

2013 VCE Biology Trial Examination Suggested Answers



Kilbaha Multimedia Publishing
PO Box 2227
Kew Vic 3101
Australia

Tel: (03) 9018 5376
Fax: (03) 9817 4334
kilbaha@gmail.com
<http://kilbaha.com.au>

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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.
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Answer Summary for Multiple-Choice Questions 2013 Kilbaha VCE Biology Trial Examination

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

ONE ANSWER PER LINE

ONE ANSWER PER LINE

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

Answer distribution:

A 10

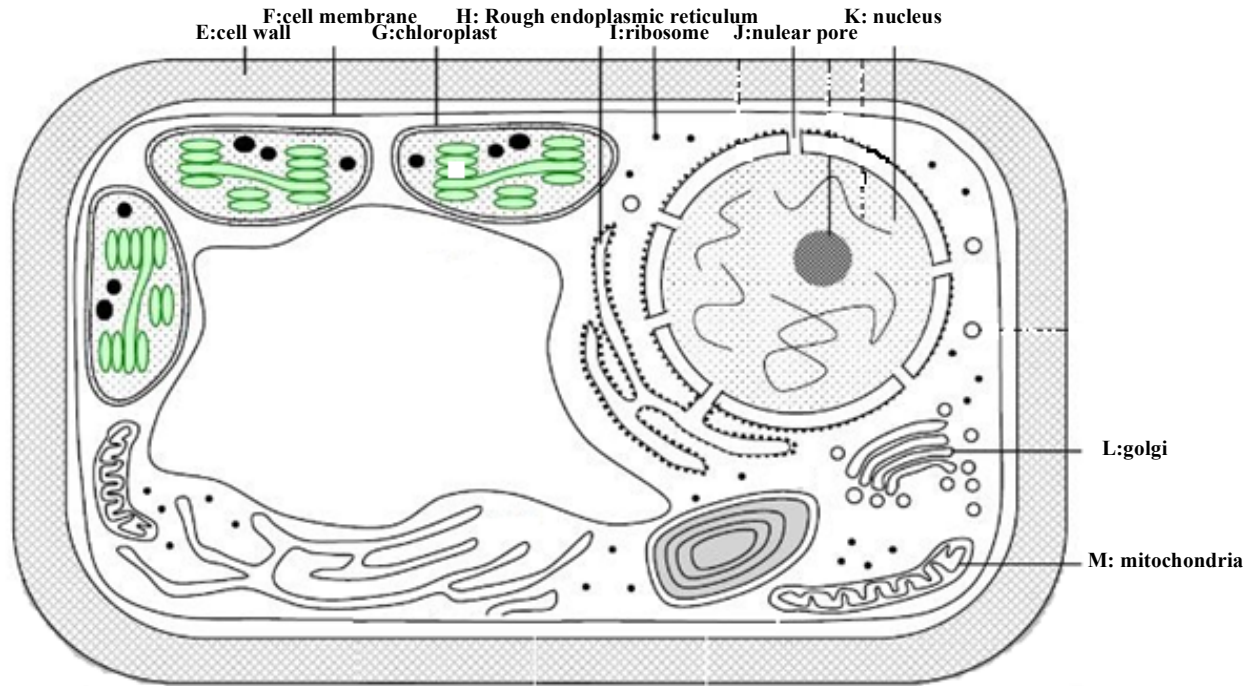
B 10

C 9

D 11

Question 1 Answer = C

Question 2 Answer = D



For question 1, the names of the various structures are added to the diagram. Protein synthesis occurs at ribosomes that are free floating (I) as well when they are on the endoplasmic reticulum, making it rough (H). Protein synthesis can also occur in chloroplasts and mitochondria as they contain ribosomes as well.

DNA is located in the nucleus (K). However, the mitochondria (M) and the chloroplast (G) both contain DNA which provides a blueprint for the synthesis of proteins needs for the processes occurring in them

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://library.thinkquest.org/12413/structures.html>

Question 3 Answer = D

The term polysaccharide refers both to carbohydrates (saccharide) as well as carbohydrates that are large (poly). There are many types of carbohydrates that students should be familiar with. Some of these include

- Glucose: a monosaccharide which is used for energy
- Ribose: a monosaccharide which is a component of nucleotides
- Sucrose: a disaccharide which is commonly called sugar
- Starch: a polysaccharide which is a form of energy storage in plants
- Glycogen: a polysaccharide which is a form of energy storage in animals
- Cellulose: a polysaccharide which is a major component of cell walls in plants

Study Design Reference:

examples of polysaccharides and their glucose monomer

Web Link:

<http://www.scientificpsychic.com/fitness/carbohydrates.html>

Note: this link has 3 pages devoted to carbohydrates

Question 4 Answer = C

The formation of proteins by joining amino acids together is a condensation polymerization reaction. This means that as the peptide bond is being formed between the carboxyl group of one amino acid and the amine group of the adjacent amino acid, water is produced, leaving a peptide bond between the two amino acids. When a peptide bond is broken, water is needed and so this is a hydrolysis reaction. This type of reaction is also catabolic as well as energy releasing. These types of reactions apply to the other groups of biomacromolecules as well

Study Design Reference:

synthesis of biomacromolecules through the condensation reaction

Web Link:

http://www.biotopics.co.uk/as/condensation_and_hydrolysis.html

Question 5 Answer = A

The formation of peptide bonds between amino acids gives rise to a particular order of amino acids. This is referred to as the primary structure of the protein and is dictated by DNA. These amino acids, due to their R groups twist and coil in the most stable orientation. The twists and coils can be recognized as α helices or β sheets within the molecule. This is referred to as the secondary structure of the protein. The final 3D shape of the polypeptide is referred to as the tertiary structure. Many proteins are fully functional as a single polypeptide. Some proteins are not functional unless several polypeptides cluster together to form the functional protein. This is referred to as the quaternary structure.

Study Design Reference:

the structure of proteins in terms of primary, secondary, tertiary and quaternary levels of organisation

Web Link:

<http://schoolworkhelper.net/protein-structures-primary-secondary-tertiary-quaternary/>

Question 6 Answer = C

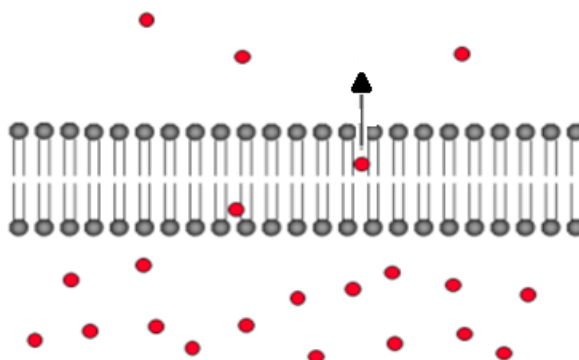
DNA is an anti parallel molecule as illustrated by the 5' and 3' annotation at either end of the single stranded DNA molecule in question. This represents a sequence of nucleotides connected together with a covalent bond (phosphodiester) between each nucleotide. The nucleotides vary according to the nitrogenous base but they also have a deoxyribose sugar and a phosphate component.

Study Design Reference:

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

Web Link:

http://en.wikipedia.org/wiki/DNA_replication

Question 7 Answer = D

Membranes are mainly composed of a phospholipid bilayer which is stable and fluid. The inside (where the majority of the substance is located) is a watery environment just like the other side of the membrane. Both these areas would be polar due to the structure of water (in fact the substance could be water). The middle of the phospholipid bilayer is non polar due to the fatty acid tails facing each other. Polar molecules can move across the membrane so long as they are small and there is a diffusion gradient. The substance is moving by diffusion (high concentration to a lower concentration) through the phospholipid bilayer. The substance could be either polar or non polar but the movement would have to be passive because the substance is moving through the bilayer.

Study Design Reference:

the structure and function of the plasma membrane and the movement of substances across it

Web Link:

<http://www.uic.edu/classes/bios/bios100/mike/spring2003/lect07.htm>

Question 8 Answer = C

A cell's proteome is defined as the proteins being manufactured within a cell at a particular time. This can vary over the life of the cell. For example an undifferentiated B cell would have a different combination of proteins expressed compared to the same cell after having differentiated into a plasma cell. The genome is the entire DNA complement within the nucleus of a particular cell. The human genome carries about 30,000 genes and they comprise about 2% of the genome. Any particular cell will only have those genes activated that are needed by that cell. Different cells will have different parts of the genome activated, hence different proteomes as well.

