marks.

Question 6 (10 marks)

a. **i.** Cancer cells contain antigenic markers that are 'self' because they are somatic cells from the body. Pathogenic organisms contain antigenic markers that are 'non-self' because they are not somatic cells. 1 mark

ii. *Any one of:*

- naïve B cells (immature B cells): come in contact with a specific antigen and clone
- B plasma cells: make specific antibodies
- B memory cells: remain in the body to initiate a faster response upon future exposure the a specific antigen

2 marks
1 mark for cell type.
1 mark for description.

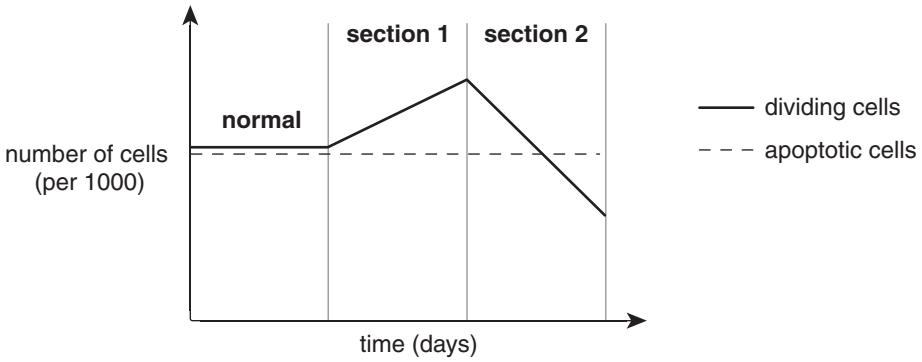
b. **i.** There are several events occurring during interphase that prepare a cell for replacement. These events include *(any two of the following)*:

- During G1 the cell grows as a result of protein synthesis, which gets the cell to a sufficient size to replicate.
- During S phase the DNA replicates so the new cells can carry the same genetic information.
- During G2 phase the DNA coils and supercoils with protein to form chromosomes so the passing of DNA information during the mitotic phase can be completed accurately.
- There are a series of checkpoints during interphase as safeguards against errors occurring during the process.

2 marks

ii. NK cells bind to markers on the surface of stressed cells or cancer cells 1 mark
and secrete perforins that stimulate apoptosis of the target cell. 1 mark

c. **i.** and **ii.**



1 + 1 = 2 marks

d. Lower temperature within the region of hair follicles should lower the rate of the chemical reaction that the chemotherapy drugs are involved in (targeting dividing cells in that region). This would maintain the integrity of the hair follicles. 1 mark

Question 7 (6 marks)

a. If all genes were transcribed in each cell, there would be a lot of energy wasted if those mRNA strands were then stopped from being translated. 1 mark

b. 3, 5, 1, 4, 2 1 mark

c. The regulator gene could be inactivated, which would mean the repressor was no longer produced. 1 mark

d. Introns are transcribed but removed prior to translation. The exons bind to form the final mRNA product which carries the correct order of nucleotides for the protein to be formed. 1 mark

e. mRNA moves through the ribosome and is read in groups of 3 nucleotides (codons). 1 mark

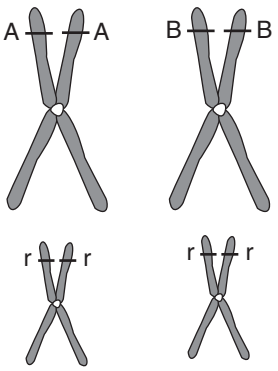
tRNA carry an anticodon which binds to the codon in position. It also carries a specific amino acid which is put in the correct position in the growing polypeptide. 1 mark

Question 8 (6 marks)

a. A and B are codominant. A and B are both dominant over O. 1 mark

b. **i.** I^AI^Brr 1 mark

ii.



