

2013 VCE Biology

VCAA Sample Examination Suggested Answers



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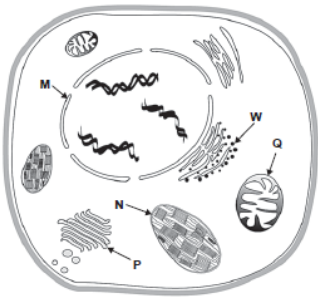
- Teachers and students are reminded that for the purposes of school requirements and external assessments, students must submit work that is clearly their own.
- Web Links have been added to these answers so that teachers and students can explore biological concepts at more depth using the Internet. All Web Links, when created, linked to appropriate sites. Teachers should check these Web Links before using them with their classes. Web Links do not last forever. Kilbaha Multimedia Publishing is not responsible for Web Links that have been altered or that link to inappropriate sites.

Answer Summary for Multiple-Choice Questions

2013 VCAA VCE Sample Examination

Q1	C	Q15	D	Q29	D
Q2	C	Q16	A	Q30	A
Q3	D	Q17	A	Q31	C
Q4	C	Q18	C	Q32	C
Q5	D	Q19	C	Q33	A
Q6	D	Q20	C	Q34	B
Q7	B	Q21	C	Q35	B
Q8	C	Q22	A	Q36	D
Q9	B	Q23	C	Q37	C
Q10	D	Q24	D	Q38	B
Q11	A	Q25	B	Q39	D
Q12	C	Q26	C	Q40	D
Q13	B	Q27	C		
Q14	B	Q28	A		

Question 1 Answer = C



Knowledge of cell structure and function is essential here. This is ‘assumed’ knowledge from the Unit 1 Course. The question, however, relates to the function of the structures (M: nucleus, N: Chloroplast, P: Golgi, Q: Mitochondria and W: Rough Endoplasmic Reticulum) in relation to their biochemistry. Structure W is a ribosome along some endoplasmic reticulum and so is involved in the manufacture of protein (polypeptides) for transport around (or out of) the cell.

Study Design Reference:

The role played by organelles including ribosomes, endoplasmic reticulum, Golgi apparatus and associated vesicles in the export of proteins

Web Link

http://www.cellsalive.com/cells/cell_model.htm

Question 2 Answer = C

Students need to be aware of the structure and function of cell membranes as well as how biomolecules are able to move across them. Facilitated diffusion is when chemicals move by diffusion (going from a high concentration to a low concentration) across a membrane with the assistance of proteins embedded in the membrane. These chemicals would not move across the membrane if the proteins were not there. The reason for the facilitation might be the chemical is too big or it may not be lipid soluble. A good example of this would be glucose, which requires glucose ‘channels’ embedded in the membrane to move across. Choices B and D relate to active transport and A relates to small lipid soluble molecules.

Study Design Reference:

The structure and function of the plasma membrane and the movement of substances across it:
– the fluid-mosaic model of a plasma membrane
– the packaging, transport, import and export of biomacromolecules (specifically proteins)

Web Link

Membrane structure: <http://www.wisc-online.com/Objects/ViewObject.aspx?ID=ap1101>

Membrane function: <http://www.johnkyrk.com/cellmembrane.swf>

OR

http://www.wiley.com/college/boyer/0470003790/animations/membrane_transport/membrane_transport.htm

Question 3 Answer = D

Proteins can have 4 levels of structure. All proteins are sequences of amino acids which are coded for by the DNA present in the cell. This is referred to as the primary structure. Amino acids within a primary sequence can interact with each other in a variety of ways and so they twist and turn to arrange themselves in the most stable configuration (α helices and β sheets are examples of secondary structures). This is referred to as the secondary structure. The final shape of each single protein is referred to as the tertiary structure. The shape is held together by a variety of stabilising bonds (such as disulfide bonds). Some proteins function at the tertiary level (many enzymes). Some proteins are a combination of polypeptides which cluster together to form the functional protein (haemoglobin, antibodies, ATPase).

Study Design Reference:

The nature of the proteome; the functional diversity of proteins; the structure of proteins in terms of primary, secondary, tertiary and quaternary levels of organisation

Web Link

<http://www.biopics.co.uk/JmolApplet/proteinjstructure.html>

Question 4 Answer = C

Graph interpretation is an important aspect of Biology. The context can be varied and in this question, it relates to photosynthesis and respiration. All organisms respire all the time to provide their energy needs. Some photosynthesise as well but only in the presence of light. Both processes require raw materials including oxygen (input for respiration and output for photosynthesis). At a light intensity of 0 units, there is no net exchange of oxygen. The plant must be respiring at the same rate as it is photosynthesising.

Study Design Reference:

Requirements for photosynthesis – excluding differences between CAM, C3 and C4 plants – including: the structure and function of the chloroplast; the main inputs and outputs of the light dependent and light independent stages.

Requirements for aerobic and anaerobic cellular respiration: the location, and main inputs and outputs, of glycolysis; the structure of the mitochondrion and its function in aerobic cellular respiration including main inputs and outputs of the Krebs Cycle and the electron transport chain.

Web Link

Resp/phs: <http://www.buzzle.com/articles/photosynthesis-and-cellular-respiration.html>

Graph interpretation: <http://staff.tuhsd.k12.az.us/gfoster/standard/bgraph2.htm>
(click on the graphing problems link as well)

Question 5 Answer = D

The stem of the question describes a biochemical process. The combination of water (H₂O) and carbon dioxide (CO₂) in the presence of energy is clearly related to photosynthesis. The product X is therefore a carbohydrate. In this case the carbohydrate is referred to as a monosaccharide.

Study Design Reference:

Requirements for photosynthesis – excluding differences between CAM, C₃ and C₄ plants – including: the structure and function of the chloroplast; the main inputs and outputs of the light dependent and light independent stages.

Web Link

<http://biology.clc.uc.edu/courses/bio104/photosyn.htm>

Question 6 Answer = D

Like in question 4, graph interpretation is an important aspect of Biology. The context can be varied and in this question it relates to enzyme functioning at different pH values. The peak of each graph is the optimum pH for each of the enzymes in question. The activity of each decreases in each direction away for the optimum pH. At a pH of 4 all enzymes have some activity but lysozyme has the highest activity.

Study Design Reference:

Requirements for aerobic and anaerobic cellular respiration: the location, and main inputs and outputs, of glycolysis; the structure of the mitochondrion and its function in aerobic cellular respiration including main inputs and outputs of the Krebs Cycle and the electron transport.

Web Link

<http://interactiveman.blogspot.com.au/2008/11/krebs-cycle-mitochondria-electron.html>

Question 7 Answer = B

Catabolic reactions are reactions that involve the breaking down of larger molecules into smaller ones. They are sometimes referred to as exergonic or downhill reactions as well. The type of reactions that would be referred to as catabolic would be cell respiration where glucose is broken down into carbon dioxide and water. Choice A, C and D are all anabolic reactions. Maltose is a disaccharide which is made by adding 2 glucose monosaccharides together. ATP is manufactured from ADP and P. Glucose is manufactured from carbon dioxide and water in the process of photosynthesis. Choice B is correct because when a lipid such as triglyceride is broken down, the product would be fatty acids and glycerol.

Study Design Reference:

Catabolic and anabolic reactions in terms of reactions that release or require energy

Web Link

<http://classes.midlandstech.edu/carterp/courses/bio225/chap05/lecture1.htm>

Question 8 Answer = C

Based on the contents of a cell, students should be able to infer a function. The cell in the question clearly contains many mitochondria. This means the energy demand of the cell would be very high and due to the process of aerobic respiration, there would be a high oxygen demand. For example a muscle cell contains many mitochondria to provide the energy for muscle contractions. A cheek cell would not have a high energy demand (making A incorrect). A mature red blood cell does not contain mitochondria (making B incorrect). Respiration does not **produce** sugars, it uses sugars (making D incorrect).

Study Design Reference:

Catabolic and anabolic reactions in terms of reactions that release or require energy

Web Link

<http://classes.midlandstech.edu/carterp/courses/bio225/chap05/lecture1.htm>

Question 9 Answer = B

We are told the diagram is of a DNA nucleotide. The 3 components of any nucleotide are a phosphate, 5 carbon sugar and a nitrogenous base. The phosphate is the same in both DNA and RNA and is represented by structure X (making C incorrect). The 5 carbon sugar in RNA is called ribose and in DNA is called deoxyribose (making A incorrect). The types of nitrogenous bases in RNA is A, G, C and U. The types of nitrogenous bases in DNA is A, G, C and T. This means a DNA molecule can be identified by the presence of T.

Study Design Reference:

Structure and function of DNA and RNA, their monomers, and complementary base pairing

Web Link

<http://dl.clackamas.edu/ch106-09/nucleoti.htm>

Question 10 Answer = D

Based on the contents of a cell, students should be able to infer a function. The organelle in the question is the golgi apparatus, which has the function of modifying and packaging macromolecules prior to their secretion. Choice A is incorrect because the SER is involved in the manufacture and transport of lipids. Choice B is incorrect because the mitochondria is responsible for energy production. Choice C is incorrect because the lysosome is responsible for the destruction of unwanted material.

Study Design Reference:

The packaging, transport, import and export of biomacromolecules (specifically proteins). The role played by organelles including ribosomes, endoplasmic reticulum, Golgi apparatus and associated vesicles in the export of proteins.

Web Link

http://www.cellsalive.com/cells/cell_model.htm

Question 11 Answer = A

Long term immunity is gained by an individual's immune system being stimulated to produce its own antibodies by being exposed to an antigen. This can be achieved by contracting a disease and the body subsequently produces antibodies in response. It can also be achieved through a vaccination, which introduces the antigen without leading to symptoms of the disease. The body produces antibodies in response to the vaccine (choice A). If antibodies are introduced artificially OR naturally, the body may have short term immunity (choice C and D). Choice B is incorrect because this is the way the body responds in an allergic reaction.

Study Design Reference:

Acquired immunity through natural and passive strategies, including the nature and production of vaccines and antibody serums and their importance in maintaining immunity for a particular disease in the human population.

Web Link

<http://www.wisc-online.com/objects/ViewObject.aspx?ID=mby601>

Question 12 Answer = C

Plants have adaptations that help them survive the threat of disease. However, they do not have an immune system and so do not produce memory cells. They have a vascular system consisting of xylem and phloem but this is not a circulatory system. Plants do have some chemical strategies that help reduce the capacity for pathogens to cause disease. These do include the production of chemicals such as salicylic acid (disrupts endocrine activity in insects). This is a chemical used clinically to manufacture aspirin and acne cream. Both have epidermal layers that prevent the entry of pathogens.

Study Design Reference:

the nature of physical and chemical barriers in plants and animals (including humans) to invading pathogens

Web Link

http://academics.smcvt.edu/twhiteford/science/natural%20defences/animal_and_plant_defenses.htm

Question 13 Answer = B

A pathogen such as the bacteria in the diagram is covered with antigens. These, on contact with the immune system trigger the production of antibodies by specific B cells. Each different B cell will make one type of antibody. Each specific antibody is a Y shaped protein that carries 2 antigen binding sites that are identical to each other. They are complimentary to the antigen (meaning they fit into the antigen), so they can bind to them, which leads to the removal of the bacteria.

Study Design Reference:

The nature, characteristics and components of the adaptive immune response including the role and actions of B cells and their antibodies in humoral immunity.

Web Link

<http://www.youtube.com/watch?v=KpNFAEbLcvk>

Question 14 Answer = B

The toxin permanently binds to a plasma membrane receptor, which makes the toxin lipid insoluble (C is incorrect). The G proteins move within the lipid bilayer and lead to the activation of chemicals such as cAMP, which activate a variety of enzymes via signal transduction. The toxin must carry a similar shape to the original signalling molecule that binds to the receptor and as such, is not a secondary messaging molecule. Neurohormones are released from neurons and this toxin is produced by the cholera bacterium and so is not a neurohormone.

Study Design Reference:

Types of signalling molecules: neurotransmitters; animal hormones; pheromones; plant growth regulators

A generalised view of how information received by a cell's receptor is transduced to an effector to initiate various cellular responses including the position of receptors for protein-based and lipid-based signalling molecules.

Web Link

http://www.wiley.com/college/boyer/0470003790/animations/signal_transduction/signal_transduction.htm

Question 15 Answer = D

A reflex arc is the basic form of stimulus/response pathway of the nervous system. Typically 3 nerves are involved. The sensory neurons detect the stimulus and transport it to the CNS where interneurons process the signal. The signal is passed to motor neurons that direct the message to an effector and an appropriate response. For cell X to pass a signal to cell Y signalling messages (neurotransmitters) pass across the synaptic gap from cell X to cell Y. The molecule will bind to a receptor on the surface of cell Y triggering a response via signal transduction.

Study Design Reference:

the nature of the stimulus-response model and the roles of the nerve pathway and chemical signals in the transmission of information from receptor to effector

Web Link

<http://www.tvdsb.ca/webpages/brownt12/files/synapse.htm>

Question 16 Answer = A

The brain is a complex organ. There are many sections to it that are able to sense different experiences (touch, smell, pain). Only the section of the brain that experiences pain is not functioning; however, the rest of the brain is functioning normally. The only way to explain this is for the ion channels of specialised neurons to be blocked. The other receptors choices are not specific enough. The skin is dotted with different types of receptors, not only pain.

Study Design Reference:

The nature of the stimulus-response model and the roles of the nerve pathway and chemical signals in the transmission of information from receptor to effector

Web Link

http://www.ivy-rose.co.uk/HumanBody/Nerves/Nerve_Function.php

Question 17 Answer = A

The diagram shows a completely intact cell breaking down into smaller sections. This is known as apoptosis and is programmed cell death triggered by signals that can be internal or external. This leads to a series of chemical responses known as signal transduction/signal amplification. It is an irreversible phenomenon and the cell debris can be cleaned up by the immune system. The lysis of cell as a result of viral infection does not break the cell into smaller parts, the plasma membrane ruptures. When a cell divides by mitosis, 2 cells (smaller) form from 1.

