2021
VCE
Biology
Trial Examination

Suggested Answers

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Answer Summary for Multiple-Choice Questions
2021 Kilbaha VCE Biology Trial Examination

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

ONE ANSWER PER LINE **ONE ANSWER PER LINE**

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

Answer distribution: A: 8 B: 8 C: 12 D: 12

Section A

Question 1
Solution: D
Each phospholipid has a polar head and non-polar tails. A membrane is where phospholipid heads face the water environment on both sides of the membrane and the tails face each other.

Study Design Reference (for Question 1)
The fluid mosaic model of the structure of the plasma membrane and the movement of hydrophilic and hydrophobic substances across it based on their size and polarity
Web Link
https://biologywise.com/fluid-mosaic-model

Question 2
Solution: B

Of all the organelles shown, there are only a few that are involved in the manufacture and secretion of a protein. These are the mitochondria (12), nucleus (11), rough endoplasmic reticulum (7) and the Golgi (15).

Study Design Reference (for question 2)
The role of different organelles including ribosomes, endoplasmic reticulum, Golgi apparatus and associated vesicles in the export of a protein product from the cell through exocytosis
Web Link
https://content.byui.edu/file/a236934c-3c60-4fe9-90aa-d343b3e3a640/1/module4/readings/cell_bio.html

Question 3
Solution: B

The mitochondria and the chloroplast both display features in support of endosymbiosis. They were once free-living organisms that were consumed (endocytosis) and became an integral part of the cell (symbiosis)

Study Design Reference (for question 3)
Chloroplasts as the site of photosynthesis, an overview of their structure and evidence of their bacterial origins
Mitochondria as the site of aerobic cellular respiration, an overview of their structure and evidence of their bacterial origins
Web Link
https://evolution.berkeley.edu/evolibrary/article/_0_0/endosymbiosis_04

Question 4
Solution: A
The joining of amino acids at the ribosome is an example of a condensation reaction. This is also called condensation polymerization.

Study Design Reference (for question 4)
The synthesis of a polypeptide chain from amino acid monomers by condensation polymerization
Web Link
https://www.slideshare.net/bassonist/condensation-hydrolysis

Question 5
Solution: D
This question could be answered by a process of elimination. The nucleic acid (DNA) is a double helical molecule and the others are not. A would be a polypeptide, C a fat and B a carbohydrate

Study Design Reference (for question 5)
The structure of DNA and proteins including similarities and differences in their subunits, and their synthesis by condensation polymerisation
Web Link
https://www.khanacademy.org/science/biology/gene-expression-central-dogma/central-dogma-transcription/a/nucleic-acids
https://sciencemusicvideos.com/ap-biology/module-6-menu-biochemistry/the-four-biomolecule-families/

Question 6
Solution: A
This is a definition question relating to how there are more than one codon that provides a code for a single amino acid. There are 64 codons in total and 20 amino acids, which provides specificity (more than enough codons), room for mutations (some codons for the same amino acid are very similar) and stop signals

Study Design Reference (for question 6)
The genetic code as a degenerate triplet code and the steps in gene expression including transcription, RNA processing in eukaryotic cells and translation.
Web Link
https://www.nature.com/scitable/topicpage/nucleic-acids-to-amino-acids-dna-specifies-935/

Question 7
Solution: D
Antibodies are comprised of 4 polypeptide chains, 2 heavy and 2 light.

Question 8
Solution: C
Each different antibody has 2 identical binding sites that is complementary to a unique antigen. The end of the light and heavy chains have a specific sequence that means when the antibody is formed it is functional.

Question 9
Solution: A
The cells that produce antibodies are called plasma B cells, which are cloned and differentiated versions of the original naïve B cell that was selected.

Study Design Reference (for Questions 7 to 9)
The characteristics and roles of components of the adaptive (specific) immune response including the actions of B lymphocytes and their antibodies (including antibody structure) in humoral immunity, and the actions of T helper and T cytotoxic cells in cell-mediated immunity.
Web Link
https://www.khanacademy.org/science/in-in-class-12-biology-india/xc09ed98f7a9e671b:in-in-human-health-and-disease/xc09ed98f7a9e671b:in-in-types-of-immunity-and-the-immune-system/a/hs-the-immune-system-review

Question 10
Solution: D
Enzymes generally end with the suffix 'ase' and so enolase is the only enzyme listed
Question 11
Solution: B
The inputs and outputs on the cycle are clearly listed. The only input not labelled is inorganic phosphate (Pi) but students should be aware that ATP forms from ADP and Pi.

Study Design Reference (for Questions 10 and 11)
The location of, and the inputs and outputs of glycolysis including ATP yield (details of the biochemical pathway mechanisms are not required)
Web Link
https://biomanbio.com/HTML5GamesandLabs/PhotoRespgames/photoresp.html

Question 12
Solution: C
This is a fact-based question that students need to consolidate. NADH provides Hydrogen for the ETC and forms NAD. ADP and Pi uses the energy provided by the movement of Hydrogen back into the matrix to make ATP. Oxygen combines with the Hydrogen in the matrix and electrons to form water.
Study Design Reference (for Question 12)
The main inputs and outputs of the Krebs (citric acid) cycle and electron transport chain including ATP yield (details of the biochemical pathway mechanisms are not required).
Web Link
https://ib.bioninja.com.au/higher-level/topic-8-metabolism-cell/untitled/electron-transport-chain.html

Question 13
Solution: D
Students should know the inputs, outputs and location for each of the 2 stages of photosynthesis. The light dependent reaction occurs in the grana (along the thylakoid membrane) and the light independent reaction occurs in the stroma of the chloroplast.