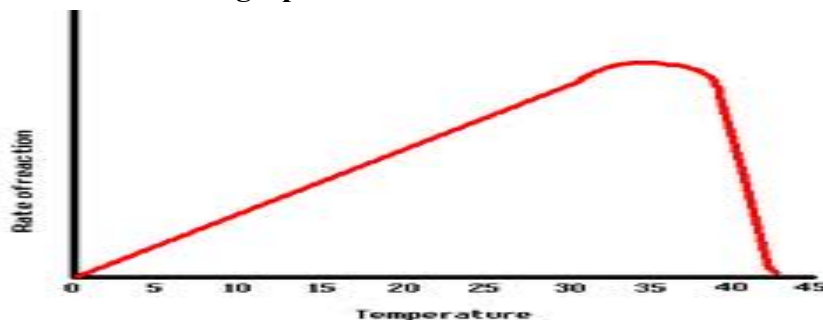
Study Design Reference:

the nature of the proteome

Web Link:

http://www.454.com/downloads/news-events/from-the-genome-to-the-proteome_FINAL.pdf

Question 9 and 10 refer to the graph below



Question 9 Answer = D

Traditionally the independent variable is the one that is deliberately changed and in this situation it is temperature. All other factors would be kept constant such as pH, amount of enzyme and amount of substrate. This is to ensure that the measured result, in this case the rate of reaction is a reflection on the changing temperature. The rate of reaction is therefore the dependent variable.

Study Design Reference:

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.uncp.edu/home/collierw/ivdv.htm>

Question 10 Answer = B

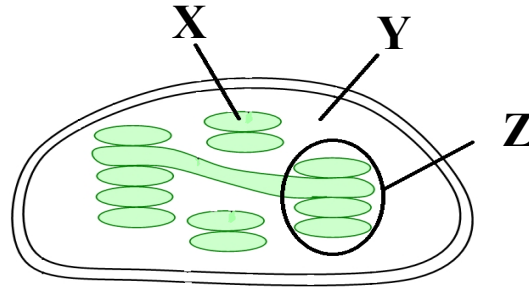
The temperature was changed and the graph illustrates that the activity of the enzyme increased from 0°C to about 36°C. This is due to the substrate and enzyme being provided with increasing kinetic energy and so they are more likely to collide with each other and cause a reaction. From 36°C to about 43°C there is a rapid decline in the activity of the enzyme. This is because the extra heat is causing the chemical bonds holding the protein (enzyme) together are starting to break. This causes an irreversible change in the 3D shape of the enzyme. The enzyme is denatured. The results of this experiment indicate. It should be noted that enzymes are not 'used up' in their chemical reactions. Once they complete one reaction, they can begin another.

Study Design Reference:

the role of enzymes as protein catalysts

Web Link:

<http://www.biologymad.com/resources/Ch%204%20-%20Enzymes.pdf>

Question 11 Answer = A

The chloroplast has two main areas where photosynthetic reactions occur. The light dependent reaction occur on thylakoid membranes enclosing the granum (X). They form stacks of thylakoid membranes called grana (Z). This reaction uses energy from light (specifically red and blue/violet wavelengths). The products of the light dependent reaction are used in the light dependent reaction which occurs in the stroma (Y).

Study Design Reference:

requirements for photosynthesis – 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.emc.maricopa.edu/faculty/farabee/biobk/biobookps.html>

Question 12 Answer = B

A synapse is the space between two nerves or between a nerve and a gland or between a nerve and a muscle. The pre synaptic membrane (axon of the neuron) is the side where neurotransmitters are released from. This is triggered by Calcium ion induced exocytosis from the axon. The neurotransmitters diffuse across the synaptic gap and bind to receptors on the post synaptic membrane (dendrite of the next neuron).

Study Design Reference:

the roles of the nerve pathway and chemical signals in the transmission of information from receptor to effector

Web Link:

http://www.mind.ilstu.edu/curriculum/neurons_intro/neurons_intro.php

Question 13 Answer = C

Neurons have extensions protruding from them that carry an action potential away from the cell body towards the synapse, which allows a fast direct message to be carried. These axons vary in length and many of them are wrapped in myelin sheaths. These allow an even faster electrical message to be transported, particularly along motor nerves which have very long myelinated axons. MS leads to the degeneration of the myelin and so the messages being sent along the damaged axons become compromised. Initially this is expressed in symptoms relating to motor nerve control. Repair to the myelin would prove ineffective because the nature of auto immune diseases is that antibodies are produced against the (in this case) myelin.

Study Design Reference:

the roles of the nerve pathway and chemical signals in the transmission of information from receptor to effector

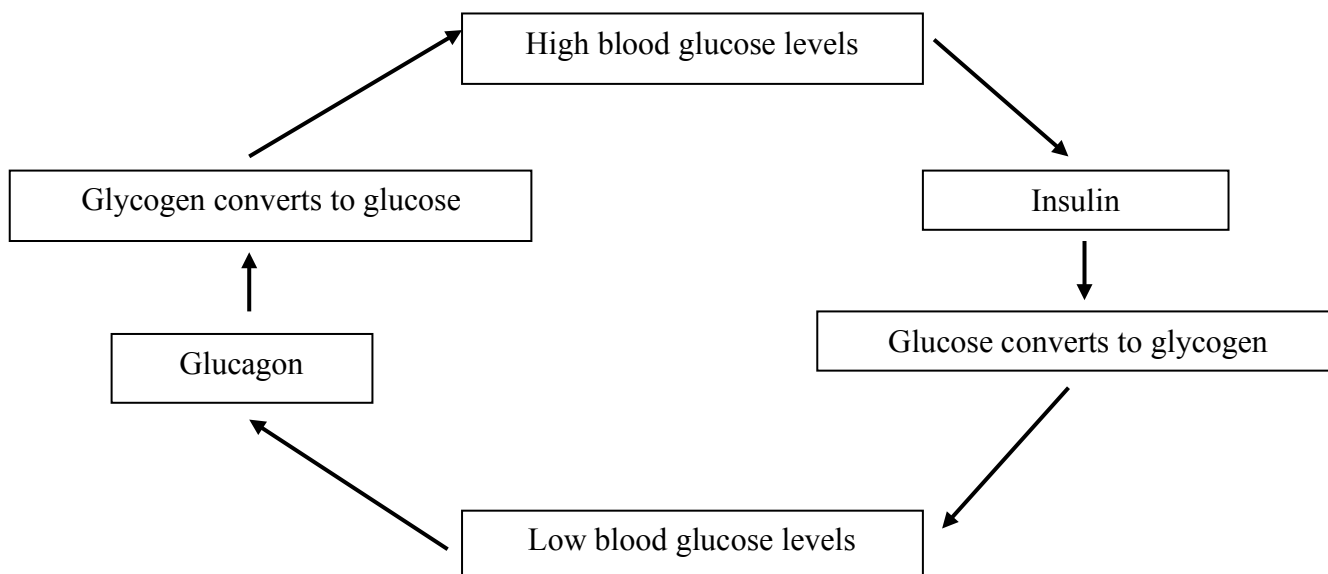
AND

disorders of the human immune response including the allergic response and autoimmune diseases

Web Link:

http://en.wikipedia.org/wiki/Multiple_sclerosis

The following two questions refer to the diagram below that illustrates how blood glucose levels in the blood are regulated.



Question 14 Answer = A

A stimulus is a factor that can be external or internal that trigger a particular response. In this case, glucagon is released as a result of this stimulus, which in turn leads to the release of glucose. The stimulus for the release of glucagon according to the diagram is low blood glucose levels.