Study Design Reference:

Apoptosis (regulated cell death) as an example of a cellular response to specific signals

Web Link

<http://www.susanahalpine.com/anim/KubyHTML/Celdeath.htm>

Question 18 Answer = C

The lymphatic system is a separate system to the circulatory system. It contains a high concentration of lymphocytes (and other types of white blood cells such as phagocytes), usually located in lymph nodes. Chemicals that normally move into the circulatory system from the interstitial fluid can also move into the lymph ducts. The movement of the lymphatic fluid is caused by skeletal muscular contractions (like in veins). If there are pathogens in the interstitial fluid, there is a good chance of the antigens coming in contact with the correct immune cells.

Study Design Reference:

The structure and role of the lymphatic system in the innate and adaptive immune response

Web Link

<http://www.lymphnotes.com/article.php/id/151/>

Question 19 Answer = C

This question is investigating the concept of self antigens. Based on the antigens protruding from each cell, the self antigens are unique to each cell. Answer A, B and D all are incorrect because the antigens are not unique to the cell in question. C is correct because the antigen is unique to cell R.

Study Design Reference:

The nature of antigens and their sources: 'self' and 'non-self'

Web Link

<http://www.niaid.nih.gov/topics/immuneSystem/pages/selfnonself.aspx>

Question 20 Answer = C

Water soluble signalling molecules bind to receptors on the cell surface as they are unable to move through the phospholipid bilayer. Water insoluble molecules, on the other hand, move through the bilayer and bind to receptors within the cell cytosol.

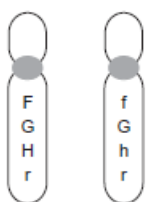
Study Design Reference:

A generalised view of how information received by a cell's receptor is transduced to an effector to initiate various cellular responses including the position of receptors for protein-based and lipid-based signalling molecules

Web Link

<http://www.wisc-online.com/Objects/ViewObject.aspx?ID=AP13704>

Question 21 Answer = C



This homologous pair of chromosomes can produce a variety of allelic combinations as a result of meiosis. The individual is homozygous rr and so no dominant alleles can appear in the gametes. There is one copy of each allele in the gametes and crossover is able to shuffle the combinations (choice C illustrates this). The loci of the alleles should remain consistent but chromosomal mutations may occur as well.

Study Design Reference:

The key events that result in the production of haploid sex cells from a diploid cell (meiosis), including recombination

Web Link

<http://www.accessexcellence.org/RC/VL/GG/comeiosis.php>

Question 22 Answer = A

This question investigates the inheritance of 2 characteristics according to the information given. You are given a mother and sons phenotype (smooth chin and straight hairline). The symbols used to represent the alleles are given and so the genotype of both would be *ssww*. If the father had a cleft chin and widows peak then his genotype must be *SsWw* because one copy of each allele is inherited from each parent and this is the only genotype possible to produce a child that is homozygous recessive. This can be supported with a punnet square (the sons genotype is highlighted).

Genotype: Mother (*ssww*) Father (*SsWw*)

Gametes: Mother (*sw*) Father (*SW, sW, Sw, sw*)

	SW	sW	Sw	sw
sw	SsWw	ssWw	Ssww	ssww

Study Design Reference:

Dihybrid crosses as independent or linked

Web Link

<http://www.ksu.edu/biology/pob/genetics/dihy.htm>

Question 23 Answer = C

Sheep P has had somatic cells removed from it. These cells have had their nucleus removed from it and inserted into enucleated ova. The resultant zygotes were then inserted into surrogate Q. The genetic material in the clone originates from the genome of sheep P.

Study Design Reference:

Application of gene technologies including gene cloning, bacterial transformations, stem cell differentiation, genetic screening, gene therapy and DNA profiling

Web Link

<http://learn.genetics.utah.edu/content/tech/cloning/clickandclone/>

Question 24 Answer = D

This question is about linked genes that interact with each other. Linked genes are genes that are located along the same chromosome. Note that all genes can have alternative alleles. In this case one of the genes has an IGF-1 form that controls growth. The other linked gene has an S allele only in small breeds (meaning an alternative allele is probably in larger breeds). It is reasonable to presume the S allele could control the activation of IGF-1. This would mean that less growth would occur in smaller breeds. Both genes are involved in growth of all breeds (lack of S in larger breeds)

Study Design Reference:

The concept of gene regulation (the switching on and off of genes by factors expressed by regulator genes and environmental factors)
Dihybrid crosses as independent or linked

Web Link

Linked genes: <http://www.ksu.edu/biology/pob/genetics/linked.htm>

Gene control: <http://www.youtube.com/watch?v=3S3ZOmleAj0>

Question 25 Answer = B

DNA replication is semi conservative, which means half of the original molecule replicated appears in each of the 2 new strands produced. Initially the DNA double helix is unzipped (the hydrogen bonds holding the double helix together) by a helicase enzyme. DNA polymerase moves along both strands placing complimentary nucleotides along the template, forming two new DNA strands. This is a complicated process because each strand is replicated in opposite directions.

Study Design Reference:

The phases of the cell cycle in eukaryotes including DNA replication, the division of the nucleus (mitosis), and cytokinesis

Web Link

http://www.wiley.com/college/pratt/0471393878/student/animations/dna_replication/index.html

Question 26 Answer = C

Plasmids are small circular strands of DNA located in bacteria. They are very well researched and are useful tools in biotechnology for transferring genes. An understanding of restriction enzymes is necessary to visualise how the plasmids can be manipulated. A restriction enzyme cuts DNA at specific recognition sites. In the case of EcoR1 it cuts DNA wherever the sequence GAATTC appears. The DNA is cut to liberate 'sticky' ends, which are useful for 'pasting' onto complementary 'sticky' ends during the process of genetic transformation. This plasmid has 4 EcoR1 recognition sites. If a circle is cut in 4 places, there are 4 sections produced.

Study Design Reference:

DNA tools and techniques: gel electrophoresis; DNA amplification; DNA sequencing; making a recombinant plasmid; bacterial transformations; DNA profiling; gene cloning; and using plasmids as gene delivery systems

Web Link

http://www.biotechnologyonline.gov.au/popups/int_splicing.html

Question 27 Answer = C

Question 28 Answer = A

Both questions relate to the interpretation of a karyotype. A karyotype is produced usually by taking diploid cells from the amniotic fluid of an unborn baby (this is not the only circumstance where a karyotype is constructed). The karyotype can then be examined for chromosomal abnormalities. The gender of the child can be determined due to the presence of the XX (female) or the XY (male). The number of autosomes can also be seen, where they should be found as 22 matching pairs. Karyotypes are usually done where there is a risk of a chromosomal abnormality such as Down syndrome. Human diploid cells should have 1 pair of sex chromosomes and 22 pairs of autosomes, giving a diploid number of 46. Other sexually reproducing organisms have different diploid numbers.

Study Design Reference:

The key events that result in the production of haploid sex cells from a diploid cell (meiosis), including recombination

Web Link

http://www.biology.arizona.edu/human_bio/activities/karyotyping/karyotyping.html

Question 29 Answer = D

Question 30 Answer = A

Mitochondrial DNA is inherited down the maternal line. A sperm carries mitochondria to propel the sperm towards the ova. Once the head of the sperm penetrates the ova, the mitochondria do not enter. The ova contains mitochondria from the mother and once the haploid nucleus from the sperm and the haploid nucleus from the ova combine to form the zygote the fertilised egg is formed. This occurs generation after generation. In the case of the pedigree, Kathy and Peter have different ancestry and hence, different mitochondrial DNA. Jethro is Peters son but Jethro inherits his mitochondrial DNA from his mother, not Peter. Jay and Rob, like Peter have different ancestry and so different mitochondrial DNA. Jackson, Eliot and Dashiell have different mothers but the same grandmother and therefore have inherited her mitochondrial DNA.

The X^H Allele, if present in Jackson must be inherited from his mother as he inherits a Y chromosome from his father.

Study Design Reference:

Pedigree analysis: autosomal and sex-linked inheritance; use of the test cross.

Determination of evolutionary relationships: comparison of DNA sequences; comparative genomics; mitochondrial DNA; phylogeny

Web Link

Note: Look at the bottom of the page for mitochondrial inheritance

http://www.ucl.ac.uk/~ucbhjow/b241/mendel_1.html

Question 31 Answer = C

Knowledge of DNA tools and techniques an important aspect of the course. The old fashion method used gel electrophoresis and the 4-laned gel pattern would be read like a barcode (method 2). With the development of laser and fluorescence technology, the sequence can be read by a laser picking up different colours that correspond to a particular sequence (method 1). An understanding of the 2 techniques is useful but the answer can be extracted from the diagrams. Gels are loaded at the negative end of the gel otherwise the DNA would not move in the correct direction.

Study Design Reference:

DNA tools and techniques: gel electrophoresis; DNA amplification; DNA sequencing; making a recombinant plasmid; bacterial transformations; DNA profiling; gene cloning; and using plasmids as gene delivery systems

Web Link

<http://www.pbs.org/wgbh/nova/body/sequence-DNA-for-yourself.html>

Question 32 Answer = C

The founder effect and the bottleneck are situations that leave small samples from larger populations. The founder effect is when a small sample of an original population relocates to a new area. The chance of the allele frequencies of each gene is the same as the original population is unlikely and so in a new environment, different features may be selected for. The same applies with a genetic bottleneck. If a large population drops suddenly in numbers, the new population may also have an unrepresentative gene pool. Both these situations are examples of genetic drift.

Study Design Reference:

A qualitative treatment of changing allele frequencies in a population and the consequences:

- the concept of the gene pool
- environmental selection pressures, gene flow, genetic drift (founder and bottleneck effects)
- natural selection as a mechanism for biological evolution

Web Link

<http://evolution.berkeley.edu/evosite/evo101/IIID3Bottlenecks.shtml>

Question 33 Answer = A

Cultural evolution is the passing on of behaviours from one generation to the next. There are many examples including language and the development of fire. The only choice that relates to behaviours in this question is observation of drawings in caves or on rocks.

Study Design Reference:

Major trends in hominin evolution from the genus *Australopithecus* to the genus *Homo* including morphological, structural and cognitive development resulting in cultural evolution and the rise of technologies

Web Link

<http://public.wsu.edu/~taflinge/culture1.html>

Question 34 Answer = B

DNA codes for protein. The same protein in different organisms may have different sequences of amino acids. DNA mutations accumulate over time and can be observed in the different amino acids within each protein. The more differences in the amino acid sequence, the more distant the evolutionary divergence. From this, the cow (Z) and the human are the most related with 17 differences and the human and the shark (V) are the least related.

Study Design Reference:

determination of evolutionary relationships: comparison of DNA sequences; comparative genomics; mitochondrial DNA; phylogeny

Web Link

http://www.gtac.edu.au/site/bioinformatics/bio_task_11.html

Question 35 Answer = B

There is clearly a normal distribution (continuous variation) of the leaf rust resistance phenotype. When a characteristic displays this kind of distribution it usually means the characteristic is polygenic. Polygenic characteristics are ones that have several genes combining for the overall phenotype. The more genes there are, the more genotypes are possible, hence more phenotypes.

Study Design Reference:

Continuous and discontinuous variation

Web Link

<http://www.biologymad.com/resources/RevisionM5Ch2.pdf>

Question 36 Answer = D

The Multi regional hypothesis states that Homo sapiens evolved in different parts of the world independently of each other. This is not logical with respect to the idea of mutations occurring spontaneously and randomly in genomes. It would be expected that in reproductively isolated groups that mutations would accumulate in the genomes of the different groups. This is not the case when comparing the genomes of humans. The Out of Africa hypothesis states that Homo sapiens evolved within Africa and then migrated to the different parts of the world. This is supported through mitochondrial DNA studies.

Study Design Reference:

Determination of evolutionary relationships: comparison of DNA sequences; comparative genomics; mitochondrial DNA; phylogeny

Web Link

<http://www.actionbioscience.org/evolution/johanson.html>

Question 37 Answer = C

Students should be aware of the similarities and differences between natural selection and artificial selection. Both rely on genetic variation within the group in question. However, where the changing environment favours particular phenotypes over others in natural selection, in artificial selection, the feature that is selected is the one the human wants (faster, higher milk yield) regardless of the environment. Both use the concept of genetic inheritance through breeding and there are measurable allele changes in the gene pool in the descendants. There is non-random mating with respect to artificial selection (eliminating A), which probably makes the descendants less suitable to survival in the wild (eliminating D). B is incorrect because mutations are random and occur spontaneously.

Study Design Reference:

Natural selection as a mechanism for biological evolution.
Selective breeding as a method of affecting and limiting the gene pool.

Web Link

<http://www.hhmi.org/biointeractive/evolution/Selection/01.html>

Question 38 Answer = B

Over the biology course students should have an appreciation of the idea how one discovery has led to an increase in knowledge and the subsequent development of new ideas. This is really illustrating technological evolution. It is not expected that you know the who and when of the discoveries but understanding how one idea can lead to another in order is. The ideas in the question need to be ordered from oldest to youngest.

Idea 1. The molecular structure of DNA was revealed to be a double helix. (Watson and Crick in the 1950s)

Idea 2. Individuals best suited to the environment have the best chance of surviving and reproducing. (Darwin in the 1800s)

Idea 3. Comparing the similarities of nucleotide sequences in different organisms helps determine how closely related the organisms are to each other. (in the 2000s)

Idea 4. Organisms can alter their structure to suit their environment and then they are able to pass this favourable alteration on to their offspring. (Lamarck in the 1700s)

Study Design Reference:

There is no specific reference to the study design for this question.