Study Design Reference (for Question 13)
Chloroplasts as the site of photosynthesis, an overview of their structure and evidence of their bacterial origins. Inputs and outputs of the light dependent and light independent (Calvin cycle) stages of photosynthesis in C3 plants (details of the biochemical pathway mechanisms are not required).
Web Link
https://media.hhmi.org/biointeractive/click/photosynthesis/

Question 14
Solution: A
Chemicals secreted from one member of a species that attracts other members of the same species are known as pheromones.

Study Design Reference (for Question 14)
The sources and mode of transmission of various signalling molecules to their target cell, including plant and animal hormones, neurotransmitters, cytokines and pheromones
Web Link
https://www.americanscientist.org/article/how-animals-communicate-via-pheromones

Question 15
Solution: D
The diagram depicts a typical signal transduction pathway. The presence of the receptor (1) allows the cell to respond to a signal, which then transduces (2) the message via a series of second messengers and a final response (3).

Study Design Reference (for Question 15)
The stimulus-response model when applied to the cell in terms of signal transduction as a three-step process involving reception, transduction and cellular response
Web Link
https://dnalc.cshl.edu/view/1018-Pathways-At-the-cell-surface.html

Question 16
Solution: C
Students should be aware of the different types of pathogens and their mode of transmission. A virus is capable of reproduction within a host cell but is not regarded as cellular as it is incapable of cellular metabolism.

Study Design Reference (for Question 16)
Invading cellular and non-cellular pathogens as a source of non-self antigens, and preventative strategies including physical, chemical and microbiological barriers in animals and plants that keep them out
Web Link
https://www.evolvingsciences.com/Pathogens.html

Question 17
Solution: D
Asthma and other allergic reactions are triggered by environmental factors such as pollen fragments with respect to thunderstorm asthma. The factors present on the pollen that trigger the allergic response are referred to as allergens as that person has developed an immune response against the factors on the pollen. The allergen is also a non self and antigenic factor that has induced an immune response.

Study Design Reference (for Question 17)
The deficiencies and malfunctions of the immune system as a cause of human diseases including autoimmune diseases (illustrated by multiple sclerosis), immune deficiency diseases (illustrated by HIV) and allergic reactions (illustrated by reactions to pollen)
Web Link
https://www.edumedia-sciences.com/en/media/656-allergy

Question 18
Solution: C
Lysozyme is a chemical secretion that offers protection of the individual who secretes it. As a result, it is regarded as an effective chemical barrier that prevents disease causing bacteria from entering the body

Study Design Reference (for Question 18)
Invading cellular and non-cellular pathogens as a source of non-self antigens, and preventative strategies including physical, chemical and microbiological barriers in animals and plants that keep them out
Web Link
https://www.evolvingsciences.com/Pathogens.html

Question 19
Solution: D
The cellular response depicted is B cell clonal expansion and antibody manufacture by B plasma cells. This process occurs within lymph nodes.
Question 20
Solution: B
Different types of naïve B cells undergo alternative splicing so that many different types of antibodies can be made. These antibodies are embedded on the surface of these cells providing receptor sites for antigens. There are billions of different types of naïve B cells as a result of this process.

Study Design Reference (for Questions 19 and 20)
The role of the lymphatic system in the immune response including the role of secondary lymphoid tissue as the site of antigen recognition. The characteristics and roles of components of the adaptive (specific) immune response including the actions of B lymphocytes and their antibodies (including antibody structure) in humoral immunity, and the actions of T helper and T cytotoxic cells in cell-mediated immunity.
Web Link
https://media.hhmi.org/biointeractive/click/immunology_primer/01.html

Question 21
Solution: D
Inhaling a COVID virus will generated a natural immune response as would being bitten by a funnel web spider (however; there would be a need for artificial intervention). Antibodies moving across the placenta is a way of minimizing disease in the developing baby; however, it is not an immune response within the baby (the mother developed the immunity). A flu vaccine introduces antigens artificially into the body that initiate an active immune response against it.

Study Design Reference (for Question 21)
The difference between natural and artificial immunity, and active and passive strategies for acquiring immunity.
Web Link
https://courses.lumenlearning.com/boundless-microbiology/chapter/classifying-immunities/#:~:text=Both%20natural%20and%20artificial%20immunity,and%20is%20sometimes%20life%2Dlong.

Question 22
Solution: B
A silent mutation is a change in a DNA sequence that still codes for the same amino acid (in this case, leucine). This is since there are 64 possible codons and some of these code for the same amino acid (redundancy in the code).

Study Design Reference (for Question 22)
the qualitative treatment of the causes of changing allele frequencies in a population's gene pool including types of mutations (point, frameshift, block) as a source of new alleles, chromosomal abnormalities (aneuploidy and polyploidy), environmental selection pressures on phenotypes as the mechanism for natural selection, gene flow, and genetic drift (bottleneck and founder effects) and the biological consequences of such changes in terms of increased or reduced genetic diversity
Web Link
https://evolution.berkeley.edu/evolibrary/article/bottlenecks_01

Question 23
Solution: C
Block mutations are sections of chromosome that move usually during meiosis and crossover. Occasionally the sections of chromosome move to non-homologous chromosomes and as a result, are called translocation mutations.