Question 15 Answer = B

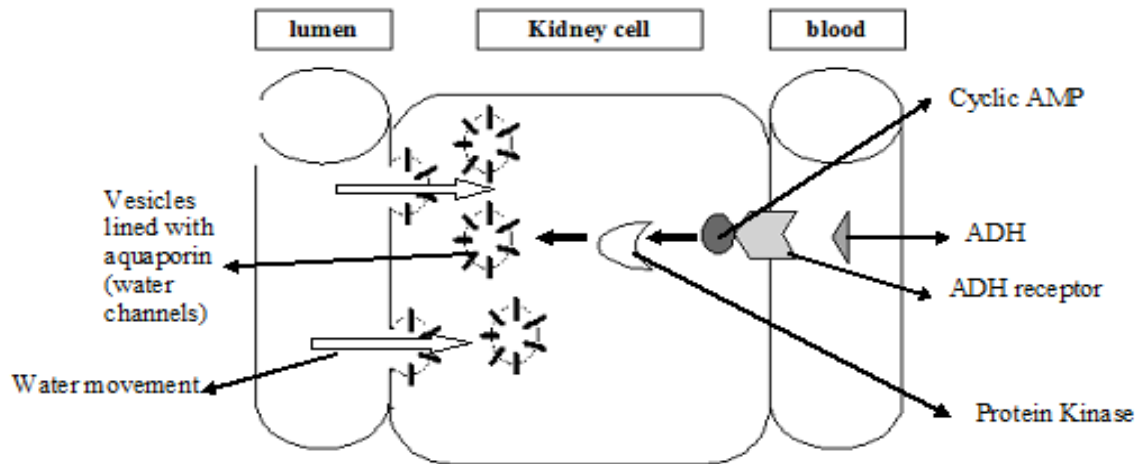
Negative feedback is defined as a homeostatic mechanism where the response that is induced reverses the direction of change of the original stimulus. In the case of glucose regulation, high levels of blood glucose trigger the release of insulin, which removes glucose from the bloodstream. Low levels of blood glucose trigger the release of glucagon, which adds glucose to the bloodstream.

Study Design Reference:

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

Web Link:

http://tle.westone.wa.gov.au/content/file/ea6e15c5-fe5e-78a3-fd79-83474fe5d808/1/hum_bio_Science_3a.zip/content/003_homeostasis/page_09.htm

**Question 16 Answer = A**

When a hormone binds to a receptor, a series of events occurs which is known as signal transduction. In this case the ADH binds to a receptor. The receptor has bound to it cAMP which leads to the activation of protein kinase. Note the shapes of the hormone, receptor, cAMP and kinase. The kinase then leads to the aquaporin lined vesicles binding to the membrane near the lumen. This enables water to move into the kidney cell more easily and eventually back into the bloodstream

Question 17 Answer = A

The ADH binds to the ADH receptor which leads to more water reabsorption into the kidney cell and hence the bloodstream. This will dilute the bloodstream and via negative feedback lead to lower levels of ADH secretion from the pancreas.

Study Design Reference (for both question 16 & 17)

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 Links:

http://www.nobelprize.org/nobel_prizes/medicine/laureates/1994/illpres/signal.html

http://www.abpschools.org.uk/page/modules/homeostasis_kidneys/kidneys6.cfm?coSiteNavigation_allTopic=1

Question 18 Answer = B

Bacterial infections are treated with antibiotics. The antibiotics disrupt the normal metabolic functioning of the bacteria with minimal side effects on the person suffering the infection. Antibiotics don't work with viruses as they do not metabolise.

Study Design Reference

the nature of cellular pathogens and noncellular agents (viruses and prions)

Web Links:

<http://www.drreddy.com/antibx.html>

Question 19 Answer = D

When the clonal expansion theory was first proposed over 30 years ago it explained the basis behind the adaptive immune response. Once the antigens are displayed by macrophages, they bind to a specific B cell which carries an appropriate B cell receptor. This leads to those B cells cloning and differentiating. One cell type produced are plasma cells, which secrete huge numbers of specific antibodies (1000/sec/cell). Once the antigen is removed, memory cells remain, so they can respond to future exposure to the same antigen in the future more rapidly.

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 Links:

<http://users.rcn.com/jkimball.ma.ultranet/BiologyPages/C/ClonalSelection.html>

Question 20 Answer = D

The fact that there has been medical intervention by injecting anti-venom into the hiker means it is artificial. The hiker needs a rapid treatment and so triggering his immune system to be activated would be counterproductive. If antibodies were injected then they could bind with the tiger snake venom (antigen) and neutralize it. The hiker could then recover fully.

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 Links:

<http://www.historyofvaccines.org/content/articles/passive-immunization>

Question 21 Answer = C

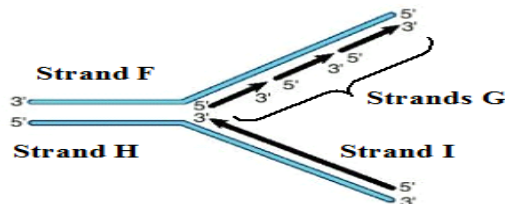
When cells undergo mitosis, there are 4 stages that can be clearly identified. Cell 1 contains a nuclear membrane and chromosomes are not clearly visible, so this cell would be in interphase (not a mitotic phase, it is in-between mitotic divisions). Cell 2 clearly has chromosomes without a nuclear membrane and is in prophase. Cell 3 is in anaphase because the sister chromatids are moving to opposite poles. Cell 4 is the stage before cell 3 and is in metaphase.

Study Design Reference

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

Web Links:

<http://www2.le.ac.uk/departments/genetics/vgec/schoolscolleges/topics/cellcycle-mitosis-meiosis>

Question 22 Answer = B

DNA is an anti parallel molecule. Because of this it is replicated in opposite directions. The leading strand (I) is continuously replicated in the 5' to 3' direction with nucleotides being placed on the 3' carbon of the deoxyribose sugar of the previously added nucleotide. The other strand (F) needs to be replicated in the opposite direction. It is replicated in small sections (Okazaki fragments) and is often referred to as the lagging strand. Through a series of steps the lagging strand is stitched together to form a continuous strand. Strand F and H were split to provide templates for the two new strands, however, they themselves were synthesized in the same semi conservative manner.

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.nature.com/scitable/topicpage/semi-conservative-dna-replication-meselson-and-stahl-421>

Question 23 Answer = B

The donkey produces gametes by meiosis that have a haploid number of 31. The horse produces gametes by meiosis that have a haploid number of 32. These combine by fertilization to form a zygote that develops into a mule. The number of chromosomes in the somatic cells of the mule would be $(31 + 32) 63$.

Study Design Reference

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

Web Links:

http://www.diffen.com/difference/Diploid_vs_Haploid

Question 24 Answer = A

The information clearly shows that as the genome gets bigger, the number of genes also increases. A prediction cannot be made about the size of the genes present in any of the organism. A conclusion cannot be made about the complexity of organisms. Many of the genes present in an E.coli would be present in a plant but there is no information available that illustrates this.

Study Design Reference

the nature of genomes, genes and the genetic code

Web Links:

http://www.yourgenome.org/landing_dgg.shtml

Question 25 Answer = C

The DNA template will be transcribed into mRNA (5'AUGCCC3'). This strand will move to the ribosome where it will be read in groups of 3 nucleotides (codons). A tRNA molecule with a complimentary and antiparallel anticodon binds to each codon in turn. The tRNA (3'UAC5' and 3'GGG5') carries a specific amino acid which gets positioned in the growing polypeptide.

Study Design Reference

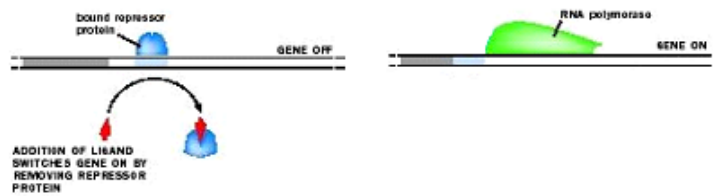
gene expression: the genetic code and roles of RNA in transcription, RNA processing in eukaryotes, and translation

Web Links:

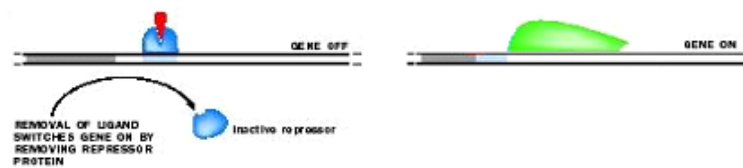
<http://learn.genetics.utah.edu/content/begin/dna/transcribe/>

Question 26 Answer = B

The first model is best represented by the diagram below where the addition of the ligand activates the gene.



The second model requires a bound ligand to be removed for the gene to be activated.