Web Link

<http://www.dnai.org/timeline/index.html>

Question 39 Answer = D

Students should be aware of convergent and divergent evolution as processes that help to explain the biological diversity on the planet. If organisms share phenotypic features but have completely different ancestry the pattern of evolution that has occurred is referred to as convergent. The explanation for this is that when the 2 unrelated ancestors are exposed to similar environments (but they may be in completely different locations) the features selected for are similar ones. For example, to evade predators, the longer legged organisms may have a selective advantage over the short legged individuals. The term structural analogies is synonymous with convergent evolution.

Study Design Reference:

Patterns of biological change: divergent and convergent evolution

Web Link

<http://txtwriter.com/backgrounders/Evolution/EVpage14.html>

Question 40 Answer = D

To calculate the absolute date (age) of a fossil, radio isotopic dating is completed. Site 1 contains human remains that date less than 10000 years. These remains would probably contain carbon and so carbon dating could be carried out. However, site 2 contains a fossil that is 110 million years old. There would be 2 reasons why carbon dating would be inappropriate for this fossil. Firstly no organic material would be left in the fossil to date and secondly, the half life of carbon 14 is about 6000 years, providing accurate dating up to about 50000 years. A different radio isotope would be needed that was present and has a longer half life. Uranium dating would be appropriate. Student should be aware of the different types of radio isotopic dating.

Study Design Reference:

Evidence for biological evolution over time: the geological time scale; relative and absolute dating techniques

Web Link

You need to look at the PDF explaining how to use the interactive

<http://phet.colorado.edu/en/simulation/radioactive-dating-game>

**End of Detailed Answers to 2013 VCAA VCE Biology Sample Examination
Multiple Choice Questions**

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Question 1

Students need to be aware of how to construct hypothesis based on an experiment that has been carried out. Students should also be able to design an experiment when provided with a hypothesis. When designing an experiment you should make clear reference to the independent (IV) and dependent variable (DV). Other factors that should be considered would be to keep other factors constant apart from the IV so that that valid conclusions can be made.

Following is an example of a suitable set up for this particular question

Take two groups of tomato plants (100 plants) that are the same age type and state of health. One group is affected with beet caterpillars, the other is unaffected. (1)

AND

Both groups are kept in the same environment (for example, the same temperature and water availability).

Wasps are released and their activity is observed (Independent variable). (1)

AND

If more wasps (Dependent variable) visited the plants eaten by caterpillars than the unaffected group then the hypothesis would be supported. (1)

To answer this type of question effectively students should:

- *plan their answer before they begin writing*
- *use only the hypothesis given in the question stem*
- *use only the information given in the question.*

Study Design Reference:

In this study a set of key skills is considered essential to Biology. Some of these skills include the capacity for students to

- formulate questions and construct hypotheses appropriate for conducting first-hand and secondhand investigations
- plan, design and conduct first-hand investigations: select and use equipment and materials appropriate to the investigation; evaluate experimental procedures and reliability of data
- collect, process and record information systematically; analyse and synthesise data; draw conclusions consistent with the question under investigation and the evidence obtained

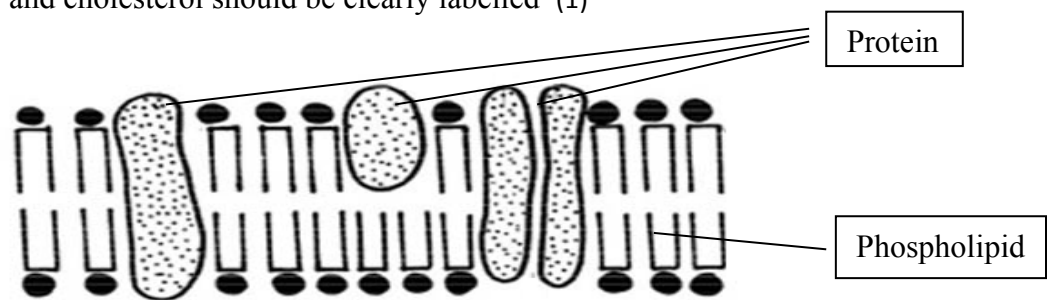
Web Link

<http://www.quia.com/quiz/162310.html>

Question 2

An understanding of protein structure, function and the application of this is an important aspect of biology.

- a. Chain X: α helix (1)
Chain Y: β pleated sheet (1)
- b. Proteins should be clearly labelled (1)
AND
The question states other major components inferring more than one
BOTH
Phospholipids and cholesterol should be clearly labelled (1)



- c. Phospholipid: water proof barrier separating internal environment from external environment. (1)
AND
Cholesterol: cell membrane fluidity
OR
Glycolipid: cell-cell recognition (1)

Note: Proteins/glycoprotein/lipoprotein cannot be assessed here

- d. Sally is correct because

the subunits are glucose/monosaccharide or nitrogen is not present (1)
AND
it is therefore a carbohydrate or it is therefore not a protein. (1)

Study Design Reference:

The functional diversity of proteins; the structure of proteins in terms of primary, secondary, tertiary and quaternary levels of organisation. The structure and function of the plasma membrane and the movement of substances across it: the fluid-mosaic model of a plasma membrane

Web Link

Protein structure: <http://lectures.molgen.mpg.de/ProteinStructure/Levels/index.html>

Membrane structure: <http://www.wisc-online.com/Objects/ViewObject.aspx?ID=ap1101>

Question 3

A high level of understanding is expected with respect to photosynthesis and respiration. This question is about photosynthesis and demands recall knowledge on the processes occurring as well as their cellular location. The regurgitation of the balanced chemical equation of photosynthesis is not enough. An understanding of the inputs and outputs of both the light dependent reaction and light independent reaction is important.

- a. Grana (thylakiod) (within the chloroplast) (1)
- b. i. Water **OR** NADP **OR** ADP and Pi (1)
ii. Oxygen **OR** NADPH **OR** ATP (1)
- c. i. inner membrane of the mitochondria (cristae) (1)
ii. Product (either of):

water
ATP. (1)

Description

Electrons are passed along electron acceptors/a series of cytochromes.
Oxygen captures electrons, which are combined with hydrogen.
Carrier molecules give up hydrogen as it is passed along. (1)

Study Design Reference:

Requirements for photosynthesis – excluding differences between CAM, C3 and C4 plants – including: the structure and function of the chloroplast; the main inputs and outputs of the light dependent and light independent stages

Web Link

<http://www.wiley.com/college/boyer/0470003790/animations/photosynthesis/photosynthesis.htm>

Question 4

Signalling molecules and their action at a cellular level is an important aspect of the key knowledge of Area of Study 2. This includes hormones and their action. In the context of the question, hormones are either lipid soluble (like a steroid hormone) or lipid insoluble (like a protein hormone). The action of both hormones is quite different and the key to understanding the question is to be able to correctly interpret the diagrams because one of the hormones clearly binds to a surface receptor (lipid insoluble) and the other to a receptor within the cytosol (lipid soluble).

- a. S (1)
AND
Hormone X, being a lipid soluble hormone, is able to pass directly through the plasma membrane and binds to a receptor in the cytosol. (1)
- b. The cells in these organs lack the **appropriate** receptors for hormone X. (1)
- c. Decrease in the concentration of receptors available for hormone X (1)
AND
Less hormone-receptor complexes, reducing the response of hormone X (1)

Study Design Reference:

A generalised view of how information received by a cell's receptor is transduced to an effector to initiate various cellular responses including the position of receptors for protein-based and lipid-based signalling molecules

Web Link

<http://classes.midlandstech.edu/carterp/Courses/bio211/chap16/chap16.htm>

Question 5

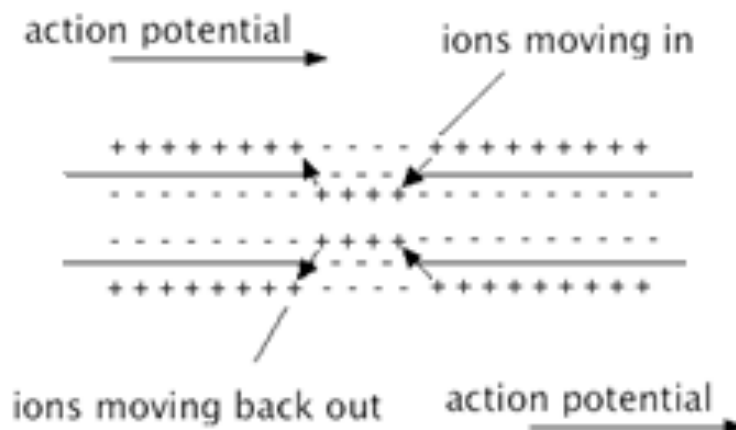
The action of a nervous system is expected knowledge in the Unit 3 4 course, particularly at the molecular level. There are several areas that students are encouraged to focus on

1. The detection of signals (signaling molecules and receptor).
2. The transmission of the nerve signal.
3. The movement of the nerve signal across the synapse.
4. The generation of a response.

This question is related to how a nerve impulse is transported across a synapse as well as how a nerve impulse is transmitted along a nerve. The synapse involves neurotransmitters that are secreted into the synapse and bind to a receptor, The nerve impulse involves the changing of the polarity of neurons by opening and closing gated ion channels in an 'all or nothing' type response.

- a. Neurotransmitter (1)
- b. The neurotransmitter is being broken down by an enzyme. (1)
- c. Positive ions (sodium) moving into the axon causes an action potential and ions (potassium) moving out restores the charge balance (1)

NOTE: A diagram must be drawn showing ion charges in a resting potential and action potential. Ion movement must be shown (1)



Study Design Reference:

Coordination and regulation at the cellular level:

The nature of the stimulus-response model and the roles of the nerve pathway and chemical signals in the transmission of information from receptor to effector.

Types of signalling molecules: neurotransmitters; animal hormones; pheromones; plant growth regulators

Web Link

General Nerve Structure and Function: <http://outreach.mcb.harvard.edu/animations/synaptic.swf>

Action Potential: <http://bcs.whfreeman.com/thelifewire/content/chp44/4402s.swf>

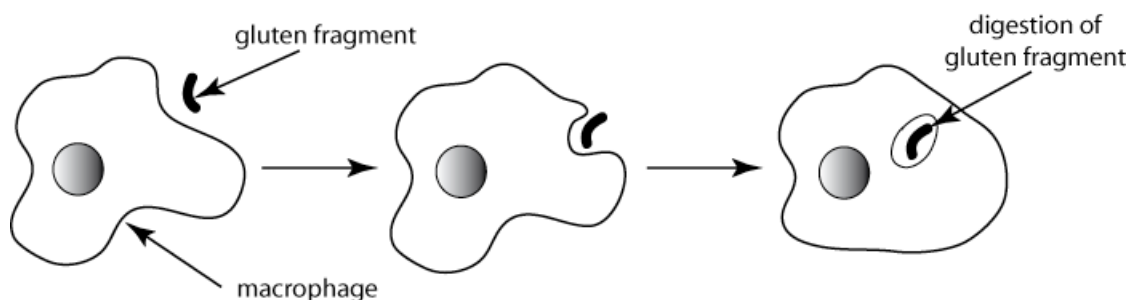
Question 6

One of the case studied systems in Unit 3 is the immune system. This is a very complex system and students are expected to have an appreciation of the basics of it at both a cellular and chemical level. Once this is achieved, an understanding of some of the problems associated with it can be investigated. This question is partly about self cells being recognized as non self, which triggers the immune system to respond. It is also about the crucial role that helper T cells play within the immune system.

- a. Autoimmune (disease) (1)
- b. macrophages engulf the gluten fragment (or a diagram showing this) (1)

AND

the fragment is digested by enzymes/lysosomes. (1)



A well labeled diagram could gain full marks

- c. cytotoxic T cell (1) that kills infected epithelial cells (1)
OR
B cells (1) these cells differentiate into memory and plasma cells to produce antibodies against epithelial cells (1)
OR
interleukins/cytokines (1) these stimulate specific immune response against epithelial cells (1)

Study Design Reference:

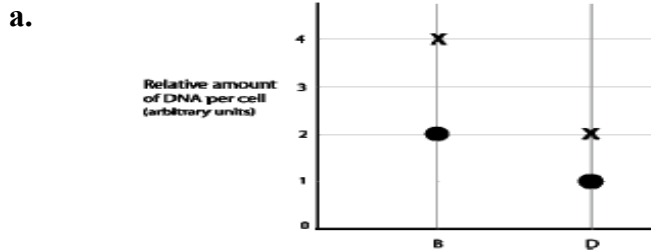
The role of the human immune system in detecting and responding to antigens:
The nature, characteristics and components of the adaptive immune response including the role and actions of B cells and their antibodies in humoral immunity and the role and actions of T helper cells and T cytotoxic cells in cell-mediated immunity
Disorders of the human immune response including the allergic response and autoimmune diseases

Web Link

<http://www.slideshare.net/doctorrao/immune-system-structure-and-functions>

Question 7

Mitosis has now been formally introduced in the study design. This links in quite well with the cell cycle and apoptosis (part of Unit 3), which this question is about.



Two examples are shown on the graph. Note that any position marked against D must be half the value of that marked against B. (1)

b. Q, S, P, R. (1)

c. Programmed cell death (1)

d. An external factor (or internal) triggers a series of reactions where the product of one leads to the stimulation of another (1). The end result is the cytoskeleton breaks down which destroys the cell. This is signal transduction as an initial signal is converted into a cellular response by a series of secondary messages (1).

e. A tumour cell (1) because they are growing where they shouldn't be (1)

OR

A skin cell between the digits (1) (for example) for the 'sculpting' of the body (1)

f. A virus is a pathogenic agent with a protein shell and nucleic acid core (1)

g. The nucleic acid from the virus could splice itself within the genome of the cell and disrupt the genes that control apoptosis. This means the cell can continue surviving with the virus inside it (1)

Study Design Reference:

Cell reproduction: the phases of the cell cycle in eukaryotes including DNA replication, the division of the nucleus (mitosis), and cytokinesis.