Study Design Reference (for Question 23)
the qualitative treatment of the causes of changing allele frequencies in a population's gene pool including types of mutations (point, frameshift, block) as a source of new alleles, chromosomal abnormalities (aneuploidy and polyploidy), environmental selection pressures on phenotypes as the mechanism for natural selection, gene flow, and genetic drift (bottleneck and founder effects) and the biological consequences of such changes in terms of increased or reduced genetic diversity
Web Link
https://evolution.berkeley.edu/evolibrary/article/bottlenecks_01

Question 24
Solution: C
This is a question that is often answered poorly. Natural selection acts on a feature that is genetically inherited by an individual and is so passed on in future generations. The feature is a phenotype whereas genotype can vary yet still lead to the same phenotype (for example brown eye colour can be BB or Bb)

Study Design Reference (for Question 24)
Environmental selection pressures on phenotypes as the mechanism for natural selection, gene flow, and genetic drift (bottleneck and founder effects) and the biological consequences of such changes in terms of increased or reduced genetic diversity
Web Link
https://www.blackwellpublishing.com/ridley/tutorials/The_theory_of_natural_selection__part_1_13.asp

Question 25
Solution: D
One ancestral horse in the same environment as humans led to the current diversity of horses. This is a good example of selective breeding where the human chose a particular phenotype (speed, colour, strength) to suit their need

Study Design Reference (for Question 25)
the qualitative treatment of the causes of changing allele frequencies in a population's gene pool including types of mutations (point, frameshift, block) as a source of new alleles, chromosomal abnormalities (aneuploidy and polyploidy), environmental selection pressures on phenotypes as the mechanism for natural selection, gene flow, and genetic drift (bottleneck and founder effects) and the biological consequences of such changes in terms of increased or reduced genetic diversity
The manipulation of gene pools through selective breeding programs.
Web Link
https://evolution.berkeley.edu/evolibrary/article/bottlenecks_01
https://evolution.berkeley.edu/evolibrary/article/evo_30

Question 26
Solution: A
Students should be aware of the general evolutionary timeline for major groups of organisms. Multicellular organisms appeared first (900MYA) then followed by animals on land (500MYA) then mammals (200MYA). Soon after flowering plants appeared (100MYA)

Study Design Reference (for Question 26)
Significant changes in life forms in Earth's geological history including the rise of multicellular organisms, animals on land, the first flowering plants and mammals
Web Link
https://www.newscientist.com/article/dn17453-timeline-the-evolution-of-life/

Question 27
Solution: D
Mitochondrial DNA is inherited from the mother and so all of Janes 4 children will carry it. Alfred's children will have their mothers mtDNA not Alfred's. However; Bertha and her children as well as Doris and her child will carry Jane's mtDNA. This makes 8 (Jane, Alfred, Berta, Charles, Doris, Howard, Nick and Liz).

Study Design Reference (for Question 27)
Molecular homology as evidence of relatedness between species including DNA and amino acid sequences, mtDNA (the molecular clock) and the DNA hybridisation technique
Web Link
https://www.pbs.org/wgbh/nova/neanderthals/mtdna.html

Question 28
Solution: B
Stratigraphic correlation is a logical process where layers of strata can be placed in order from youngest to oldest. The youngest layer has to be layer A as the top layers in the other areas contain fossils that existed before that layer. Then layer B and by default H as they contain the same types of fossils.

Study Design Reference (for Question 28)
evidence of biological change over time including from palaeontology (the fossil record, the relative and absolute dating of fossils, types of fossils and the steps in fossilisation), biogeography, developmental biology and structural morphology
Web Link
https://quizlet.com/3337129/test?answerTermSides=2&promptTermSides=6&questionCount=19&questionTypes=4&showImages=true

Question 29
Solution: A
Index fossils are relatively common, only existed for a short time period, fossilize well and are found in many areas. They give paleontologists a reference point to enable a more precise age range of the other fossils in the area. In this question, fossil A is the index fossil.

Study Design Reference (for Question 29)
evidence of biological change over time including from palaeontology (the fossil record, the relative and absolute dating of fossils, types of fossils and the steps in fossilisation), biogeography, developmental biology and structural morphology
Web Link
https://www.britannica.com/science/index-fossil

Question 30
Solution: A
The different craniums show a varying position of the foramen magnum. Cranium 1 and 2 have the position more posterior than 3 and 4 meaning the latter are bipedal. The inference from this is that the arm leg ratio would be roughly equal compared to 1 and 2 who are still likely to be arboreal.

Study Design Reference (for Question 30)
Major trends in hominin evolution from the genus *Australopithecus* to the genus *Homo* including structural, functional and cognitive changes and the consequences for cultural evolution
Web Link
http://efossils.org/book/anatomical-evidence-bipedalism#:~:text=Major%20morphological%20features%20diagnostic%20(i.e.,anterior%20portion%20of%20the%20iliac

Question 31
Solution: C
Cognitive changes such as problem solving are correlated with a larger cranial capacity. This enabled development of tools and more effective hunting skills.