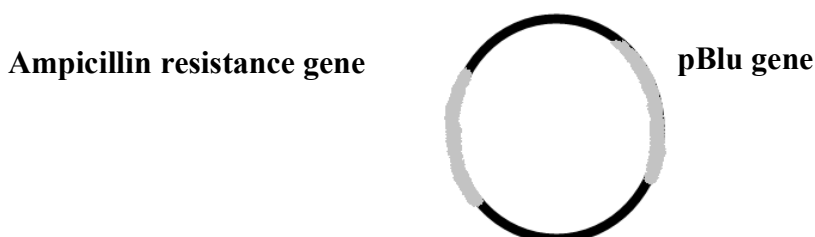


Study Design Reference

the concept of gene regulation (the switching on and off of genes by factors expressed by regulator genes and environmental factors)

Web Links:

<http://www.public.iastate.edu/~mbhattac/bhattacharyya/Slide%20Show.pdf>

Question 27 Answer = D

Plasmids are small circular DNA molecules that can be isolated, manipulated and then reinserted into bacteria. It is then that genes expression can occur because the bacteria contain the appropriate environment for this to occur. This question illustrated that the modified gene inserts within the pBlu gene and so a transformed bacteria will be white in the presence of x-gal. It should be noted that not all the bacteria will take up the plasmid. If they all did, there would be no need for this complicated set of steps. Choice A and C are culture plates without ampicillin and so all bacteria, both transformed and not transformed will grow. In the presence of ampicillin only the bacteria that have taken up the plasmid are able to survive. Choice B is wrong because without x-gal identification of the bacteria that have taken up the **modified** plasmid cannot be made as they will all be white (some may have taken up the unmodified plasmid). In the presence of ampicillin and x-gal, this identification can be made. The white colonies contain bacteria that have taken up the modified plasmid because the pBlu gene is inactive, making the colony white. The blue colonies could be discarded and the white ones used for further work.

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 Links:

<http://www.dnalc.org/resources/animations/transformation1.html>

Question 28 Answer = D

In the man's diploid cells that are not undergoing mitosis, there would be 2 alleles present (A and B). However, after S phase, the DNA has replicated which means each allele has another copy (one chromosome is made up of 2 identical chromatids). This means there would be 4 alleles present at this stage.

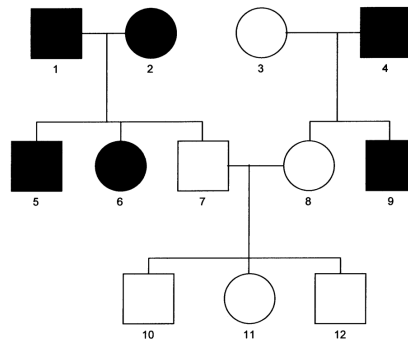
Study Design Reference

the nature of chromosomes, alleles, genotype

Web Links:

http://www.cellsalive.com/cell_cycle.htm

Interpretation of pedigrees is an important aspect of mendelian inheritance. It is important to read the pedigree accurately because occasionally there are more than one multiple choice question relating to the pedigree.



Question 29 Answer = B

The first question to answer when interpreting pedigrees is to determine whether the trait is dominant or recessive. As 1 and 2 are both expressing the trait and they produce 7 who is unaffected, the pattern must be dominant. The second question to answer is whether the trait is autosomal or sex linked. As it is dominant, to eliminate sex-linkage, look for a male who expresses the trait (1, 4, 5 and 9). In each case, for the trait to be sex-linked dominant they must have a mother who expresses the trait (5 does but 9 doesn't) and their daughters must all express the trait as well (1 does but 4 doesn't)

Question 30 Answer = D

Individual 1 and 2 are both heterozygous and the punnet square below illustrates the possible genotypes of their offspring

	T	t
T	TT	Tt
t	Tt	tt

The highlighted genotypes are the only possible combinations making the chance that 6 is heterozygous $2/3$ or 66%.

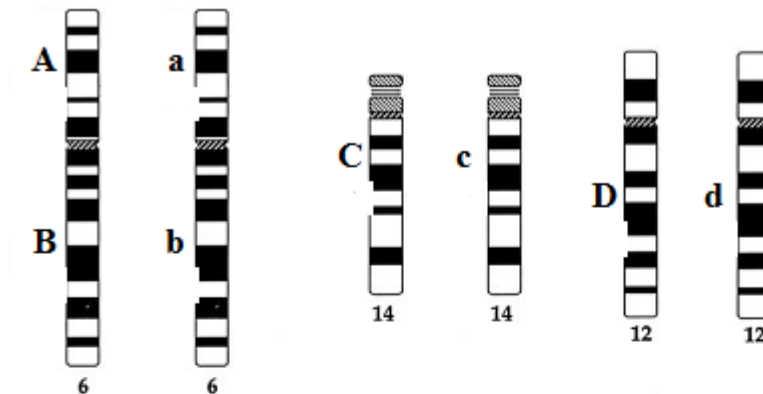
Study Design Reference

pedigree analysis: autosomal and sex-linked inheritance

Web Links:

http://biol.wvu.edu/young/321/stuff/resources/optional_genetics_question/prob.pdf

Genes A and B are linked which means they are found along the same chromosome and genes A&B, C and D are on different pairs of chromosomes and are independently inherited.



Question 31 Answer = C

Annotation for linked genes is different to genes that are independently inherited. Genes A and B are linked and so the genotype of the individual with respect to these 2 genes is AB/ab. The other 2 pairs of chromosomes carry genes that are independently inherited and are annotated traditionally (CcDd).

Question 32 Answer = A

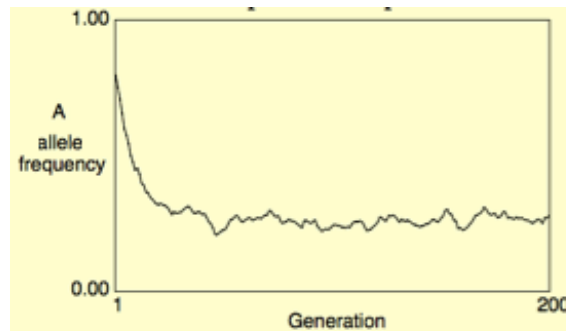
Genes A and B are linked and so are the only genes from the diagram that may cross over each other during meiosis. The result of cross over is recombination, which means new allelic combinations are possible (in this case, Ab and aB would be recombinants)

Study Design Reference

dihybrid crosses as independent or linked

Web Links:

<http://bit.ly/19KvRte>

Question 33 Answer = A

The drug sensitive worms are becoming less prevalent within the population and so the proportion of 'A' alleles has rapidly dropped and then leveled out. Alternatively, the proportion of drug resistant alleles 'a' is increasing because those worms that carry them are more likely to survive when exposed to the drug. Alleles present do not mutate into 'better' forms, the environment provides the 'factor' (in this case the nematode drug) that enables particular phenotypic forms (in this case drug resistant nematodes) to survive better.

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

Web Links:

<http://science.howstuffworks.com/environmental/life/genetic/gene-pool2.htm>

Question 34 Answer = A

Natural selection is the survival of the fittest. In a changing environment those individuals who are able to survive better have a particular variation that is advantageous (bigger beak, faster swimmer, better camouflage). Organisms do not mutate to suit the environment (that is a Lamarckian comment) the variation must originally be present in the gene pool.

Study Design Reference

natural selection as a mechanism for biological evolution

Web Links:

http://evolution.berkeley.edu/evolibrary/article/evo_25

Question 35 Answer = B

Relative dating techniques use the rule that the deeper you dig, the older the fossil. The strata layers that are lower down in each area will contain the older fossils. By doing stratigraphic correlation we can see that layer 5 in area 1 contains a fossil that is same as layer 4 in area 2. Since area 2 has 2 more layers that are deeper, it contains the older fossils.

**Study Design Reference**

the geological time scale; relative dating techniques

Web Links:

<http://homepage.usask.ca/~mjr347/prog/geoe118/geoe118.039.html>

Question 36 Answer = D

Isotopes are used to measure the absolute ages of fossils. In this case, the organic material being carbon dated is at least 22920 years old. Rather than 0.1g being present if the organic matter was fresh, there is 0.01g present. The number of half lives can be calculated (see below). The material is slightly over 4 half lives old

0.1g	5730yrs
0.05g	5730
0.025	5730
0.0125	5730
0.00625	5730

Study Design Reference

the geological time scale; absolute dating techniques

Web Links:

http://paleobiology.si.edu/geotime/main/foundation_dating3.html

Question 37 Answer = D

The forearms of the 3 vertebrates show structural homologies because the bones present have the same basic pattern. This infers all 3 vertebrates had a common ancestor with the same forearm bone pattern. Each organism moved into a new environment and different features were selected for, which gives the sizes and shapes of each bone (and the forearm) a different function. This is evidence for divergent evolution.