2 marks

For full marks, students must show: four chromosomes; chromosome pairs; two chromatids per chromosome; allele labels; and consistent loci for each gene (does not matter where on the chromosome). Award 1 mark if any one of the above is missing; award no marks if more than one are missing.

c. Yes, it is possible if both are heterozygous for both genes. 1 mark

The B positive parent could be I^{B}iRr and the A positive parent could be I^{A}iRr, which would mean there is a chance ($\frac{1}{16}$) of producing an O negative (iirr) child. 1 mark

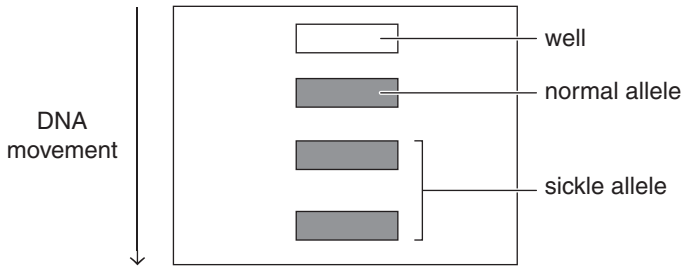
Question 9 (8 marks)

a. A **primer** is a sequence of single-stranded nucleotides complimentary to a target sequence on the DNA to be tested. The primers should anneal in two places with the target sequence in between. 1 mark

***Taq* polymerase** replicates DNA but is still functional after being exposed to high temperature, which is part of the PCR process. 1 mark

b. Restriction enzymes cut the DNA at specific sequences (2–6 nucleotides long). The sickle allele has the specific sequence once along the allele, allowing it to be cut into two fragments. The normal allele does not contain the specific sequence and is not cut. 1 mark

c.



2 marks

The following points should be included in the diagram:

- *Clear diagram of a gel showing well position and the direction the DNA is moving.*
- *Three bands present.*
- *The two lower bands are the smaller sickle alleles, the higher band the normal allele.*

All three of the above points should be included for 2 marks; only two points will earn 1 mark.

d. Yes it is an example of natural selection. There was variation in the original population with some sickle alleles and normal alleles within the gene pool. 1 mark

With malaria in the environment, the people who are carriers of sickle alleles are at a selective advantage and are more likely to survive to reproductive age. 1 mark

In the malaria environment, the proportion of sickle alleles increases in comparison to the non-malaria environment. 1 mark

Question 10 (7 marks)

a. There was variation in the original population of ancestral elephants and two groups became geographically isolated from each other (due to migration). 1 mark

The environments they migrated to were different to each other and so natural selection favoured different phenotypes within each group. 1 mark

Over time, the groups become so different to each other that they became different species and would no longer be able to successfully breed with each other. 1 mark

b. The mitochondrial DNA in the woolly mammoth and the Indian elephant would be more similar as they have a more recent common ancestor, about 2 million years ago. 1 mark

The African elephant would have the most variety in their mitochondrial DNA compared to the other two elephants, as they have been in existence as African elephants for about 3 million years. 1 mark

c. The amount of ^{14}C in a set mass of the fossil is compared to the amount of ^{12}C in the same mass of the fossil. This is compared to the known amount in organisms alive today. 1 mark

^{14}C decays with a known half-life (5760 years) and so the amount present can be used to determine the age of the fossil. 1 mark

Question 11 (6 marks)

a. A hominin is a human or a human ancestor; most that have been found are bipedal. 1 mark

b. The remains were scattered on the floor of the cave and so there are several problems in determining the age. These include *(any two of the following)*:

- They are not in sedimentary layers with volcanic rock above and below so radioisotopic dating is a problem.
- Many remains from many organisms are present, and they may have lived at vastly different times so any dating will be confusing.
- In order to date some of the fossils the actual bone would need to be used, which means the actual specimens will be lost to science.
- The fossils cannot be dated based on location on the ground, as they are scattered.

2 marks

c. **i.** Evidence would include a more central foramen magnum at the base of the skull and a bowl-shaped pelvis to support the weight of the upper torso. 1 mark

ii. Evidence would include a larger cranial capacity to body–size ratio. 1 mark

d. Cultural evolution is the behaviours (customs/language) that are kept within a group and are passed on to successive generations – in this case, the deposition of the bodies of the dead into areas which are difficult to access. 1 mark