Study Design Reference (for Question 31)
Major trends in hominin evolution from the genus *Australopithecus* to the genus *Homo* including structural, functional and cognitive changes and the consequences for cultural evolution
Web Link
http://efossils.org/book/anatomical-evidence-bipedalism#:~:text=Major%20morphological%20features%20diagnostic%20(i.e.,anterior%20portion%20of%20the%20iliac

Question 32
Solution: C
A plasmid is a circular strand of DNA and if there are 2 HindIII restriction enzyme binding sites, 2 fragments will be produced. Based on the size reference, the 2 strands will be 1.2kbp and 3.9kbp.

Study Design Reference (for Question 32)
The use of enzymes including endonucleases (restriction enzymes), ligases and polymerases
Web Link
https://www.khanacademy.org/science/biology/biotech-dna-technology/dna-cloning-tutorial/a/restriction-enzymes-dna-ligase

Question 33
Solution: B
Once restricted samples of DNA are added to the wells of a gel at the negative end with the buffer already added, it is advisable to turn on the power source, otherwise no separation will occur.

Study Design Reference (for Question 33)
The use of gel electrophoresis in sorting DNA fragments, including interpretation of gel runs
Web Link
https://learn.genetics.utah.edu/content/labs/gel/

Question 34
Solution: D
Transgenic organisms have DNA added from another species. In this case a fragment of mRNA has been manufactured complimentary to the 'ripening' mRNA naturally produced by the tomato plant. The technology is genetic modification as it artificially changes the ripening process using sequences that are part of the tomatoes genome.

Study Design Reference (for Question 34)
The distinction between genetically modified and transgenic organisms, their use in agriculture to increase crop productivity and to provide resistance to insect predation and/or disease, and the biological, social and ethical implications that are raised by their use
Web Link
https://ricochetscience.com/transgenic-or-gmo/

Question 35
Solution: C
Social reasons against genetic screening could lead to stigmatization and discrimination within the community. In the case of a family with Huntington's disease as a burden, lack of knowledge with a positive test could alleviate family distress

Study Design Reference (for Question 35)
Techniques that apply DNA knowledge (specifically gene cloning, genetic screening and DNA profiling) including social and ethical implications and issues
Web Link
https://www.who.int/genomics/elsi/gentesting/en/

Question 36
Solution: A
Relenza is an anti influenza medication that, if taken soon after exposure can relieve the development of symptoms. The drug binds to the neuraminidase enzyme on the surface of newly formed virus particles in a cell and prevents them from being released from the cell.

Study Design Reference (for Question 36)
The concept of rational drug design in terms of the complementary nature (shape and charge) of small molecules that are designed to bind tightly to target biomolecules (limited to enzymes) resulting in the enzyme's inhibition and giving rise to a consequential therapeutic benefit, illustrated by the Australian development of the antiviral drug Relenza as a neuraminidase inhibitor
Web Link
https://www.centerwatch.com/directories/1067-fda-approved-drugs/listing/4105-relenza

Question 37
Solution: A
When a disease begins in one area and does not spread, it is not a worldwide problem and is classified as an epidemic.

Study Design Reference (for Question 37)
strategies that deal with the emergence of new diseases in a globally connected world, including the distinction between epidemics and pandemics, the use of scientific knowledge to identify the pathogen, and the types of treatments.
Web Link
https://www.jhsph.edu/covid-19/articles/achieving-herd-immunity-with-covid19.html

Question 38
Solution: C
Accuracy cannot be commented on because the true value for the optimum pH of this enzyme is not known. The experiment was repeated but not reproduced. Based on the method given it seems that pH is the only variable being tested. The results seem consistent however, the third trial at pH 7 is quite different to the others at the same pH and so precision cannot be guaranteed

Question 39
Solution: C
Both IV and DV are quantitatively measured. The controlled variables need to stay the same throughout all trials and it is pretty clear that pH 3 is the environment that the enzyme is most active in making a conclusion viable.

Question 40
Solution: B
The IV (concentration of protease) should be on the horizontal axis and the DV (rate of amino acid production) should be on the vertical axis. As the data is quantitative, the graph should be a line graph and it should be scaled properly.

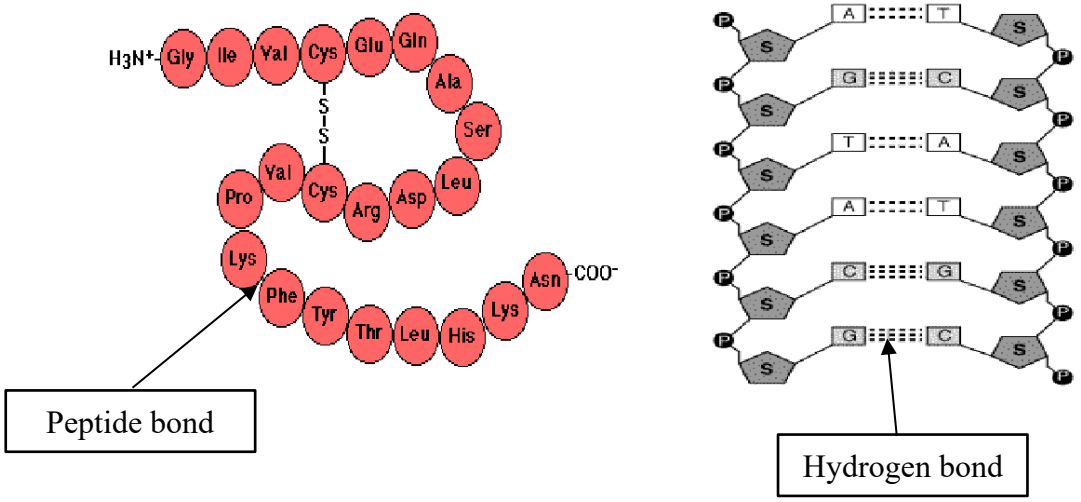
Study Design Reference (for Questions 38 to 40)
The characteristics of scientific research methodologies and techniques of primary qualitative and quantitative data collection relevant to the selected investigation, including laboratory work (biochemistry, cytology, immunology) and/or fieldwork (geomorphology); precision, accuracy, reliability and validity of data; and minimisation of experimental bias
Ethics and issues of research including identification and application of relevant health, safety and bioethical guidelines
Web Link
https://en.wikipedia.org/wiki/Placebo-controlled_study