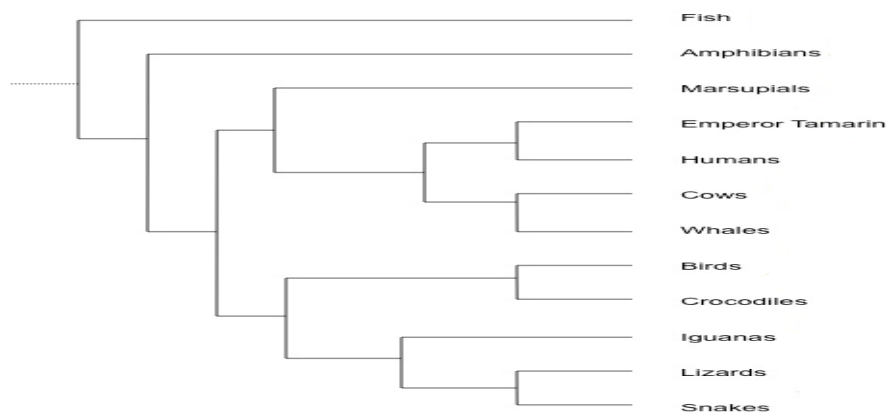
Study Design Reference

patterns of biological change; divergent and convergent evolution

Web Links:

http://en.wikipedia.org/wiki/Divergent_evolution

http://en.wikipedia.org/wiki/Convergent_evolution

Question 38 Answer = B

When interpreting evolutionary trees, the most closely related organisms are the ones who have a more recent common branch connection. The crocodiles and the birds diverged more recently, followed by humans and cows, whales and marsupials and then fish and snakes.

Study Design Reference

determination of evolutionary relationships; phylogeny

Web Links:

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

Question 39 Answer = C

The first hominin to master fire was *Homo erectus*. The Australopithecines existed about 3 million years ago and they were one of the first hominins to walk upright. *Homo habilis* (about 1.5 million years ago) has been associated with elaborate tools for hunting and preparing food, which probably enabled them to have an omnivorous diet. *Homo neanderthals* (about 200,000 years ago) coexisted with modern humans but they struggled to survive after the ice age about 30,000 years ago. Prior to both humans and neanderthals, the *Homo erectus* (about 1 million years ago) has been associated with mastering fire. This would provide a wider diet and better chance of survival.

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 Links:

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

Question 40 Answer = A

Somatic cell gene therapy will alter somatic cells only. For example, if the normal form of the factor VIII gene (as opposed to the allele that can lead to haemophilia) is inserted into some stem cells from the bone marrow, the individual will be cured of this disease. However, they will certainly have more of an opportunity to conceive children which will lead to an increase of the faulty alleles in the gene pool. Their genotype has not changed, just their health status.

Study Design Reference

human intervention in evolutionary processes:

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

Web Links:

http://www.ornl.gov/sci/techresources/Human_Genome/medicine/genetherapy.shtml

**End of 2013 Kilbaha VCE Biology Trial Examination
Detailed Answers to Multiple Choice Questions**

Kilbaha Multimedia Publishing
PO Box 2227
Kew Vic 3101
Australia

Tel: (03) 9018 5376
Fax: (03) 9817 4334
kilbaha@gmail.com
<http://kilbaha.com.au>

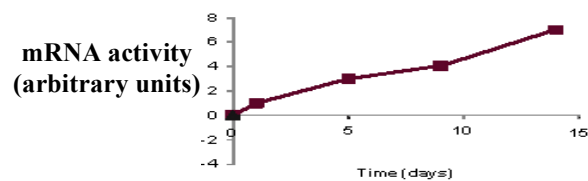
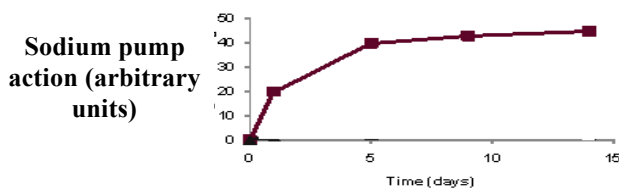
Answers to Short Answer Questions

Question 1 (5 marks)

	Salmon Body Fluids	Ocean Water	Fresh Water
Total Solute Concentration	1.0%	3.5%	0.1%
Proportion of the total solute that is NaCl	50%	99%	trace

a. The data table is needed for answering part a.

- i. The ocean is salty (3.5%) and therefore hypertonic (high concentration of solutes) in comparison to fresh water (0.1% solutes) which is hypotonic (low concentration of solutes). Students need to state that the movement is from hypotonic to hypertonic (1 mark) **and** explain why (1 mark)
- ii. The total solutes in the salmon body fluids are 1%. Of those solutes, 50% is salt. Students just need to be able to understand what the table is displaying. (1 mark)



b.

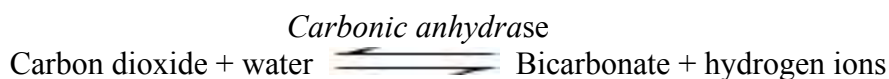
The salmon are moving from a hypertonic to a hypotonic environment and so risk gaining too much water due to osmosis. To combat this the mRNA activity increases enabling sodium pumps to be produced up to a point (1 mark). The pumps would bring salt into the salmon cells so they are more hypertonic while they acclimatize (1 mark).

Study Design Reference:

the structure and function of the plasma membrane and the movement of substances across it

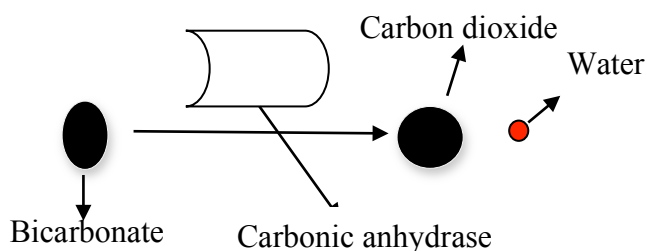
Web Link:

http://highered.mcgraw-hill.com/sites/0072495855/student_view0/chapter2/animation_how_osmosis_works.html

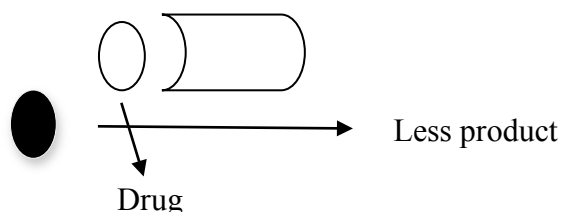
Question 2 (7 marks)

This reaction is reversible and the initial information gives a reason for this. However, it should be noted that most enzymes are not reversible. This reaction would go in either direction depending on the needs of the cell.

- a. i. All enzymes within living things are protein (1 mark) There are a few enzymes that are RNA-based, one example is ribozyme. Students would not be expected to know this.
- ii. All enzymes have a specific active site (1 mark) that is complimentary to the substrate. Once the substrate binds to the enzyme, the reaction will occur.
- b. For fluid to build up in the eye, carbonic anhydrase would be converting bicarbonate ions and hydrogen ions into carbon dioxide and water (1 mark). This would not be the usual direction of this reaction in the eye as stated in the information.
- c. A labelled diagram must be drawn accurately (1 mark)



The above diagram illustrates the action of the enzyme in the eye that produces water and could lead to blindness. The diagram below shows the drug having the same shape as the substrate (1 mark), which means it is competing for the active site. This means less (carbon dioxide and **water**) product would be produced, which would lead to less pressure in the eye



Question 2 (continued)

- d. Before drugs are release into the marketplace, rigorous testing must be undertaken. There are several factors that would need to be taken into account.
- Many individuals would need to have been tested, including some who were given a placebo.
 - A quantitative test would need to be conducted with each subject to determine the effectiveness of the drug when comparing the test group with the control group.
 - The difference in the 2 groups would need to be significantly different. Just a small improvement would not be ideal.
 - Side effects would need to be minimal and any listed on the drug packaging
 - The drug should be affordable

Students should discuss **two** points (2 marks)

Study Design Reference:

The role of enzymes as protein catalysts, their mode of action and the inhibition of the action of enzymes both naturally and by rational drug design

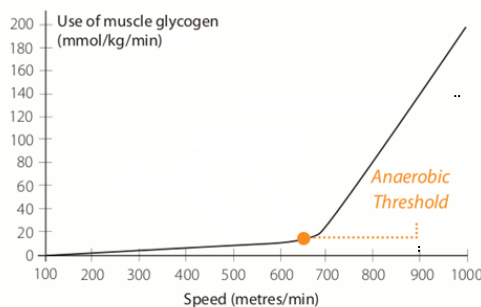
Web Link:

<http://www.rsc.org/Education/Teachers/Resources/cfb/enzymes.htm>

<http://www.worthington-biochem.com/introbiochem/inhibitors.html>

Question 3 (6 marks)

Students need an understanding of cell respiration for this question. The context revolves around training racehorses and the graph is there for interpretation.