Apoptosis (regulated cell death) as an example of a cellular response to specific signals

Web Link

Mitosis: http://www.biology.arizona.edu/cell_bio/tutorials/cell_cycle/main.html

Apoptosis: <http://www.susanahalpine.com/anim/KubyHTML/Celdeath.htm>

Question 8

A detailed understanding of the events associated with protein synthesis is required. This is occasionally tested by students being provided with a DNA sequence and a list of codons. It has been regularly assessed over the past few years in the form of a written answer, usually after the interpretation of a cell diagram showing the relevant events. There are many key terms associated with the process and a good way to summarise it would be with a flow chart.

- a. i. Transcription (1)
- ii. the DNA template strand is made by RNA polymerase (1)
AND
pre-mRNA is produced. This undergoes post-transcriptional modification, such as introns are removed (1)
AND
mRNA leaves the nucleus (1)
- b. The molecule is tRNA, which has an anticodon and a specific amino acid (1)
AND
The process is translation occurring at the ribosome (1)
AND
The tRNA anticodons attach to the mRNA codons and a protein/polypeptide is produced (1)

Study Design Reference:

Molecular genetics: gene expression: the genetic code and roles of RNA in transcription, RNA processing in eukaryotes, and translation

Web Link

Using the genetic code: <http://learn.genetics.utah.edu/content/begin/dna/transcribe/>

Details: <http://www.wisconline.com/Objects/ViewObject.aspx?ID=AP1302>

Question 9

Mendelian inheritance continues to be a focus of the biology course. There are many aspects of Mendelian inheritance and after developing an understanding of the key terms the best way to develop a better understanding of the concepts is to complete practice questions. The links below have a large amount of practice questions. This question demands a pedigree to be correctly interpreted and then appropriate genotypes of individuals and chances of individuals expressing certain characteristics can be determined.

- a. I1: $X^H X^h$ I2: $X^h Y$ (both for 1)
- b. 100%(1)
- c. 50% (we know it is a boy) (1)
- d. I1: Gg
I2: Gg
II1: gg
II2: GG **OR** Gg (1 incorrect loses a mark, 2 incorrect gains zero)

Study Design Reference:

Patterns of inheritance involving the monohybrid cross: dominance; recessiveness; co-dominance; multiple alleles; pedigree analysis; autosomal and sex-linked inheritance; use of the test cross.

Web Link

<http://biology.clc.uc.edu/courses/bio105/geneprob.htm>

http://www.phschool.com/science/biology_place/biocoach/inheritance/problems.html

http://www.ucl.ac.uk/~ucbhjow/b241/mendel_1.html

<http://www.mansfield.ohio-state.edu/~sabedon/biol1128.htm>

Question 10

Fossils and their interpretation is an integral part of Unit 4 Area of Study 2. This particular question relates not only to the interpretation of fossils but to the inference of how they may contribute to the way of life of the once living organism. This question also delves into how cultural and technological evolution has influenced the lifestyle of various hominins.

- a. Set 2
AND 2 OF
prominent brow ridge
OR
smaller cranial capacity
OR
face protrudes more
OR
foramen magnum is positioned further back. (2 characteristics for 2 marks)
- b. Evidence of:
Tools
OR
use of fire. (1)
- c. i. Articulate speech/writing/painting/ceremonies enabled information to be passed on. (1)
- ii. Any of:

the brain – an increase in capacity leads to greater processing of information
OR
precision grip led to the ability to make tools for fine manipulation
OR
structures involved with speech led to communication through speech. (1)
- iii. yes – medical advances or genetic manipulation mean that modern humans are interfering in their own selection to the extent that natural selection no longer operates
OR
no – humans still exist in many different environments and are still subjected to different selective pressures, for example, disease(1)

Students could argue either for or against the statement; however, a mark will only be awarded if a reasoned argument is presented.

Study Design Reference:

Hominin evolution: shared characteristics which define primates, hominoids and hominins, major trends in hominin evolution from the genus *Australopithecus* to the genus *Homo* including morphological, structural and cognitive development resulting in cultural evolution and the rise of technologies

Web Link

<http://www.becominghuman.org/>

Question 11

When fossils are located, their relevant place in time can be inferred. This can be done in 2 ways

1. Relative dating: Using the concept of strata correlation where the deeper layers contain the older fossils
2. Absolute dating: Using radio isotopic dating to determine the actual time of existence of the organism

Usually at a fossil dig there is a lot of evidence available to help interpret the lifestyle of a particular organism. You are encouraged to use common sense and logic with their interpretation.

- a. strata near the top are more recent (or the converse)
OR
strata are laid down in chronological order. (1)

- b. i. The decrease in bird numbers was due to:
predation by humans/dogs
OR
habitat destruction by dogs/humans/volcanic eruption. (1)

ii. The evidence given needs to relate to the answer given in 7.b. i. , such as:
dog bones in the strata
OR
pottery, indicating human settlement
OR
charred plant remains, indicating habitat destruction by humans
OR
charred plant remains, indicating human settlement/volcanic eruption. (1)

- c. i. Founders (founder effect is also acceptable) (1)

ii. population separated/no gene flow(1)
AND
natural selection occurs (or a suitable description of this process) (1)
AND
when brought back together, they are unable to produce viable/fertile offspring(1)

Study Design Reference:

The geological time scale; relative and absolute dating techniques
Environmental selection pressures, gene flow, genetic drift (founder and bottleneck effects),
allopatric speciation

Web Link

<http://regentsprep.org/Regents/earthsci/rockcorrelation.htm>

http://www.youtube.com/watch?v=B_tgHPbbyCg

Question 12

Many organisms that we have direct contact with are the product of artificial selection. The differences between natural and artificial selection is the central focus in this question.

- a. The humans are the selective agent (1)
AND
the phenotype selected for is the tastiness/nuttiness of the fruit. (1)
- b. (i) The genotype is identical or the plants are clones. (1)

(ii) The lack of variety means that for example, should a disease occur, the resistance would be the same and may lead to extinction. (1)
- c. No, as there has been no change to the plant's DNA/genome/genes. (1)

Study Design Reference:

Natural selection as a mechanism for biological evolution, selective breeding as a method of affecting and limiting the gene pool.

Web Link

<http://learn.genetics.utah.edu/content/variation/artificial/>

**End of Detailed Answers to 2013 VCAA VCE Biology Sample Examination
Short Answer Questions**

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VCE Biology 2013–2016

Written examination

Examination specifications

Overall conditions

The examination will be sat at a time and date to be set annually by the Victorian Curriculum and Assessment Authority.

There will be 15 minutes reading time and 2 hours 30 minutes writing time.

VCAA examination rules will apply. Details of these rules are published annually in the *VCE and VCAL Administrative Handbook*.

The examination will be marked by a panel appointed by the VCAA.

The examination will contribute 60 per cent to the Study Score.

Content

All outcomes in Unit 3 and Unit 4 will be examined. All the key knowledge that underpins the outcomes in Unit 3 and Unit 4, and the set of key skills listed on page 12 of the study design are examinable.

Questions will require students to apply Biology knowledge and skills that are related to Unit 3 and/or Unit 4.

The examination will assess a representative sample of the key knowledge and key skills that underpin the outcomes of Unit 3 and Unit 4. While students will not be required to complete practical exercises within the examination, they may be asked to draw on their practical experience when answering questions.

Each outcome will be approximately equally weighted.

Format

The examination paper will consist of two sections. Examination questions will be presented in a question and answer book.

- **Section A** will consist of 40 multiple-choice questions. Each question will be worth 1 mark. Students will be required to mark their responses on a multiple-choice answer sheet. This section will be worth 40 marks.

All questions in Section A will be compulsory.

- **Section B** will consist of short answer questions and will be worth 70 marks.

The total for the examination will be 110 marks.

Approved materials and equipment

Students are permitted to bring into the examination room: pens, pencils, highlighters, erasers and rulers.

Advice

During the 2013–2016 accreditation period for VCE Biology, examinations will be prepared according to the examination specifications above. Each examination will be an interpretation of these specifications and will test a representative sample of the key knowledge and key skills.

This sample examination is published in order to exemplify the new examination format.

Answers to multiple-choice questions are provided on page 40. Answers to other questions are not provided. Selected questions from previous examination papers from 2004–2011 are indicative of the type and scope of questions that may be expected.



Victorian Certificate of Education

Year

SUPERVISOR TO ATTACH PROCESSING LABEL HERE

STUDENT NUMBER

Letter

Figures

Words

BIOLOGY

Written examination

Day Date

Reading time: *.* * to *.* * (15 minutes)

Writing time: *.* * to *.* * (2 hours 30 minutes)

QUESTION AND ANSWER BOOK

Structure of book

Section	Number of questions	Number of questions to be answered	Number of marks
A	40	40	40
B	x	x	70
			Total 110

- Students are permitted to bring into the examination room: pens, pencils, highlighters, erasers, sharpeners and rulers.
- Students are NOT permitted to bring into the examination room: blank sheets of paper and/or white out liquid/tape.
- No calculator is allowed in this examination.

Materials supplied

- Question and answer book of 37 pages.
- Answer sheet for multiple-choice questions.

Instructions

- Write your **student number** in the space provided above on this page.
- Check that your **name** and **student number** as printed on your answer sheet for multiple-choice questions are correct, **and** sign your name in the space provided to verify this.
- All written responses must be in English.

At the end of the examination

- Place the answer sheet for multiple-choice questions inside the front cover of this book.

Students are NOT permitted to bring mobile phones and/or any other unauthorised electronic devices into the examination room.

SECTION A – Multiple-choice questions**Instructions for Section A**

Answer **all** questions in pencil on the answer sheet provided for multiple-choice questions.

Choose the response that is **correct** for the question.

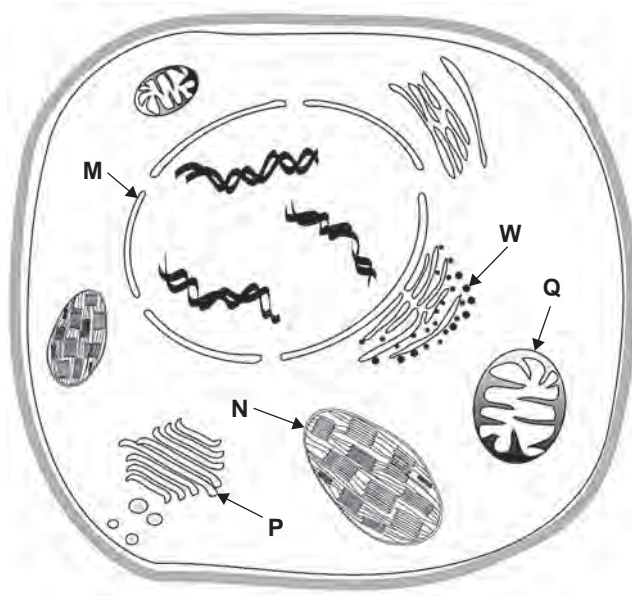
A correct answer scores 1, an incorrect answer scores 0.

Marks will **not** be deducted for incorrect answers.

No marks will be given if more than one answer is completed for any question.

Question 1

Consider the following plant cell.



A process occurring at structure **W** in this plant cell would be

- A. packaging of molecules.
- B. aerobic respiration.
- C. protein synthesis.
- D. DNA replication.

Question 2

Facilitated diffusion is a form of cell transport that

- A. moves oxygen and carbon dioxide across membranes.
- B. occurs against a concentration gradient.
- C. requires specific protein channels.
- D. uses energy supplied by ATP.

Question 3

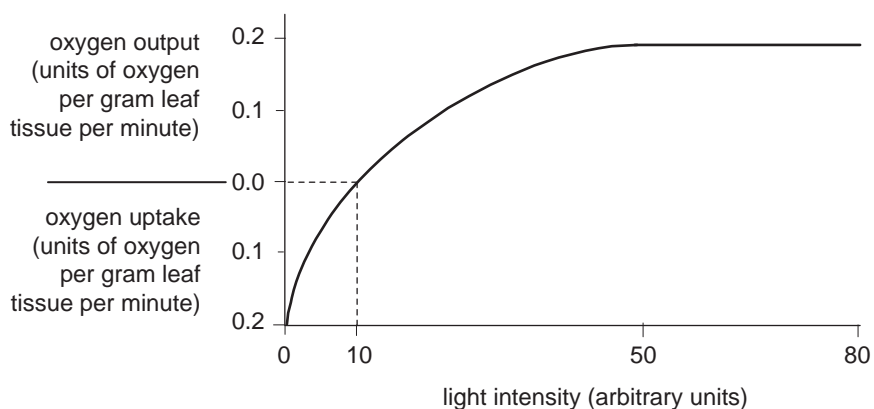
Insulin is a complex protein that is said to have a quaternary structure.

This means that insulin

- A. cannot be denatured.
- B. lacks disulfide bridges.
- C. contains all the known amino acids.
- D. has more than one polypeptide chain.

Question 4

The following graph shows the relationship between light intensity and net oxygen uptake or output by a particular green plant.

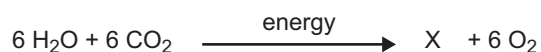


At a light intensity of 10 units

- A. the rate of photosynthesis is zero.
- B. the rate of aerobic respiration is zero.
- C. oxygen produced by photosynthesis is equal to the oxygen used by aerobic respiration.
- D. oxygen produced by photosynthesis is equal to twice the oxygen used by aerobic respiration.

Question 5

Consider the following diagram that is a summary of an important biochemical process.