End of answers to Section A

Section B

Question 1 (Total 9 marks)

a)



1 mark for each bond correctly labelled **(2 marks)**

b) Gly-Ile-Val (a sequence of any 3 from the diagram above) **(1 mark)**

c) A sequence on the template strand upstream from the section of DNA to be transcribed (promotor) enables the RNA polymerase to bind to it **(1 mark)**
The mRNA formed from the template carries the codons for the polypeptide whereas the complementary strand would not transcribe into the correct sequence of codons **(1 mark)**

d) TCATGC
Transcription occurs where RNA polymerase places nucleotides complementary to the template strand **(1 mark)**
forming a sequence of AGUACG **(1 mark)**
Translation occurs at the ribosome where each codon binds to a complementary anticodon on tRNA and the specific amino acids (ser and leu) are joined by a peptide bond **(1 mark)**

Study Design Reference
Nucleic acids as information molecules that encode instructions for the synthesis of proteins in cells. The synthesis of a polypeptide chain from amino acid monomers by condensation polymerisation The structure of DNA and the three forms of RNA including similarities and differences in their subunits. The genetic code as a degenerate triplet code and the steps in gene expression including transcription, RNA processing in eukaryotic cells and translation.
Web Link
https://sciencemusicvideos.com/ap-biology/module-6-menu-biochemistry/proteins-ap-interactive-tutorial/

Question 2 (Total 6 marks)

a) Conservation of energy **(1 mark)**

b) Presence of lactose enables the lactose to bind to a repressor **(1 mark)**
Repressor changes conformational shape meaning it is no longer able to bind with the operator part of the Lac operon **(1 mark)**
RNA polymerase binds to the promoter and is not obstructed by the repressor and so the operon genes are transcribed **(1 mark)**

c) Presence of the glucose stops the expression of the operon genes because when lactose only is present the expression is high **(1 mark)**
Glucose could inhibit the binding of the RNA polymerase and so regardless of availability of lactose, gene cannot be expressed **(1 mark)**

Study Design Reference
Use of the *lac* operon as a simple prokaryotic model that illustrates the switching off and on of genes by proteins (transcriptional factors) expressed by regulatory genes.
Web Link
https://phet.colorado.edu/sims/cheerpj/gene-network/latest/gene-network.html?simulation=gene-machine-lac-operon

Question 3 (Total 10 marks)

a) Mitochondria and chloroplasts have several features in common including

- Both have 2 membranes
- Both have circular DNA
- Both have ribosomes
- Both replicates independently of the of the cell

Note: 3 features required for full marks **(3 marks)**

b) At low light intensity the rate of photosynthesis may be equal to the rate of respiration **(1 mark)**

The carbon dioxide and water are reactants for photosynthesis that are gained as the products of respiration and the reactants of cellular respiration (glucose and oxygen) are gained as the products of photosynthesis **(1 mark)**

Enough energy (ATP) is provided from respiration to sustain the metabolic demands indefinitely **(1 mark)**

c) Non-competitive: the same number of enzymes are always inhibited so when substrate is in excess the rate of reaction is lower than when no inhibitor is present **(1 mark)**

Competitive: as the substrate concentration increases the proportion of inhibitors to substrate decreases meaning the effect of the inhibitor is minimized **(1 mark)**

d) Cyanide binds to a site on cytochrome oxidase away from the active site that leads to a change in the shape of the active site. **(1 mark)**

This prevents the electrons from binding with hydrogen and NADP to form NADPH, which is one of the products of the light dependent reaction **(1 mark)**

Study Design Reference

Chloroplasts as the site of photosynthesis, an overview of their structure and evidence of their bacterial origins

Mitochondria as the site of aerobic cellular respiration, an overview of their structure and evidence of their bacterial origins

The purpose of photosynthesis

The purpose of cellular respiration

The mode of action of enzymes including reversible and irreversible inhibition of their action due to chemical competitors at the active site, and by factors including temperature, concentration and pH

Web Link

Photosynthesis and respiration: https://craven.instructure.com/courses/12394/pages/online-interactives-photosynthesis-and-cellular-respiration

Enzyme inhibition: https://sciencemusicvideos.com/ap-biology/module-9-energy-and-enzymes/enzyme-inhibition-and-regulation-interactive-tutorial/

Question 4 (Total 9 marks)

a) **(i)** Signalling molecule 1 is hydrophilic because it binds to extracellular receptors and signalling molecule 2 is hydrophobic because it binds to intracellular receptors **(1 mark)**