- Make sure you bring a transparent ruler into the examination for questions such as this one. For a horse running at 900m/min it is consuming 140 mmol glycogen/kg/min. Be sure to include units in your answer (1 mark)
- The anaerobic threshold would be that point at which the glycogen stores begin rapidly breaking down (1 mark).

AND

Anaerobic respiration is the generation of energy in the absence of oxygen, which is inefficient compared to aerobic respiration. For a horse running slower than 650m/min, it is able to use glycogen as an energy source efficiently (aerobically) because not much glycogen is being used up (1 mark).

OR

For a horse running faster than 650m/min there is a rapid increase in the demand for glycogen. This infers inefficient (anaerobic) breakdown of glycogen (1 mark)
The anaerobic threshold would be that point at which the glycogen stores begin rapidly breaking down (1 mark).

If students give a detailed explanation without defining the anaerobic threshold, then they should still get 2 marks.

- With a question such as this one, a clear comparison needs to be made. Two examples need to be given.
 - Anaerobic respiration produces 2 ATP where aerobic respiration produces 36/38 ATP
 - Anaerobic respiration produces more heat per glucose molecule and aerobic respiration produces less heat.
 - Anaerobic respiration does not use oxygen where aerobic respiration uses oxygen
 - Anaerobic respiration occurs in the cytosol where aerobic respiration mainly occurs in the mitochondria.
 - Anaerobic respiration provides ATP fast where aerobic respiration provides energy more slowly.
 - Anaerobic respiration involves glycolysis where aerobic respiration involves glycolysis, krebs cycle and the electron transport chain.

(2 comparisons for 2 marks)

Question 3 (continued))

- d. Above the anaerobic threshold will put the body under oxygen stress. To compensate, more muscle mass could be formed, which would spread the lode on the muscles. This would lead to a higher anaerobic threshold and a faster racehorse over a long distance (1 mark)

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 chain.

Web Link:

<http://hyperphysics.phy-astr.gsu.edu/hbase/biology/celres.html>

http://www.eslbee.com/contrast_aerobic_vs_anaerobic_training.htm

Question 4 (4 marks)

Experiment design questions are likely in a biology examination. The Unit 1 to 4 Biology Course expects a key set of skills to be acquired. This includes the capacity to investigate and inquire scientifically. During the course you carried out several experiments and completed reports on them. This is the main place where this skill was acquired.

- a. A pheromone is a chemical substance that is released by one organism to influence the biology and/or behaviour of another. In this case the tomato plant secretes the chemical substance and the *Cuscuta* grows towards it.
(1 mark)
- b. When structuring an answer to an experiment design question such as this you need to keep everything as simple as possible. The way the question will be assessed revolves around the way the question is asked. With a hypothesis such as

‘That a chemical released from the tomato plant causes the *cuscata* to grow towards it’

The independent variable is the presence of the chemical from the tomato plant. (1 mark). The independent variable is the factor the experimenter deliberately changes. The dependent variable is the direction of growth of *Cuscata* (1 mark). The dependent variable is the measured change as a result of the influence of the independent variable. The method would involve using 2 groups *Cuscata* plants (10 plants in each group). The *Cuscata* in one group is exposed to the chemical extracted from tomato plants by putting the same amount of the chemical the same distance away from each *Cuscata* plant. The other group is not exposed to the chemical. Measure the direction of growth of the shoots from the *Cuscata* (1 mark). Keep all other factors constant and the result that would confirm the chemical is a pheromone is if there is significant growth towards the chemical. A diagram could illustrate this (the question says you may use a diagram) and the question could be answered in a variety of ways. For example you could place tomato plants different distances from *Cuscata*.

Study Design Reference:

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

Web Link:

Signalling molecules: http://frank.itlab.us/learning/NO_signals.pdf

Experimental design:

http://www.lhup.edu/sboland/independent_and_dependent_variab.htm

Question 5 (6 marks)

- a. Students should be able to work out what ‘false negative’ means. It means that the individual is pregnant but it doesn’t show on the test (1 mark) because the level of hCg hormone in the urine would be too low (only slightly above zero compared to much higher levels at 10 weeks) to record a positive change in the test (1 mark)
- b.

	Hormone	
	hCG	progesterone
Difference 1	Bind to receptors on the surface of the cell	Bind to receptors within the cytosol
Difference 2	Lipid insoluble	Lipid soluble

There is 1 mark per difference. There must be a comparison made to gain full assessment. Other differences would be acceptable such as

- The effect of steroid hormones are longer lasting than protein hormones
 - Protein hormones act faster than steroid hormones
- c. Discuss the importance of these two cells in generating a monoclonal antibody

B cell: Produce a specific antibody (1 mark). The trick in monoclonal antibody research is to locate the B cell that is needed for the job.

Tumour cell: Continue to reproduce indefinitely (1 mark). If the B cell is fused with the tumour cell, a continuous supply of specific antibodies will be available

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.

AND

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:

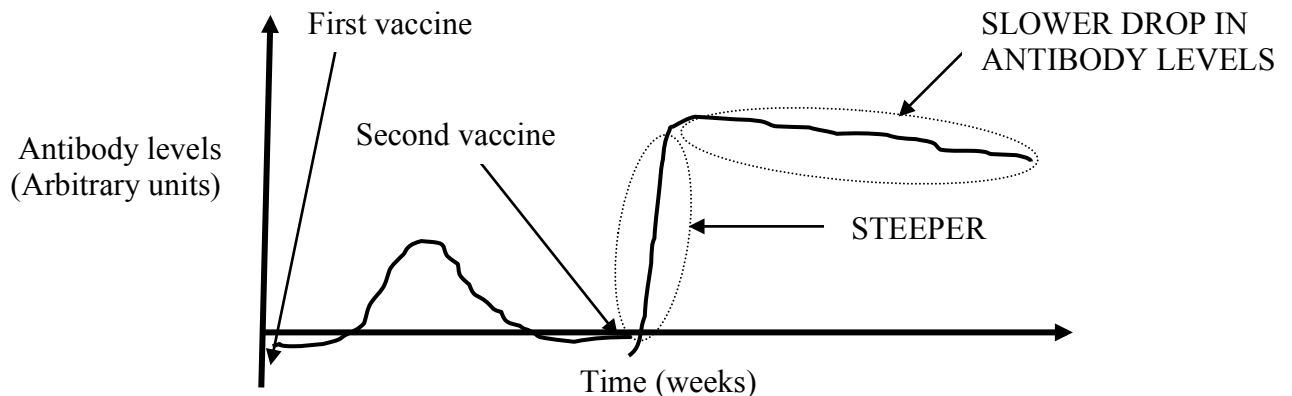
Steroid and protein: <http://www.wisc-online.com/objects/ViewObject.aspx?ID=AP13704>

Monoclonal antibodies:

<http://www.bio.davidson.edu/courses/molbio/molstudents/01rakarnik/mab.html>

Question 6 (5 marks)

- a. Attenuated viruses are viruses that are made non pathogenic by a variety of methods (for example heating to denature the DNA); however, they still retain the antigens (protein) on the surface of the virus (1 mark). There are 3 diseases to combat in this case, requiring 3 attenuated viruses, which stimulates 3 different B cells to produce 3 different specific antibodies against the 3 diseases (1 mark).
- b. Students should understand about artificial active immunity. Initially (after the 1st vaccine) the body will take some time to produce antibodies and once they are formed, the level of antibodies taper fairly rapidly. The key is that memory B cells remain that can activate that part of the immune system very rapidly on the second exposure (second vaccine)



The graph must be accurate and clearly show a steeper increase in antibody levels, to a higher level, more quickly after the second vaccine (1 mark). This is due to the memory cells cloning and differentiating more quickly into plasma cells.