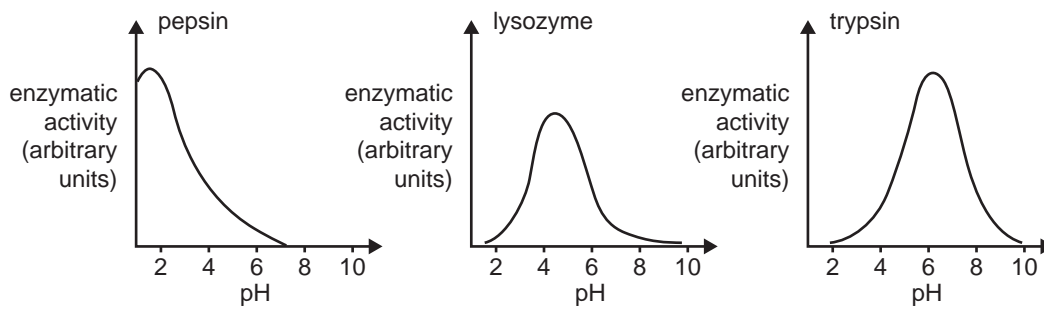


The product, X, in this biochemical process is

- A. ADP.
- B. a polymer.
- C. an amino acid.
- D. a monosaccharide.

Question 6

Examine the following graphs.



From these graphs it is reasonable to infer that at a pH of 4

- A. trypsin would be inactive.
- B. all the pepsin would be denatured.
- C. all three enzymes would lack a functional active site.
- D. lysozyme has the highest activity of the three enzymes.

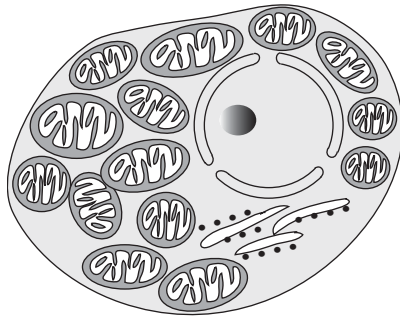
Question 7

An example of a catabolic reaction includes the formation of

- A. maltose from glucose.
- B. fatty acids and glycerol from lipids.
- C. ATP and water from ADP and inorganic phosphate.
- D. glucose and oxygen from carbon dioxide and water.

Question 8

Examine the following cell.

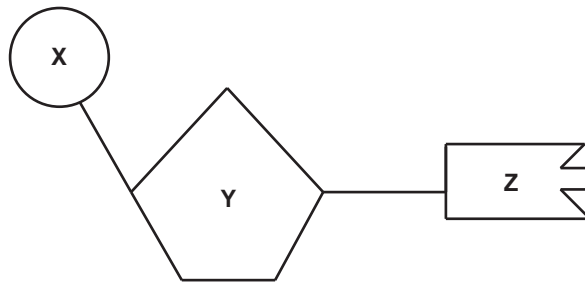


Based on the internal structure, the cell is likely to

- A. be a cheek epithelial cell.
- B. be a mature red blood cell.
- C. require high levels of oxygen.
- D. produce high levels of sugars.

Question 9

The following diagram represents a nucleotide with subunits X, Y and Z.



This nucleotide could be identified as a monomer of DNA but not RNA if

- A. X is ribose.
- B. Z is thymine.
- C. Y is phosphate.
- D. Z is paired with cytosine.

Question 10

The Golgi apparatus is responsible for the

- A. manufacture of lipids.
- B. production of energy for the cell.
- C. destruction of unwanted cellular molecules.
- D. modification and packaging of protein molecules.

Question 11

A person will gain long-term immunity after

- A. administration of the chicken pox vaccine.
- B. the inflammatory response to a bee sting.
- C. an injection of immunoglobulin if exposed to mumps.
- D. the passage of antibodies from their mother.

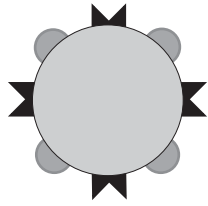
Question 12

One of the similarities between the defence mechanisms of a plant and an animal includes the

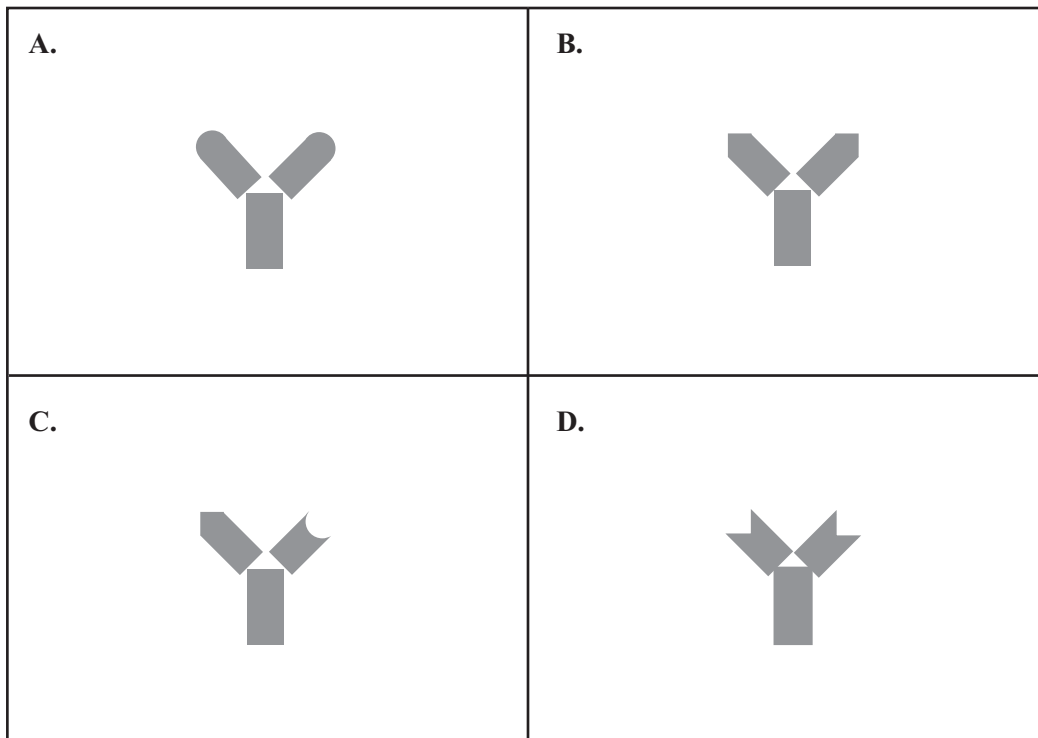
- A. production of memory cells.
- B. release of immune cells through a circulatory system.
- C. use of an epidermal layer to inhibit the invasion of pathogens.
- D. production of salicylic acid to warn cells of an invading pathogen.

Question 13

A disease-causing bacterium has the following structure.



What kind of antibodies would be most effective against this type of bacterium?

**Question 14**

Vibrio cholerae produces a toxin that binds to a plasma membrane receptor on intestinal cells of the host. The toxin permanently activates the G protein in target cells, causing them to lose water rapidly. When a person is infected with cholera they suffer severe dehydration.

The *V. cholerae* toxin

- A. is an example of a second messenger molecule.
- B. disrupts normal signal transduction in the cell.
- C. is a lipid-soluble molecule.
- D. acts as a neurohormone.

Question 15

Consider two cells (X and Y) in a reflex arc in the nervous system. Cell X is transmitting a signal to cell Y. Signal transduction commences

- A. in the cytosol of cell X.
- B. along the axon of cell X.
- C. in the myelin sheath of cell X.
- D. at the synapse between cells X and Y.

Question 16

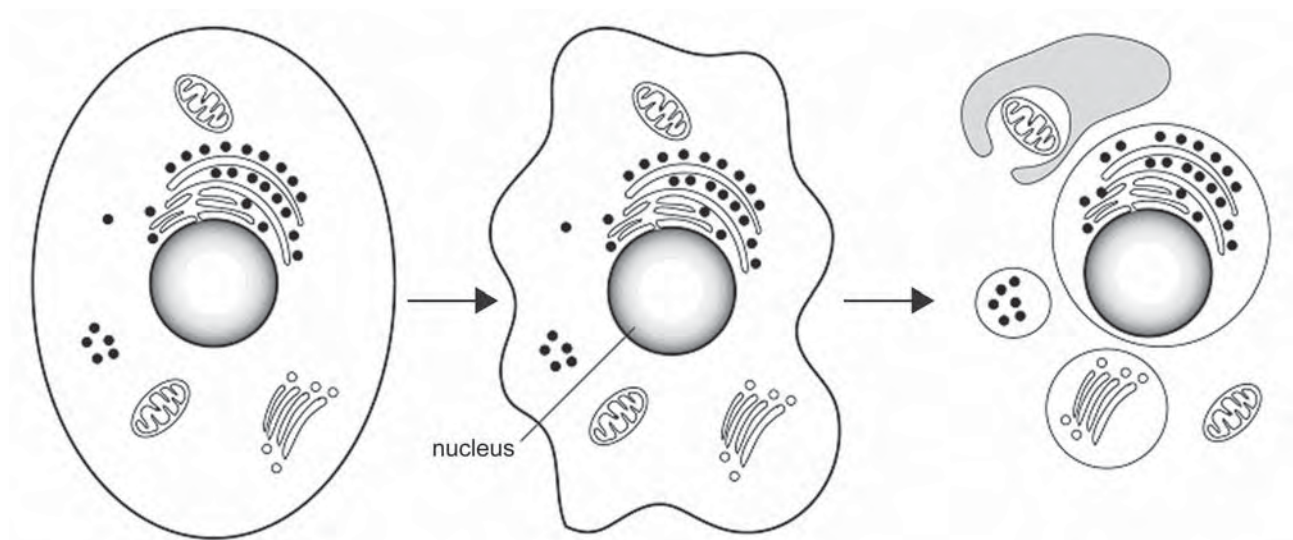
Recent research has demonstrated that members of some families are unable to feel pain. They respond normally to touch, temperature and pressure, and have no signs of nerve disease.

From this information it is reasonable to conclude that in the affected people

- A. ion channels are blocked in one group of specialised neurons.
- B. neurons in the skin are unable to respond to external stimuli.
- C. neurons are unable to produce neurotransmitters.
- D. brain cells fail to respond to electrical signals.

Question 17

The following diagram outlines a process that occurs in multicellular organisms.



This process

- A. begins with a signal binding to a specific receptor.
- B. occurs when a virus replicates within a cell.
- C. is part of mitosis.
- D. is reversible.

Question 18

The lymphatic system

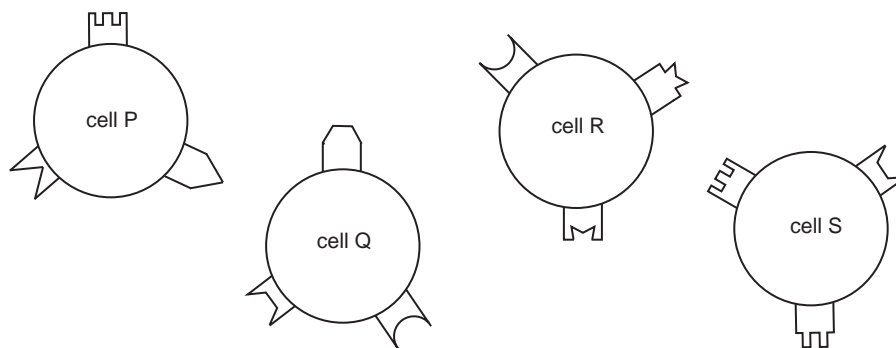
- A. controls blood clotting.
- B. contains red blood cells.
- C. contains phagocytic cells.
- D. has vessels with thick, muscular walls.

Question 19





Cells of the immune system have different kinds of structures on their surfaces. Three of the structure types that exist are

- the cell's own antigens, called self antigens
- receptors that enable a cell to identify its own antigens on any other cell
- receptors that identify foreign antigens on foreign cells.

Examine the following cells and the various structures on their surfaces.



From the information provided you are able to conclude that

- A. structure  is a self antigen for cell P.
- B. structure  is a self antigen for cell Q.
- C. structure  is a self antigen for cell R.
- D. structure  is a self antigen for cell S.

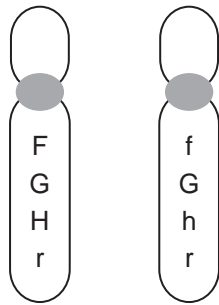
Question 20

Most water-soluble signalling molecules initiate responses within their target cells by

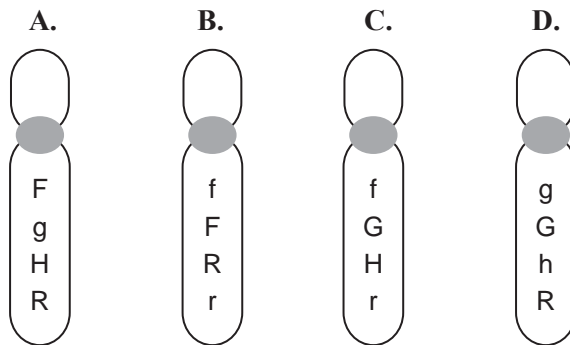
- A. forming a signalling molecule-receptor complex that binds to a site on a DNA molecule.
- B. bringing about an initial response of carbohydrate molecule production.
- C. attaching to receptors on the membranes of their target cells.
- D. activating a multistep pathway involving lipid molecules.

Question 21

A pair of homologous chromosomes involved in normal meiosis in an ovary carries the alleles shown.