(ii) Signalling molecule 1 activates 2nd messengers such as enzymes that leads to a response whereas signalling molecule 2 eventually activates a gene that leads to the expression of a protein **(1 mark)**

(iii) Signalling molecule 1 is likely to be short lasting because activation of an enzyme will only last for as long as the ligand is available **(1 mark)**

Signalling molecule 2 is likely to last for longer as the ligand activates a gene and so many proteins will be expressed which will remain for longer sustaining the response **(1 mark)**

b) Pheromones move between members of the same species via air or water that elicit a response whereas neurotransmitters move between neurons across a synapse **(1 mark)**

c) The target cell is either a diseased cell (infected with virus or cancerous) or an old cell **(1 mark)**

An external signal is picked up by the target cell via cytokines that are secreted due to the presence of the faulty cell **(1 mark)**

2nd messengers are activated leading to the activation of caspase that cleave internal protein skeletons within the cell **(1 mark)**

This forms blebs/apoptotic bodies that (secrete their own cytokines) activating the endocytosis by macrophages **(1 mark)**

Study Design Reference

The sources and mode of transmission of various signalling molecules to their target cell, including plant and animal hormones, neurotransmitters, cytokines and pheromones

Difference in signal transduction for hydrophilic and hydrophobic signals in terms of the position of receptors (on the membrane and in the cytosol) and initiation of transduction (details of specific chemicals, names of second messengers, G protein pathways, reaction mechanisms or cascade reactions are not required)

Apoptosis as a natural, regulatory process of programmed cell death, initiated after a cell receives a signal from inside (mitochondrial pathway) or from outside (death receptor pathway) the cell resulting in the removal of cells that are no longer needed or that may be a threat to an organism, mediated by enzymes (caspases) that cleave specific proteins in the cytoplasm or nucleus (details of specific cytoplasmic or nuclear proteins are not required)

Web Link

Signal transduction: https://www.khanacademy.org/science/ap-biology/cell-communication-and-cell-cycle/changes-in-signal-transduction-pathways/a/intracellular-signal-transduction

Apoptosis: http://lifescienceinteractive.com/tag/apoptosis

Question 5 (Total 7 marks)

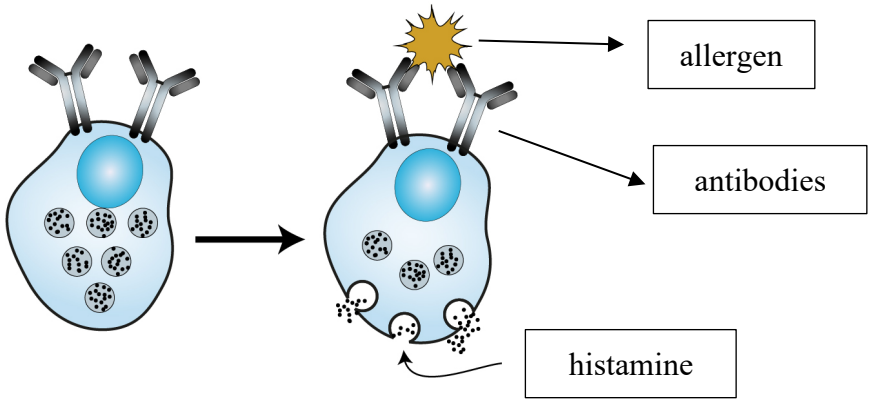
a) **(i)** B cell, T cell and natural killer cell **(1 mark)**

(ii) Neutrophil **(1 mark)**

(iii) The APC or dendritic cell has a large number of extensions giving it a large surface area **(1 mark)**

When an antigen is displayed there is a greater chance of contact between the antigen and a complementary naïve B or T cell **(1 mark)**

b)



NOTE: diagram (1 mark) with all 3 labels illustrated (2 marks) **(3 marks)**

Diagram modified from: http://2014.igem.org/Team:Linkoping_Sweden/Project/Culprit

Study Design Reference

The characteristics and roles of components (macrophages, neutrophils, mast cells, dendritic cells, complement proteins) of the innate (non-specific) immune response to an antigen including the steps in the inflammatory response

The deficiencies and malfunctions of the immune system as a cause of human diseases including autoimmune diseases (illustrated by multiple sclerosis), immune deficiency diseases (illustrated by HIV) and allergic reactions (illustrated by reactions to pollen)

Web Link

Components of the innate immune system: https://www.healio.com/hematology-oncology/learn-immuno-oncology/the-immune-system/components-of-the-immune-system

Allergic response: https://www.cityallergy.com/13-the-process-of-an-allergic-reaction/

Question 6 (Total 9 Marks)

a) Inject the CD 38 antigens into an organism (such as a mouse) that will develop an immune response against the antigen **(1 mark)**
Isolate the B Plasma cells from the mouse that produce antibodies against the CD 38 antigen **(1 mark)**
Fuse the isolated B Plasma cells with a tumour cell to form a hybridoma that is able to divide as well as express the specific antigens against the CD38 antigen **(1 mark)**
Allow the hybridomas to divide and produce the monoclonal antibodies in sufficient quantities to be used for immunotherapy **(1 mark)**

b) Side effect explanations
Itching: the myeloma cells circulate around the body and so if the monoclonal antibody binds to the CD 38 receptor on their surface, apoptosis will be stimulated. If this occurs in the blood vessels near the skin, it could cause itching
Fever: If macrophages endocytose the myeloma cells covered with the monoclonal antibodies, the macrophage could secrete fever causing cytokines
Cold-like symptoms: As the immune system is activated as a result of taking the monoclonal antibodies, cold like symptoms may develop