The graph must also show the antibody levels dropping more slowly than the first vaccine (1 mark). This is due to the hypersensitizing of the immune system.

- c. There would be several groups that would still be susceptible. Students need to list 2 groups such as
- Unvaccinated adults (may be ignorant/object to vaccinations/be immigrants who have not been vaccinated)
 - Unvaccinated babies
 - Older citizens who have an immune system that is not functioning well
 - People suffering AIDS or other similar immune system disorders
 - Vaccinated people who have not responded to the vaccine

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://biology.clc.uc.edu/courses/bio105/immune.htm>

Question 7 (6 marks)

- a. The stem of the question shows the disease is rare (1 in 50000). Both parents are symptom free yet they can conceive a child with the condition. If this is the case, the disease must be recessive. If it was sex-linked recessive the father would have to have the disease to pass it on to a child. This means the disease is **autosomal recessive** (1 mark)
- b. Both parents must be heterozygous and for them to have another child with the disease, there would be a 25% chance (1 mark). The punnet square below illustrates this.

	F	f
F	FF	Ff
f	Ff	ff

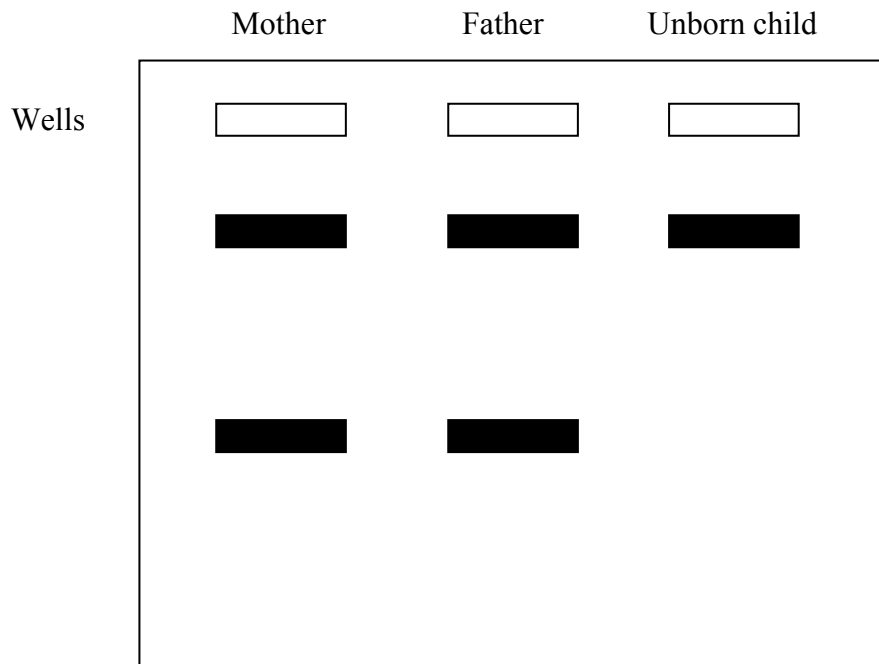
- c. PCR (Polymerase Chain Reaction) produces many copies of a particular section of DNA very quickly. A PCR machine will produce literally millions of copies of a particular section of DNA by repetitive cycles of heating the DNA to break the hydrogen bonds, then cooling to allow a DNA polymerase (taq polymerase) to synthesise DNA along the single stranded templates. Students should get across the idea that DNA is doubled each cycle and that many cycles occur (up to 30) (1 mark)

PCR also uses primers that are single stranded DNA sequences (often 20-30 nucleotides long) that are complimentary to both ends of the target sequence (in this case the frataxin gene). The primers provide an anchor for the taq polymerase to bind to so the strand can be replicated. Students need to get across the idea that primers target the section in question (1 mark).

Question 7 (continued)

A mother and father without the disease chose to have an unborn child genetically tested for the disease because they already had one child with the disorder.

- d. Use the gel below to show the genetic profile of the mother, father and unborn child if the child was also diagnosed with Freidrich's ataxia.



Both the mother and father have 2 bands, with one short fragment (normal allele) and one longer fragment (faulty allele) (1 mark). The unborn child has two copies of the faulty allele which is a long allele compared to the normal allele. There will be one band at the same position as the larger band in the mother and father (1 mark)

Study Design Reference:

inheritance: patterns of inheritance involving the monohybrid cross: dominance; recessiveness; autosomal and sex-linked inheritance
DNA tools and techniques: gel electrophoresis

Web Links:

http://www.biology.arizona.edu/mendelian_genetics/problem_sets/monohybrid_cross/monohybrid_cross.html

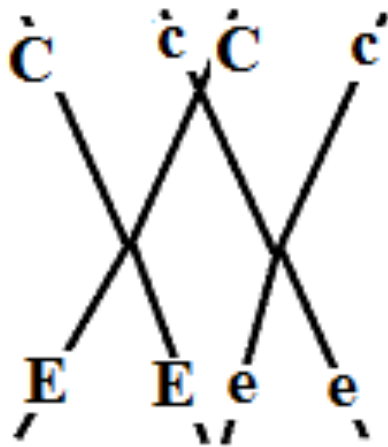
<http://www.youtube.com/watch?v=GLgt-EGkhZs>

Question 8 (6 marks)

The genes used in the question are

Curly Wing (C)	straight wing (c)
Barr Eyes (B)	normal eyes (b)
Normal Wings (V)	vestigial wings (v)
Normal Body (E)	ebony body (e)
Minute Bristles (M)	normal bristles (m)

- a. The phenotype is the expressed characteristic and so a fly with a genotype of $VvBbMM$ will have Normal wings, Barr eyes and Minute bristles (1 mark)
- b. The genotypic annotation illustrates the two genes are linked. This means the genes are located on the same chromosome. At metaphase I, each chromosome is found as 2 identical chromatids (1 mark). If crossing over is occurring between the 2 genes then a suitable diagram would be



The location of the genes needs to be accurately shown (1 mark).

Question 8 (continued)

- c. If genes are linked but further apart it would be expected they would produce more recombinants proportionally compared to the earlier result. The data below would be appropriate but other results could also be correct. The recombinants should be roughly equal as well as the original parental phenotypes (1 mark).

	Curly wing Minute bristles	Curly wing Normal bristles	Straight wing Minute bristles	Straight wing Normal bristles
Numbers of offspring	225	100	100	225

- d. The punnet square below shows all the possible genotypes for a cross such as this one. The highlighted genotypes are homozygous for both genes.

	BV	Bv	bV	bv
BV	BBVV	BBVv	BbVV	BbVv
Bv	BBVv	BBvv	BbVv	Bbvv
bV	BbVV	BbVv	bbVV	bbVv
bv	BbVv	Bbvv	bbVv	bbvv

The answer is 25% (1 mark)

The justification could revolve around constructing a punnet square as illustrated OR using other strategies (1 mark).

Study Design Reference:

inheritance: dihybrid crosses as independent or linked

Web Links:

<http://www.slideshare.net/gurustip/dihybrid-crosses-gene-linkage-and-recombination#btnNext>

<http://click4biology.info/c4b/10/gene10.2.htm>

Question 9 (5 marks)

Proteins such as *cytochrome c* are coded for by genes (DNA). As a result of mutation, variation in the DNA between reproductively isolated organisms would accumulate over time. The evidence for this is in the amino acid differences between the organisms.

Organism	Amino acid name and position in <i>cytochrome c</i>						
	18	19	20	21	22	23	24
Human	phe	iso	met	lys	cys	ser	glu
Rhesus monkey	phe	iso	met	lys	cys	ser	glu
Horse	phe	val	glu	lys	cys	ala	glu
Wheat	phe	lys	thr	lys	cys	ala	ser

- a. The organism that is most related to the human is the rhesus monkey. (1 mark). It has no differences in its amino acid sequence compared to the others (horse 3, wheat 4).