Chromosomes detected in eggs produced would include

**Question 22**

In humans, a smooth chin and a straight hairline are each inherited as autosomal recessive traits. The alleles for each of the genes involved are

chin line – **S** : cleft chin
s : smooth chin

hairline – **W** : widow's peak
w : straight hairline

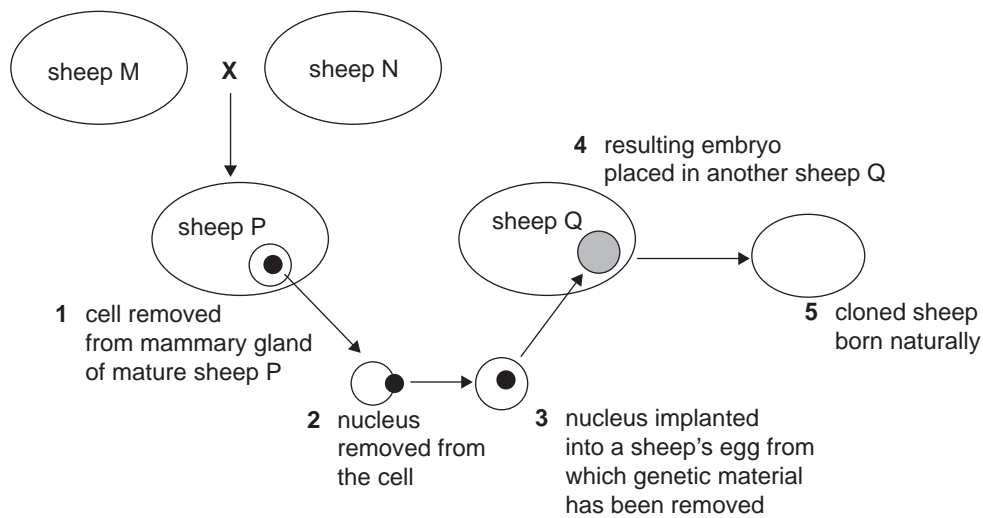
A mother and son each have a smooth chin and a straight hairline. The father of the boy has a cleft chin and a widow's peak.

The father's genotype must be

- A. **Ss Ww.**
- B. **SS WW.**
- C. **ss WW.**
- D. **ss ww.**

Question 23

The following diagram summarises the steps involved in the production of a cloned sheep.



The chromosomes in the cells of the cloned sheep will be identical with those in the cells of

- A. sheep M.
- B. sheep N.
- C. sheep P.
- D. sheep Q.

Question 24

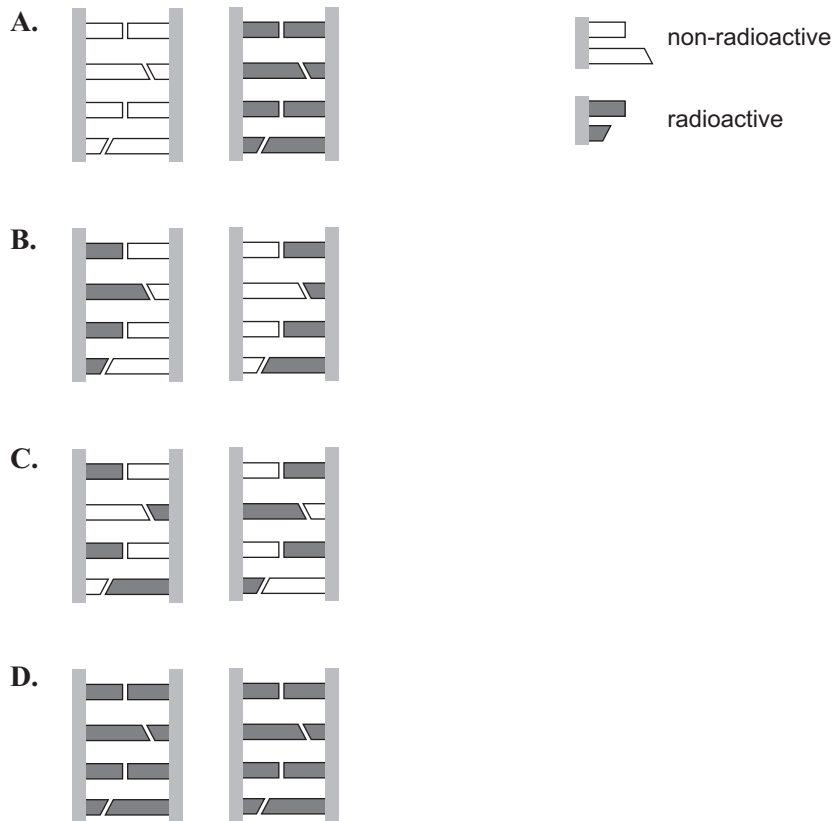
Domestic dogs vary greatly in adult size. All dog breeds have the IGF-1 gene coding for a hormone which promotes growth to adolescence. Scientists have discovered that all small dog breeds have an allele, called S, of another gene close to IGF-1.

The best hypothesis to explain the size range in dogs is that

- A. IGF-1 is the only gene controlling growth in dogs.
- B. the gene product of the S allele is a promoter of IGF-1.
- C. large breeds cannot produce a transcript of the IGF-1 gene.
- D. when S is translated its product inhibits IGF-1 gene expression.

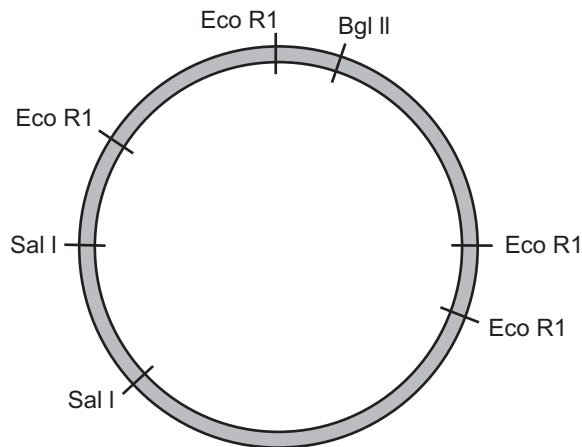
Question 25

DNA was incubated with radioactive nucleotides. After one cycle of replication the distribution of radioactive and non-radioactive nucleotides in the DNA would be



Question 26

The following diagram indicates the cutting sites of three different restriction enzymes on a particular bacterial plasmid.

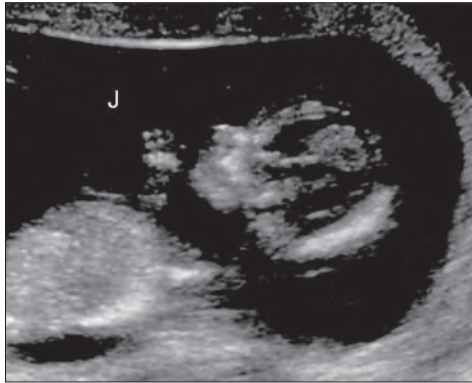


If the plasmid was incubated with the restriction enzyme Eco R1, the number of pieces of DNA obtained would be

- A.** two.
- B.** three.
- C.** four.
- D.** seven.

Use the following information to answer Questions 27 and 28.

The following ultrasound image shows a fetus at the week 12 stage of development.



The area J surrounding the fetus contains amniotic fluid which includes skin cells from the fetus. A small sample of amniotic fluid can be extracted and the skin cells cultured. The following image is of a karyotype prepared from cultured skin cells of the fetus in the photograph.



Question 27

The number of autosomes in this karyotype is

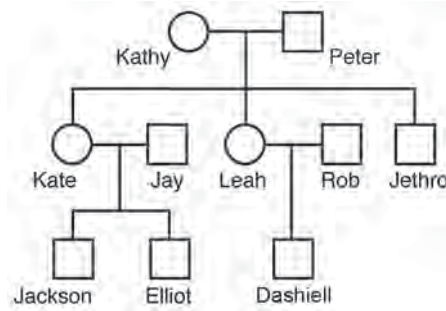
- A. 22
- B. 23
- C. 44
- D. 46

Question 28

Examination of the karyotype reveals that the fetus

- A. is a male.
- B. has a defective allele.
- C. has an extra X chromosome.
- D. has three number 13 chromosomes.

Use the following information to answer Questions 29 and 30.



Question 29

From an analysis of this pedigree, individuals with the same mitochondrial DNA (mDNA) include

- A. Kathy and Peter.
- B. Peter and Jethro.
- C. Jay, Rob and Jethro.
- D. Jackson, Elliot and Dashiell.

Question 30

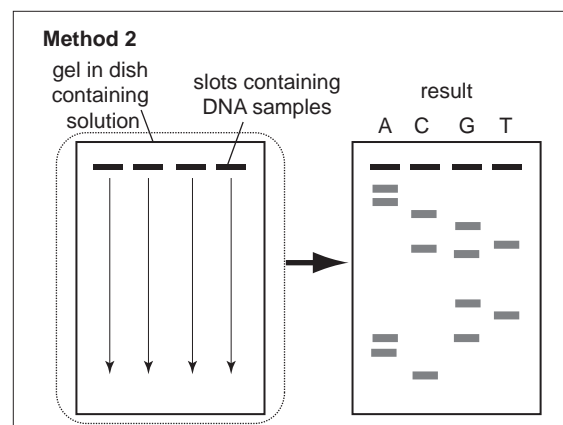
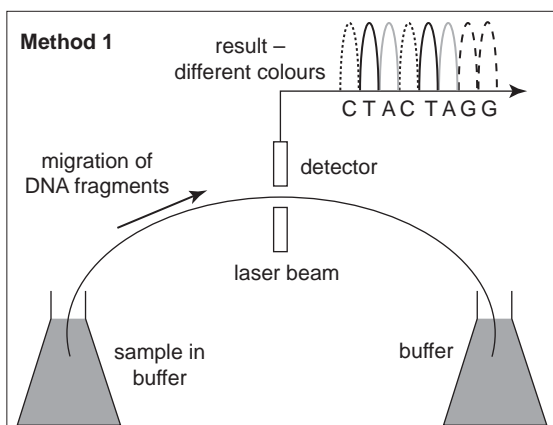
Jackson is known to have the X^H allele.

It is reasonable to claim that the allele must also be present in

- A. Kate.
- B. Peter.
- C. Elliot.
- D. Jethro.

Question 31

The following figures show two different methods used to sequence DNA.



It would be correct to conclude that

- A. method 1 requires 4 slots for the loading of the DNA.
- B. method 2 uses a laser beam to separate the individual nucleotides.
- C. method 1 uses fluorescent dyes to distinguish between the different nucleotides.
- D. method 2 requires the DNA to be loaded at the positive end on the sequencing gel.

Question 32

The founder effect and bottleneck are examples of

- A. gene flow.
- B. speciation.
- C. genetic drift.
- D. selection pressures.

Question 33

There is evidence that *Homo sapiens* and *Homo neanderthalensis* coexisted in Europe more than 30 000 years ago. Both of these species left signs of cultural evolution from this period.

An example of evidence which would show that cultural evolution was occurring in these groups at this time is

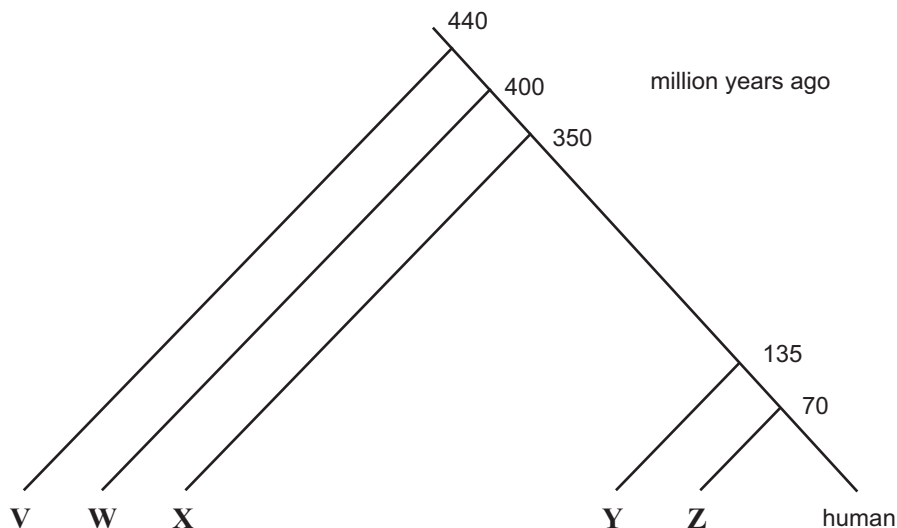
- A. drawings and carvings on rocks.
- B. animal remains close to a *Homo* skeleton.
- C. male and female skeletons in the same area.
- D. *Homo sapiens* and *Homo neanderthalensis* skeletons in the same area.

Question 34

Comparisons of the amino acid sequences of the α -globin polypeptide have been made between humans and a number of other vertebrates. The number of differences is shown in the table below.

Organism	shark	kangaroo	carp	cow	newt
Amino acid differences in α -globin compared to human	79	27	68	17	62

An evolutionary relationship between these vertebrates was determined and illustrated in the figure below.

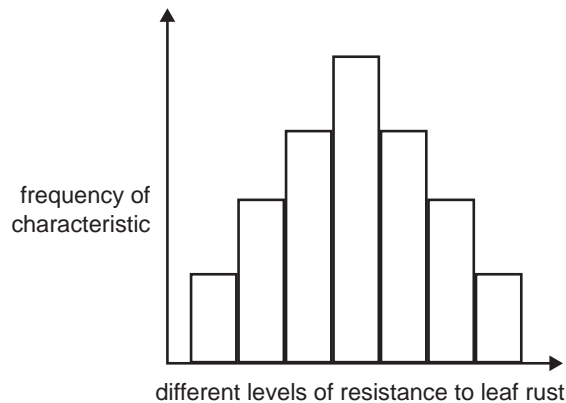


Based on the information provided, the correct placement of each animal on the figure to show the evolutionary relationship is

- A. V = cow, W = kangaroo, X = newt, Y = carp, Z = shark.
- B. V = shark, W = carp, X = newt, Y = kangaroo, Z = cow.
- C. V = carp, W = shark, X = kangaroo, Y = newt, Z = cow.
- D. V = kangaroo, W = cow, X = newt, Y = shark, Z = carp.