NOTE:2 side effects explained and there must be a link to the immune system for full assessment **(2 marks)**

c) The main factors would be

- Have a large group of individuals that all have myeloma, but are otherwise generally healthy
- Divide the large group into 2 smaller groups, one the experimental group and the other a placebo group
- All individuals have no knowledge of which group they are placed in and the will take the medication (placebo or drug) at the same time
- The trial would need to be terminated if any significant side effects were experienced
- There would need to be a significant difference between the placebo group and the experimental group

NOTE: 3 factors should be discussed **(3 marks)**

Study Design Reference
The use of monoclonal antibodies in treating cancer.
Web Link
Monoclonal antibodies: https://en.wikipedia.org/wiki/Monoclonal_antibody
Clinical trial studies: https://www.australianclinicaltrials.gov.au/what-clinical-trial#:~:text=Clinical%20trials%20are%20research%20investigations,what%20side%20effects%20might%20occur.

Question 7 (7 marks)

a) **(i)** 5 million years ago **(1 mark)**
(ii) No remains of mammoth fossils between about 10,000 years ago to about 4 million years ago **(1 mark)**
The structural differences in the fossils found are different enough to warrant a different evolutionary line **(1 mark)**

b) The different populations are reproductively isolated from each other by a geographic barrier and have developed different features to enable them to be recognised as different phenotypically to each other **(1 mark)**
When they do interact with each other they are still able to produce fertile offspring **(1 mark)**

c) The fossil would need to possess structural homologies with all the elephant descendants depicted in the phylogenetic tree, so it can be categorised as a common ancestor. **(1 mark)**
With a half life of 8 million years, there would need to be between 4.75 half lives elapsed to place the fossil at 38 million years old.
OR
There would be about 3.5% of the isotope remaining in the sample of volcanic rock to give an age of 38 million years **(1 mark)**

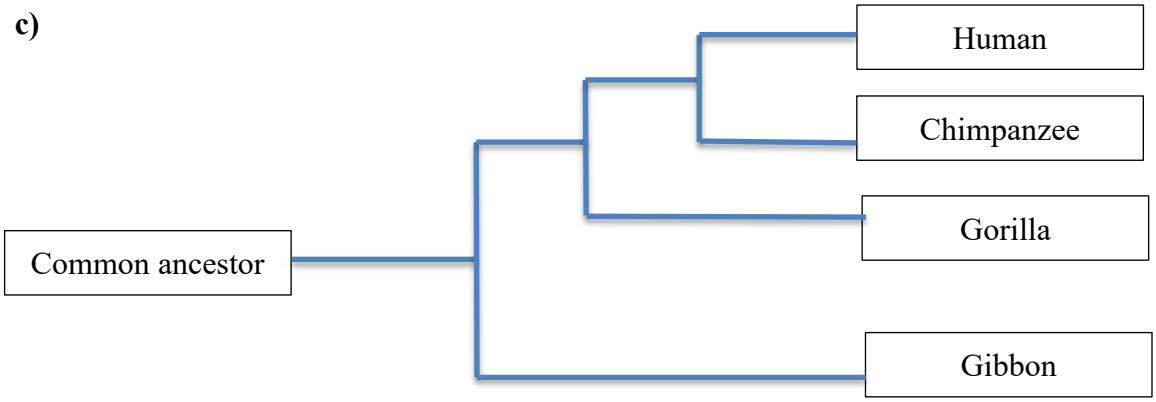
Study Design Reference
The use of phylogenetic trees to show relatedness between species
evidence of biological change over time including from palaeontology (the fossil record, the relative and absolute dating of fossils, types of fossils and the steps in fossilisation), biogeography, developmental biology and structural morphology
Patterns of biological change over geological time including divergent evolution, convergent evolution and mass extinctions
Processes of evolution including through the action of mutations and different selection pressures on a fragmented population and subsequent isolating mechanisms (allopatric speciation) that prevent gene flow
Web Link
Phylogenetic trees: https://media.hhmi.org/biointeractive/click/Phylogenetic_Trees/01.html
Evidence for evolution: https://www.khanacademy.org/science/biology/her/evolution-and-natural-selection/a/lines-of-evidence-for-evolution
Radio isotopic dating: https://phet.colorado.edu/sims/cheerpj/nuclear-physics/latest/nuclear-physics.html?simulation=radioactive-dating-game

Question 8 (6 marks)

a) Quantitative measurements give a numerical value which is not subject to bias, such as the % differences in DNA sequences between species whereas qualitative measurements are based on worded descriptions that are more subject to bias **(1 mark)**

b) Isolate a particular homologous gene loci from the 2 species in question and heat to about 90°C in separate test tubes to denature the DNA strands. This is called the temperature of melting (Tm) **(1 mark)**
Mix the strands from the 2 species together and let the samples cool. Some of the strands from the 2 species will hybridise together **(1 mark)**
The samples are reheated to melt the hybridised DNA and the difference in the Tm of the hybridised strands will give a measure of relatedness (for example: If the Tm is 2°C lower than the original, there are 2 nucleotides different between the 2 species at that gene loci) **(1 mark)**

c)