		SECOND POSITION					
		U	C	A	G		
FIRST POSITION	U	phe	ser	tyr	cys	U	THIRD POSITION
		leu		stop	stop	A	
	C	leu	pro	his	arg	U	
				glu		C	
	A	iso	thr	asp	ser	A	
		met		lys	arg	G	
	G	val	ala	asp	gly	U	
				glut		C	
						A	
						G	

The codon table

Look up each amino acid in the 'codon' table and work out the sequence of 3 nucleotides that would code for the amino acid. Note that there are several other codons that would be correct due to the redundancy of the code. For example, ser can have 4 codons (UCU, UCC, UCA, UCG, AGU, AGC)

Question 9 (continued)**b.****i.**

Wheat	phe	lys	thr	lys	cys	ala	ser
Possible mRNA (1 mark)	UUU	AAA	ACU	AAA	UGU	GCU	AGU
DNA template (1 mark)	AAA	TTT	TGA	TTT	ACA	CGA	TCA

There could be many other sequences

- ii.** The ancestor had Val at position 19 and the codons required would be any of GUU, GUC, GUA, GUG. The monkey has Iso at position 19 and the codons are AUU, AUC, AUA (1 mark)

The most probable mutation would be a change of the first nucleotide in the codon from G to A. For example, GUU could change to AUU. This is called a point mutation. This is more likely than any other mutation (deletion, addition) as mutations are random and spontaneous (1 mark).

Study Design Reference:

Molecular genetics; gene expression: the genetic code and roles of RNA in transcription and translation

Evidence for biological evolution over time; molecular homology

Web Links:

<http://learn.genetics.utah.edu/content/begin/dna/transcribe/>

<http://users.rcn.com/jkimball.ma.ultranet/BiologyPages/T/Taxonomy.html>

Question 10 (5 marks)

Karyotypes traditionally were arranged by developing a photograph of a metaphase spread. The chromosomes were then cut out and arranged in their pairs from largest to smallest. This was a time consuming and potentially inaccurate method compared to the multicolour FISH probe method.

- a. A DNA probe is a single stranded section of DNA which is complementary to a section of DNA in a sample (1 mark). The probe is bound to (in this case) a fluorescent dye so that if the probe binds to the target DNA it will be clearly visible (1 mark).
- b. A translocation is a small section of one chromosome recombining on a different homologue. This would be observed by chromosomes having more than one colour (1 mark).
- c. Interphase is that part of the cell cycle where chromosomes are not visible. There are 2 main events within the cell cycle that leads to the production of chromosomes. The first event is the S phase where the entire nuclear genome is replicated (1 mark). The second event is the G2 phase where the DNA strands are coiled with protein to form visible chromosomes (1 mark).

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.cellsalive.com/cell_cycle.htm

Question 11 (7 marks)

It is expected students understand about the concept of fossilisation and the subsequent dating as well as interpretation of it. Many questions will provide a context that students are not familiar with such as this one relating to the evolution of air breathing vertebrates.

- a. Rapid burial in sediments
In an anaerobic environment (lacking oxygen)

NOTE: Generally both these condition would lead to the effective fossilisation of an organism such as *Rhinodipterus*. Either condition would suffice or an explanation is not necessary.

- b. Radio-isotopic dating (such as K/Ar) (1 mark)
Measure the amount of remaining isotope in known metamorphic layers near the fossil and compare this to the amount of that isotope in 'fresh' rock. The radioisotopes decay at a set rate known as the half life and so the age of the fossil can be determined. (1 mark)
- c. The air contains proportionally more oxygen than the lower levels of oxygen in the ocean (1 mark)

Those that hold the bubble for longer have a selective advantage over the other fish and so are able to survive more effectively to reproductive age (1 mark).

Leading to a change in the gene pool and over many generations, the physical change of extracting oxygen from air means evolution of this feature has occurred (1 mark)

- d. Fossil evidence of animals with limbs that predates fossil evidence of animals with lungs (1 mark)

Study Design Reference:

evidence for biological evolution over time: the geological time scale; relative and absolute dating techniques; the fossil record

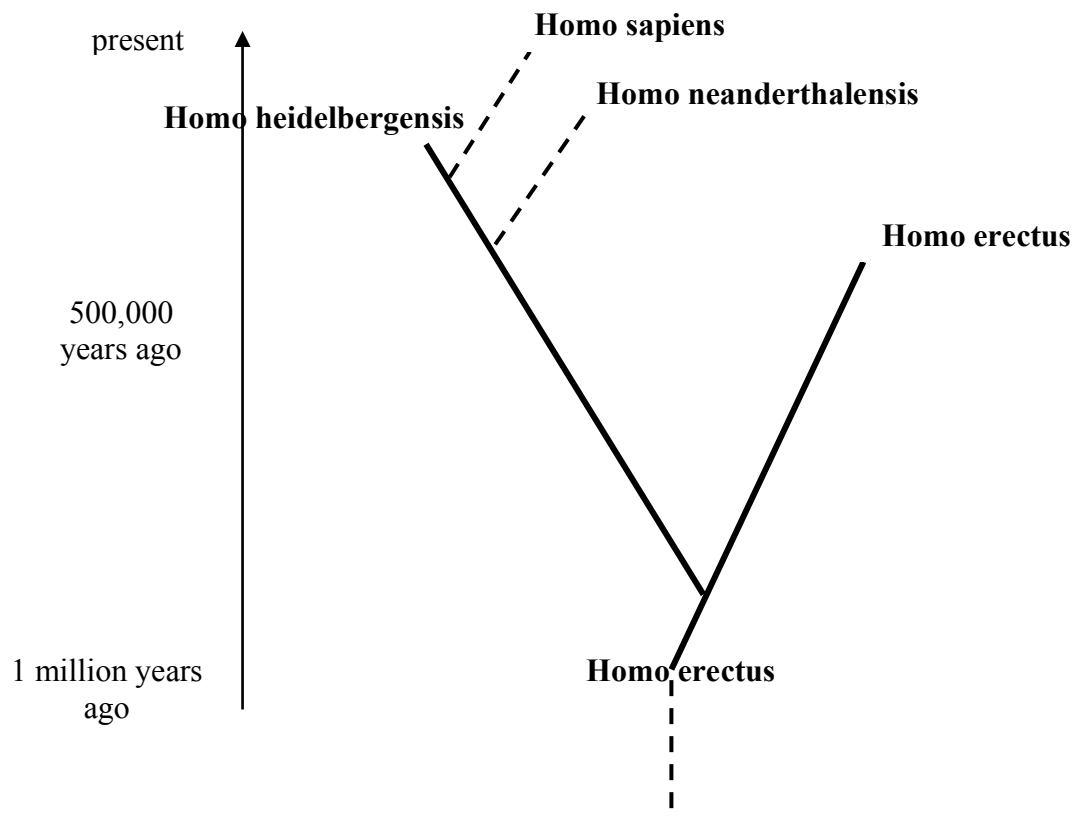
Web Links:

http://evolution.berkeley.edu/evolibrary/article/evo_01

http://paleobiology.si.edu/geotime/main/foundation_dating2.html

Question 12 (8 marks)

- a. As mt DNA mutates at a set rate (1 mark) (for example: 1 nucleotide every 1000 years), there should be no more differences between the nucleotides within mt DNA of any 2 humans that illustrates a divergence of any longer than 200,000 years ago (1 mark) (say 200 differences)
- b. Have sections of homologous DNA from both species (amplified using PCR) and heat it in separate containers to break the hydrogen bonds. Mix the samples from both species together to hybridise some of the strands (1 mark). Reheat and measure the amount of heat needed to break the hydrogen bonds in the hybridized strands. The difference in heat needed is a measure of how similar the nucleotide sequences are (1 mark).
NOTE: If there is one nucleotide difference, it will require about 1 degree less to break the hydrogen bonds.
- c. The nucleotide sequences in the hybridized strands studied would have more differences (1 mark) in comparison to the nucleotide sequences within each group, which would have more similarity to each other (1 mark).

Question 12 (continued)

The Homo sapiens should branch from the H. heidelbergensis line at no later than the 200,000 years ago AND the Homo sapiens should be in line with the present day (1 mark).

The Homo neanderthalensis line should branch from the H. heidelbergensis line at no later than 300,000 years ago AND the Homo neanderthalensis line should be in line with (about) the 30,000 year mark (1 mark).

Study Design Reference:

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

Web Links:

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

http://www.ornl.gov/sci/techresources/Human_Genome/elsi/humanmigration.shtml

**End of 2013 Kilbaha VCE Biology Trial Examination
Detailed Answers**

Kilbaha Multimedia Publishing PO Box 2227 Kew Vic 3101 Australia	Tel: (03) 9018 5376 Fax: (03) 9817 4334 kilbaha@gmail.com http://kilbaha.com.au
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