Question 35

Members of a barley plant species show varying levels of partial resistance to the leaf rust, *Puccinia hordei*. The graph below shows the distribution of a population of barley plants with regard to this characteristic.



With respect to rust resistance, these plants show

- A. high mutation rates.
- B. polygenic inheritance.
- C. discontinuous variation.
- D. inheritance due to a single pair of alleles.

Question 36

Scientific opinion was once evenly divided regarding the geographical origin of the modern human. Two hypotheses were put forward – the ‘Out-of-Africa’ hypothesis and the ‘Multi-Regional’ hypothesis.

In general, researchers now accept that the ‘Out-of-Africa’ hypothesis is better supported by current information. Findings from worldwide human fossil sites that would best support the ‘Out-of-Africa’ hypothesis include

- A. dating of fossils by radioactive uranium.
- B. the degree of decomposition of remains.
- C. the present-day climate of the region.
- D. variations in mitochondrial DNA.

Question 37

Selective breeding over many generations has produced gradual changes in farm animals.

It is reasonable to state that such gradual changes in a herd of cattle

- A. result from random mating in the herd in each generation.
- B. are due to the occurrence of gene mutations in each generation.
- C. result from the restriction of breeding to chosen animals in the herd.
- D. will improve traits that enhance the survival of the animals in the wild.

Question 38

The following statements are about ideas, discoveries and techniques.

Idea 1. The molecular structure of DNA was revealed to be a double helix.

Idea 2. Individuals best suited to the environment have the best chance of surviving and reproducing.

Idea 3. Comparing the similarities of nucleotide sequences in different organisms helps determine how closely related the organisms are to each other.

Idea 4. Organisms can alter their structure to suit their environment and then they are able to pass this favourable alteration on to their offspring.

What would be the correct sequence of timing from oldest to youngest?

A. 1 3 2 4

B. 4 2 1 3

C. 3 1 4 2

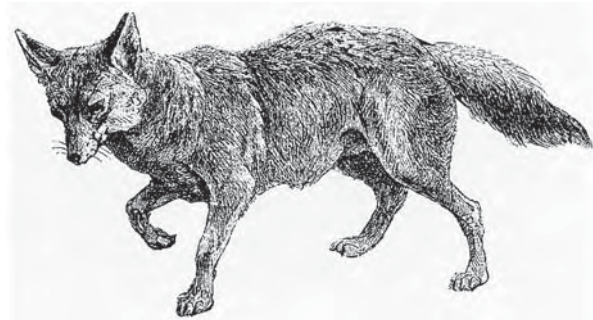
D. 2 4 3 1

Question 39

Examine the following drawings.



Tasmanian tiger



American grey wolf

The Tasmanian tiger (now extinct) and the American grey wolf evolved independently of each other, but show similar physical structures and hunting behaviours.

The similarities between the two organisms are most likely a result of

- A. homology.
- B. genetic drift.
- C. allopatric speciation.
- D. convergent evolution.

Question 40

In 2006, two separate palaeontology laboratories were set up in the Sahara desert.

Laboratory 1 – uncovered a burial site that contained human remains. More than 200 human remains were found and they were dated from 10 000 to 4500 years ago.

Laboratory 2 – discovered a 110-million-year-old plant-eating dinosaur, *Nigersaurus*, in a nearby area in a different sedimentary layer.

To date the fossils accurately, the two groups of palaeontologists would most likely have used

- A. carbon-14 dating for both the human and dinosaur remains.
- B. uranium-235 dating for both the human and dinosaur remains.
- C. uranium-235 dating for the human remains and carbon-14 dating for the dinosaur remains.
- D. carbon-14 dating for the human remains and uranium-235 dating for the dinosaur remains.

SECTION B – Short answer questions

Instructions for Section B

Answer **all** questions in the spaces provided. Write using black or blue pen.

Question 1 (3 marks)

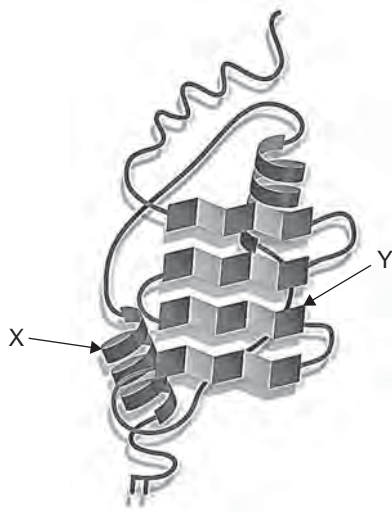
The beet caterpillar is an insect pest of the tomato plant. When a beet caterpillar starts to eat a tomato plant, the plant responds by producing a chemical known as jasmonic acid. Jasmonic acid and its derivatives have a variety of odours.

Some scientists have suggested that these odours attract wasps to the caterpillar-affected plants.

Outline an experiment that you would carry out to test this hypothesis. Describe results that would support the hypothesis.

Question 2 (8 marks)

The diagram below shows the structure of a particular protein molecule.



- a. The protein contains two distinctive types of polypeptide chains labelled X and Y. What are the names of these two types? 2 marks

chain X _____

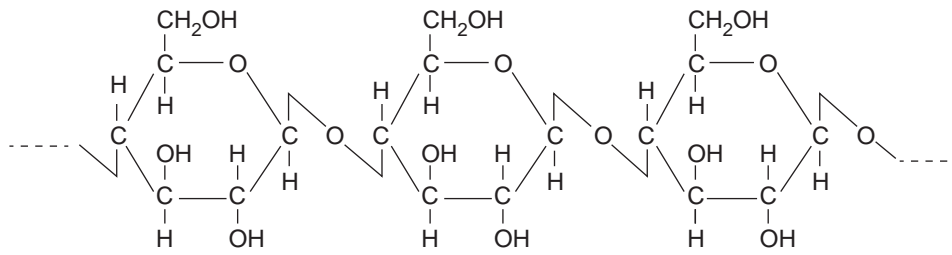
chain Y _____

- b. Proteins can be found in the membrane of a cell. Draw a labelled diagram to show the arrangement of both proteins and other major components in the plasma membrane. 2 marks

Consider the molecules you have labelled in your diagram in **part b**.

- c. Apart from the protein molecules, describe the roles played by the molecules in the plasma membrane. 2 marks

The following diagram shows a portion of an unknown macromolecule found in cells. The remaining portion of the macromolecule contains the same repeating unit.



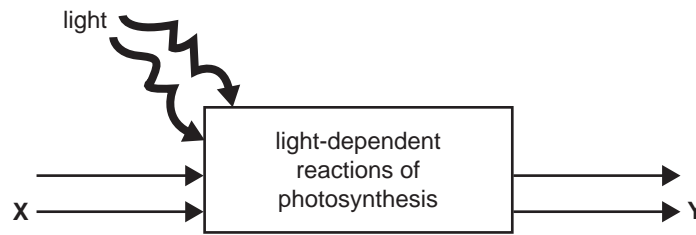
Two students discuss this diagram. Sally suggests it represents cellulose. Toby disagrees. He suggests that the diagram represents the enzyme cellulase.

d. Name the student who is correct and explain why.

2 marks

Question 3 (6 marks)

The following diagram shows a simplified representation of the first stage of photosynthesis.

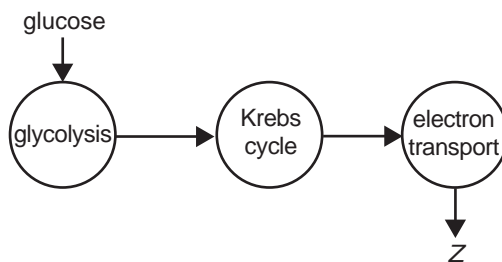


a. Where in the plant cell would the first stage of photosynthesis occur? 1 mark

b. i. Name one input item that X could represent. 1 mark

ii. Name one output item that Y could represent. 1 mark

The breakdown of glucose in aerobic respiration can be represented as occurring in three stages, as shown below.

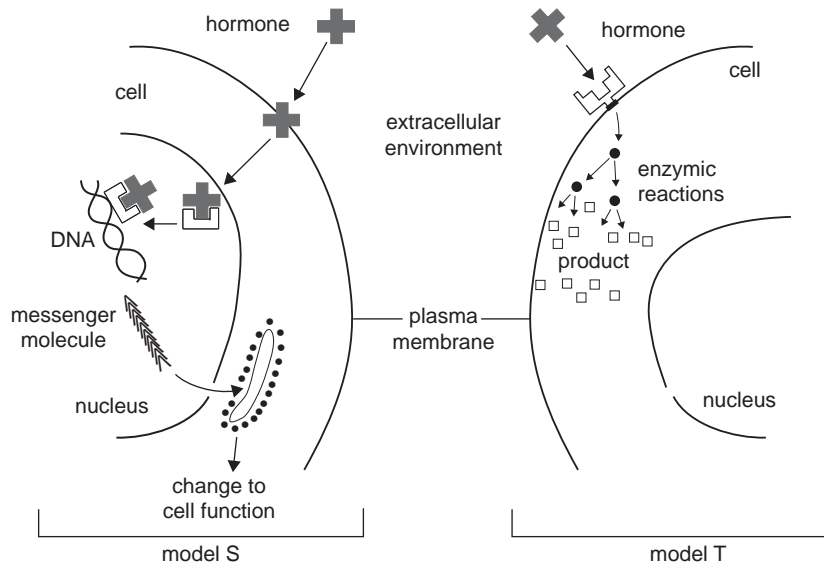


c. i. Within a cell, where does the electron transport stage of aerobic respiration occur? 1 mark

ii. Describe what happens during the electron transport stage.
In your answer include the name of product Z. 2 marks

Question 4 (5 marks)

Hormone X is a lipid-soluble hormone produced by one of the human endocrine glands. Consider each of the following general models for signal reception and transduction.



- a. Which model, model S or model T, best corresponds to the mechanism of hormone X? Explain your choice.

2 marks

Some tissues in the human body would not respond to hormone X.

- b. What is the most likely explanation for this condition?

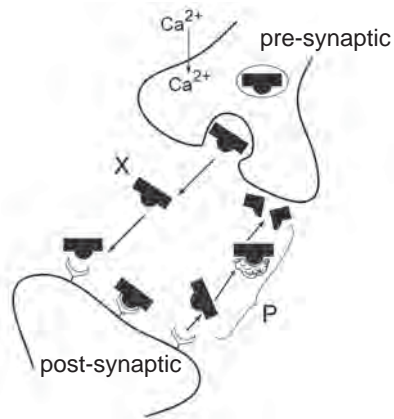
1 mark

- c. A tissue that has been responsive to hormone X may, over time, lose its response to hormone X, even though the concentration of hormone X remains unchanged. Based on your understanding of how a hormone controls the functioning of cells, suggest reasons for this decrease in responsiveness.

2 marks

Question 5 (4 marks)

The following diagram shows a synapse between the end of one neurone and the dendrite of another.



a. What is the general name for molecule X? 1 mark

b. Describe what occurs at stage P. 1 mark

c. Explain, with the use of a diagram, how the message is transmitted along the axon of the post-synaptic neuron. 2 marks

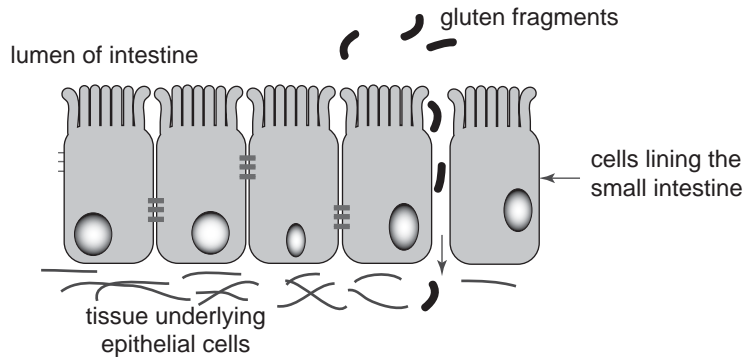
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Question 6 (5 marks)

Coeliac disease in humans is caused when cells of the immune system attack the epithelial cells that line the small intestine.

- a. What is the general name given to this type of disorder? 1 mark

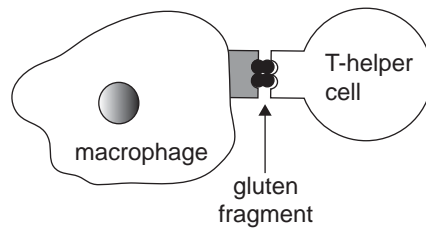
Coeliac sufferers are unable to break down the gluten found in grains such as wheat. One of the features of coeliac disease is ‘leaky gut syndrome’. A small gap appears between the epithelial cells that line the small intestine. Gluten fragments enter the gap and accumulate under the epithelial cells. Macrophages are stimulated to remove the fragments.



- b. Explain how a macrophage is able to remove and destroy a gluten fragment. You may use a written answer or labelled diagrams or both. 2 marks

Once a macrophage has destroyed a gluten fragment, it displays a piece of the fragment on its membrane using a special major histocompatibility complex (MHC) marker. A T-helper cell then attaches to the MHC marker-antigen complex.

The macrophage T-helper cell complex is shown below.



The macrophage T-helper cell complex stimulates other cells and chemicals to target and damage epithelial cells that line the intestine.

- c. Name one cell or chemical that would be stimulated by the macrophage T-helper cell complex and state its function.