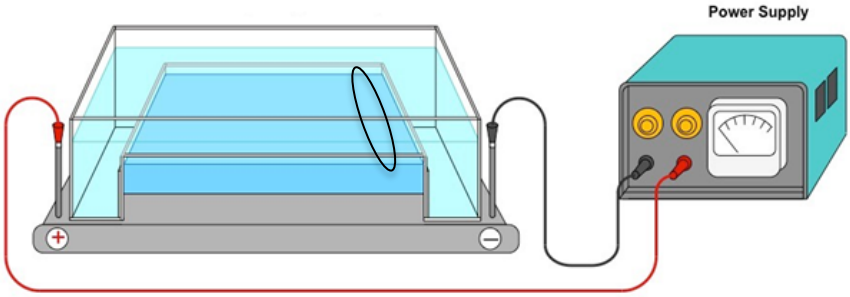


NOTE: correct branching all correct (2) with an error (1) **(2 marks)**

Study Design Reference
Molecular homology as evidence of relatedness between species including DNA and amino acid sequences, mtDNA (the molecular clock) and the DNA hybridisation technique
Web Link
https://www.cliffsnotes.com/study-guides/biology/biochemistry-ii/molecular-cloning-of-dna/dna-hybridization

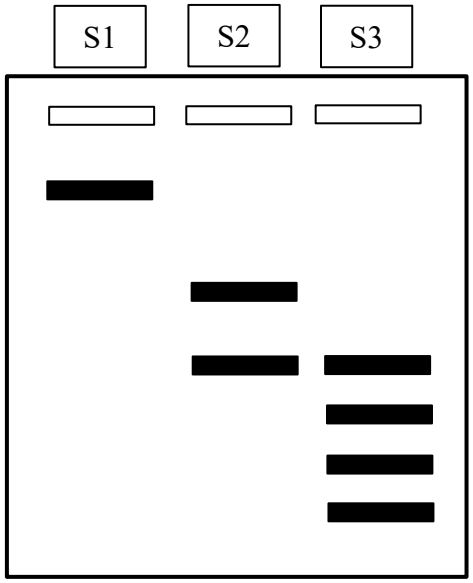
Question 9 (4 marks)

a)



NOTE: wells need to clearly be at the negative end of the gel **(1 mark)**

b)



NOTE: Lanes clearly labelled and with the correct number of bands in the correct position. Subtract 1 mark for each error made

(3 marks)

Study Design Reference
The use of gel electrophoresis in sorting DNA fragments, including interpretation of gel runs
Web Link
https://www.khanacademy.org/science/ap-biology/gene-expression-and-regulation/biotechnology/a/gel-electrophoresis#:~:text=Gel%20electrophoresis%20is%20a%20technique,move%20towards%20the%20positive%20electrode.

Question 10 (14 marks)

a) If the oxygen level that rice plants are exposed to is increased then the biomass of the rice plants will increase **(1 mark)**

b) No oxygen is a control **(1 mark)**
To see that an increase in biomass is due to increasing oxygen levels and not any other factor **(1 mark)**

c) Controlled variables include
- Equally sized rice plants were used
- Duration of experiment was 30 days

NOTE: other controlled variables such as temperature, soil pH were not given and so should not be acceptable answers. 2 variables for 2 marks **(2 marks)**

d) At zero % oxygen there is the lowest rate of biomass increase per day of 1.5g day **(1 mark)**
Rice plant will anaerobically respire that produces ethanol, carbon dioxide and ATP **(1 mark)**
Insufficient ATP is available for biomass to increase more when compared to when oxygen is provided to the soil **(1 mark)**

e) **(i)** Not calibrating the electronic balance prior for the final weight calculation **(1 mark)**

(ii) the result 2.1 g/day is more in line with the results gained at 5% and 15% oxygen so the experiment does not need to be repeated again **(1 mark)**

f) Minimum amount of aeration needed is about 15% **(1 mark)**
The amount of biomass increase between 15 and 20% is about 0.1g/day whereas the increase between 10 and 15% is about 0.7g/day. As oxygen aeration is expensive, 15% oxygen is appropriate **(1 mark)**

g) The main limitations evident are
- Not enough oxygen levels have been tested (including concentrations above 20%)
- Only 2 repeats were completed

NOTE: 1 limitation needs to be given **(1 mark)**

Not enough oxygen: give a more specific oxygen concentration where saturation occurs and considering oxygen aeration is expensive, this would have been an appropriate change to improve reliability

Only 2 repeats: If experiments are repeated more times a more reliable average could be gained thus enabling better conclusions to be made about ideal oxygen aeration %

NOTE: the limitation chosen needs to be discussed in terms of improving reliability

(1 mark)

Question 10 (continued)

Study Design Reference
The biological concepts specific to the investigation and their significance, including definitions of key terms, and biological representations
The characteristics of scientific research methodologies and techniques of primary qualitative and quantitative data collection relevant to the selected investigation, including laboratory work (biochemistry, cytology, immunology) and/or fieldwork (geomorphology); precision, accuracy, reliability and validity of data; and minimisation of experimental bias
Methods of organising, analysing and evaluating primary data to identify patterns and relationships including sources of error and limitations of data and methodologies
Web Link
https://ib.bioninja.com.au/standard-level/topic-2-molecular-biology/25-enzymes/enzyme-experiments.html

End of 2021 Kilbaha VCE Biology Trial Examination Units 3 and 4
Detailed Answers

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