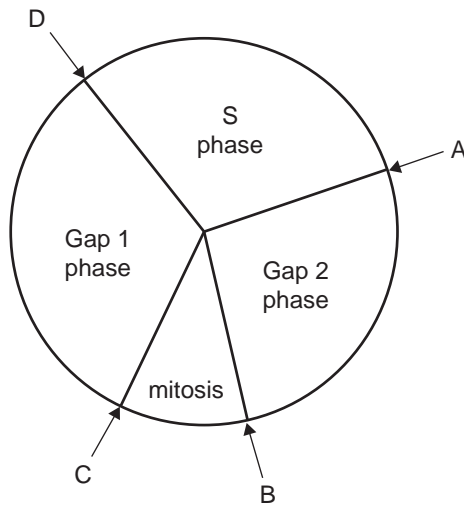
2 marks

name _____

function _____

Question 7 (9 marks)

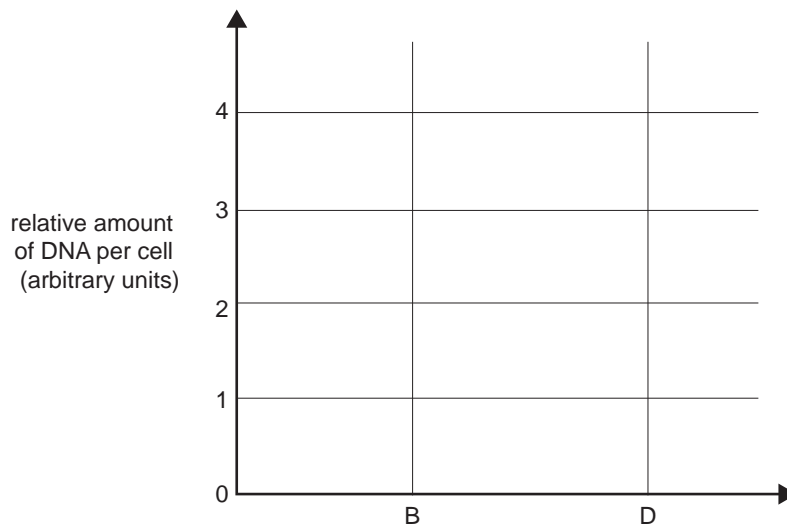
When a cell replicates it goes through a series of events that can be summarised by the following diagram. The cycle moves in a clockwise direction and includes mitosis. Note four points, labelled A, B, C and D.



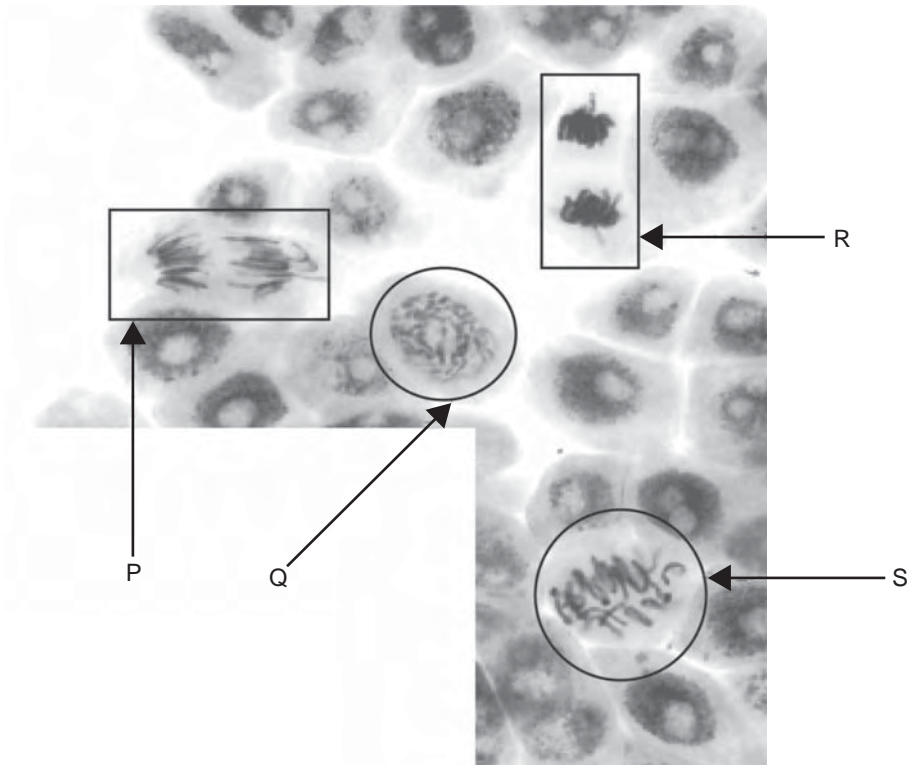
Given that two cells are formed as a result of replication, a cell must replicate its DNA during the cycle.

- a. Using crosses, mark on the graph below the relative amount of DNA present at each of the points B and D in the cycle.

1 mark



The following photograph shows a group of cells, some of which are replicating by mitosis. The letters P, Q, R and S indicate cells that are at different points in the cell cycle.



- b. Starting with the cell closest to the beginning of mitosis, arrange the letters P, Q, R and S in the order in which they would occur during the cell cycle. 1 mark

If a serious error occurs during mitosis, the daughter cells may not survive to complete the cell cycle and apoptosis can occur.

- c. What is apoptosis? 1 mark

- d. Suggest how apoptosis can be explained as an example of signal transduction. 2 marks

- e. In relation to the immune system, name one type of cell that could be destroyed by apoptosis and explain the benefit of this response. 2 marks

Some types of cancers are caused by viruses whose genetic material is integrated with the host cell's DNA and, as a result, the cell is unable to undergo apoptosis.

f. What is a virus?

1 mark

g. Suggest a mechanism to explain how a tumour virus (a virus associated with cancer) may interfere with a host cell's ability to undergo apoptosis.

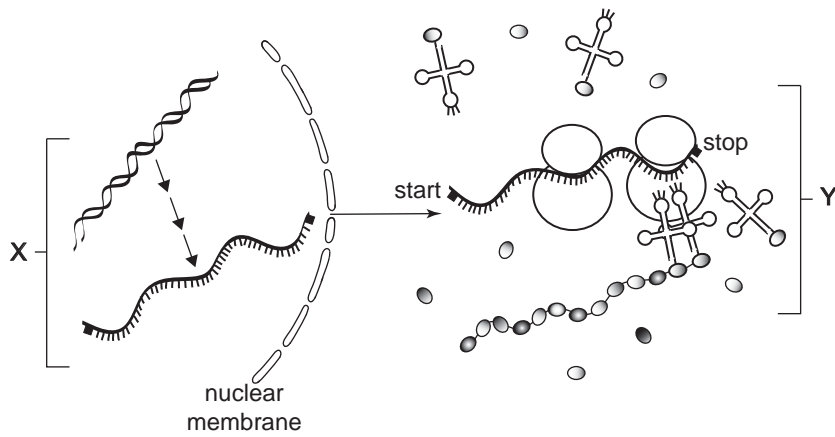
1 mark

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**SECTION B – continued
TURN OVER**

Question 8 (7 marks)

The following diagram outlines processes that occur in living cells.



a. i. Name the process represented at X. 1 mark

ii. Describe the sequence of events that occurs during the process at X. 3 marks

In the process at Y, the molecule shown below has a specific function.

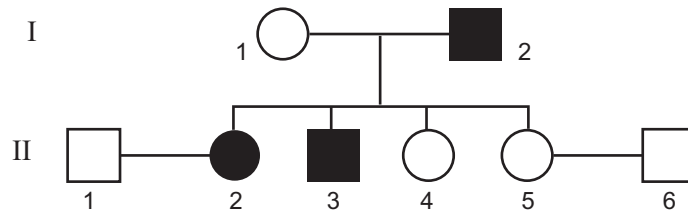


- b. Describe the structure of this molecule and then relate its structure to the specific function that the molecule has in the process occurring at Y.

3 marks

Question 9 (5 marks)

Haemophilia is an X-linked recessive condition. The following pedigree shows a portion of a family in which some members have haemophilia. Those on the pedigree with haemophilia are shaded.



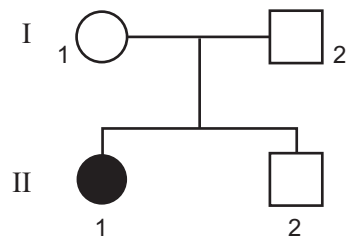
- a. Use appropriate allele symbols from X^H , X^h and Y to indicate the genotype of each of the following individuals. 1 mark

I1 _____ and I2 _____

- b. The couple II1 and II2 have a son.
What is the probability that the child has haemophilia? 1 mark

- c. The couple II5 and II6 have a son.
What is the probability that the child has haemophilia? 1 mark

The following pedigree is of a family in which one member (shaded) has an autosomal recessive condition. The alleles of the gene locus involved are G and g .



- d. Give a possible genotype for each of the four members of the family. 2 marks

I1 _____

I2 _____

II1 _____

II2 _____

Question 10 (6 marks)

The pictures below show views of skulls from *Homo erectus* and *Homo sapiens*.

skull set 1



skull set 2



- a. With reference to two structural features of the skull, which skull set represents *Homo erectus*? Justify your choice. 2 marks

skull set _____

justification _____

According to one interpretation of the hominid fossil record, *Homo habilis* is thought to have existed about 2 million years ago.

- b. What kind of discoveries have been made at *Homo habilis* sites that have increased our understanding of the technological evolution of hominids? 1 mark

The rate of technological evolution has been increased by cultural evolution of *Homo sapiens*.

- c. i. Describe one example of the effect that cultural evolution has had on the rate of technological evolution.

1 mark

Cultural evolution depended on the development of physical capabilities of the Homo genus.

- ii. What physical feature has played the most important role in this advancement? How has this feature developed over evolutionary time?

1 mark

feature _____

development _____

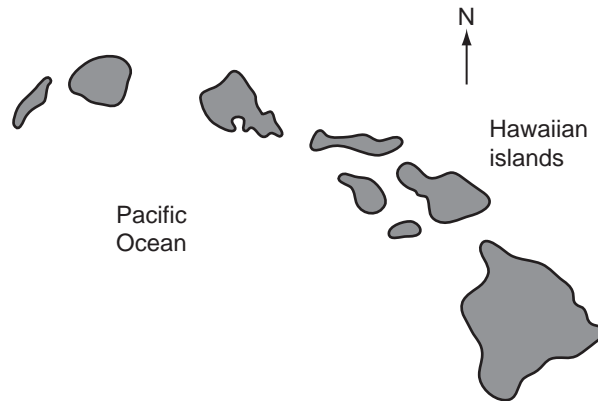
Arguably, modern *Homo sapiens* have taken the manipulation and control of the environment to its highest level in history.

- iii. Does this mean that our species will no longer physically evolve by the mechanism of natural selection? Justify your answer.

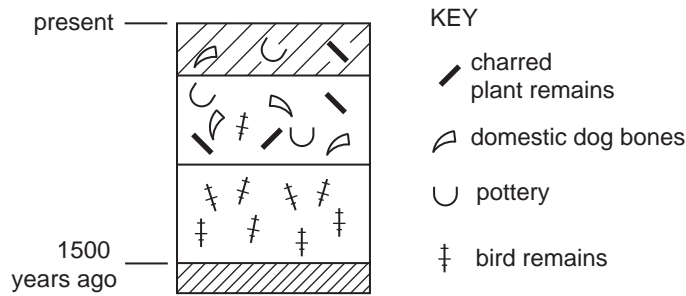
1 mark

Question 11 (7 marks)

The islands of Hawaii in the Pacific Ocean were formed as a result of volcanic action in which small landmasses were thrown up by submarine volcanoes. The youngest of the islands lies to the east of the oldest.



A similar pattern of deposition has been found across all islands, shown by the profile below.

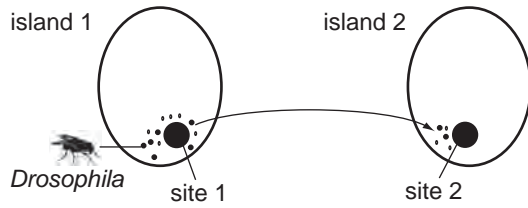


a. What assumption is made about the formation of strata when interpreting profiles such as this? 1 mark

b. i. State a hypothesis to account for the disappearance of many of the bird species from the groups of islands. 1 mark

ii. Provide evidence to support your hypothesis. 1 mark

Biologists studied many species of the fruit fly, *Drosophila*, living on the Hawaiian islands. The species varies widely in appearance, behaviour and habitat. The diversity of *Drosophila* can be explained by the successive colonisation of newly formed islands by a small number of individuals ‘island-hopping’ from the neighbouring westerly island. This is represented in the diagram below.



- c. i. What name is given to this small group of colonising individuals? 1 mark

- ii. Explain how the new and old colonies became separate species. 3 marks

Question 12 (5 marks)

Long before the development of agricultural crops, hunter-gatherers in southern Africa would pick the tastiest nutty fruits of the marula tree and scatter them around their camps. These would germinate and grow into fruit-bearing trees. The best seeds would be chosen from these trees and the process would be repeated.

- a.** Explain how this practice is an example of selective breeding. In your answer include the selective agent and the phenotypic characteristic being acted on. 2 marks

Current domestication processes include marcotting. This involves peeling away bark from a branch, stimulating the branch to produce roots. The branch is then cut and planted in soil.

- b. i.** What can you infer about the genotype of trees propagated through marcotting? 1 mark

- ii.** Outline one disadvantage of a plantation of marula trees grown through marcotting compared to a natural population of marula trees. 1 mark

- c.** Should the fruit from marcotted marula trees be labelled as genetically modified (GM)? Explain why. 1 mark

Answers to multiple-choice questions

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

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