

2020 VCE Biology Trial Examination Suggested Answers



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Answer Summary for Multiple-Choice Questions 2020 Kilbaha VCE Biology Trial Examination

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

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

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

Answer distribution:

A: 10

B: 10

C: 8

D: 12

Section A**Question 1****Solution: B**

Structure E is cholesterol that helps to maintain membrane fluidity, which could also be thought of as structural integrity. G is a protein channel; B is a glycolipid and A1 is a phosphate head.

Question 2**Solution: B**

The inner region of the membrane is hydrophobic or lipophilic, which means the amino acids facing this environment are also lipophilic for stability. The phosphate heads are hydrophilic, the tails are hydrophobic, and the phospholipids are not held together with chemical bonds.

Question 3**Solution: D**

The glycoprotein is associated with reception and recognition, typical of proteins on the surface of cells rather than the membranes found on grana. Virus's do not possess a membrane and ribosomes are not membrane bound

Study Design Reference (for Questions 1 – 3)

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 4**Solution: B**

The genome is the same in each cell of a multicellular organism (give or take a few mutations) but the proteome can vary from cell to cell depending on which genes are active. Some cells live for a long time and it would be expected that the combination of interacting proteins within that cell would not be the same; however, the genome would remain unchanged.

Study Design Reference

Protein functional diversity and the nature of the proteome

Web Link

<https://microbenotes.com/difference-between-genomics-and-proteomics/>

Question 5**Solution: C**

One of the molecules is DNA (with deoxyribose carbohydrate) and the other molecule is RNA (with ribose carbohydrate). Both molecules carry adenine, guanine and cytosine nucleotides. The DNA is double stranded and connected by complementary base pairing but the RNA is single stranded and not connected to another strand. Both strands are formed by condensation reactions either via DNA replication or transcription.

Study Design Reference

The structure of DNA and the three forms of RNA 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>

Question 6**Solution: A**

A hydrolysis reaction is the opposite to a condensation reaction and each bond that is broken by hydrolysis, one water molecule is used. 20 amino acids are connected by 19 peptide bonds thus requiring 19 water molecules to be completely hydrolyzed.

Study Design Reference

The synthesis of a polypeptide chain from amino acid monomers by condensation polymerization

Web Link

<https://www.slideshare.net/bassonist/condensation-hydrolysis>

Question 7**Solution: D**

Most enzymes end with the suffix 'ase'. The first part of the name is usually related to the reaction it catalyses.

Study Design Reference

The role of enzymes as protein catalysts in biochemical pathways

Web Link

<https://www.ebi.ac.uk/intenz/rules.jsp>

Question 8**Solution: A**

Both organelles contain ribosomes as well as circular DNA, which is in support of the endosymbiotic theory. NADPH is only involved in photosynthesis, not respiration. The crista and matrix are unique to the mitochondria and the grana is unique to the chloroplast. The cytosol is located outside both organelles.

Question 9**Solution: D**

At high light intensity the rate of photosynthesis would be higher than the rate of respiration, which would mean more carbon dioxide would be removed from the solution and oxygen would be put into the solution.

Question 10

Solution: A

To express proteins, it would be expected that DNA would be present to provide the blueprint to make the mRNA. The mRNA would be translated into a protein at the ribosome (partly rRNA) by using tRNA to translate the message.

Study Design Reference (for Questions 8-10)

The purpose of cellular respiration

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

The purpose of photosynthesis

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

Web Link

<https://www.khanacademy.org/science/high-school-biology/hs-cells/hs-prokaryotes-and-eukaryotes/a/chloroplasts-and-mitochondria>

Question 11**Solution: D**

Glycolysis occurs in the cytosol of cells and is the conversion of glucose to pyruvate (pyruvic acid), ATP and NADH.

Study Design Reference

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: A**

The molecule moves across the membrane of the cell and binds to intracellular receptors. This means the molecule is easily able to move across the membrane and is therefore not water soluble. It would be described as hydrophobic.

Study Design Reference

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)

Web Link

<https://study.com/academy/lesson/signal-transduction-for-hydrophilic-hydrophobic-signals.html>

Question 13**Solution: B**

Pheromones are produced within an individual as a result of some type of stimulus. The pheromone is released into the external environment off the organism to possibly be absorbed by another member of the same species. The pheromone will stimulate a change in functioning in the target organism.

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

Web Link

<https://www.americanscientist.org/article/how-animals-communicate-via-pheromones>

Question 14**Solution: D**

The correct sequence for a response such as this one is reception, transduction then response

Study Design Reference

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 15**Solution: B**

Caspase is a type of proteolytic enzyme that when active cleaves the cytoskeleton which is a fibrous protein holding the cells shape. Once the cytoskeleton is cleaved the cell can no longer hold its shape and starts forming blebs.

Study Design Reference

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

<https://www.youtube.com/watch?v=DR80Huxp4y8>

Question 16**Solution: A**

Cell replacement as well as apoptosis is occurring regularly in a multicellular individual. If the rate of replacement exceeds the rate of removal then more cells would accumulate in the body, typical of a cancerous growth

Study Design Reference

Malfunctions in apoptosis that result in deviant cell behaviour leading to diseases including cancer.

Web Link

<https://www.khanacademy.org/science/biology/cellular-molecular-biology/stem-cells-and-cancer/a/cancer>

Question 17**Solution: C**

A virus is non cellular and so B is incorrect. A bacteria is a prokaryote making A incorrect. Malarial-like protists do not possess a cell wall, making D incorrect. Fungi are eukaryotic and possess a cell wall.

Study Design Reference

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.evolvingciences.com/Pathogens.html>

Question 18**Solution: B**

As the bromelain is a chemical because it is an enzyme, it is a form of chemical defense against opportunistic pathogens. Physical barriers are solid structures that prevent the entry of pathogens such as wax and mucus.

Study Design Reference

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://courses.lumenlearning.com/boundless-biology/chapter/plant-defense-mechanisms/>

Question 19**Solution: D**

The initial response does not involve cells of active immunity such as lymphocytes and plasma cells. It would also not include antibodies because they are produced by plasma cells. A neutrophil is a small and plentiful type of white blood cell that is usually the first to a site of infection and then they will begin to phagocytose the invading pathogen.

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

Web Link

<https://sciencemusicvideos.com/ap-biology/module-29-menu-the-immune-system/immune-system-1-non-specific-innate-responses-interactive-tutorial/>

Question 20**Solution: D**

Cell 1 is an antigen presenting cell that phagocytoses the pathogen and displays antigens on its surface. The antigens can bind to complementary receptors on the surface of immature T cells that can differentiate into helper T cells (cell 4). The helper cell can bind to receptors on the surface of cytotoxic T cells (cell 5) and via cytokines activate them to multiply and move to the site of infection. The helper cell can also (via cytokines) activate B cells to differentiate into Plasma cells (cell 2) which secrete specific antibodies and memory cells (cell 3) for protection against future exposures.

Study Design Reference

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: C**

An allergy is activated by the allergen binding to antibodies embedded in receptors on the surface of mast cells. The antibodies have been formed as a result of previous exposure. Once the allergen binds, the exocytosis of vesicles containing histamine is activated. The histamine then leads to an inflammatory response and in this case an allergic reaction.

Study Design Reference

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 22**Solution: A**

The mosquito is the insect that varies in its resistance, not the plasmodium. In a DDT rich environment, the resistant mosquitos are at a selective advantage and survive the effect of the spray and increase in numbers. Organisms do not develop resistance; members of the population may be more able to survive.

Study Design Reference

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 23**Solution: A**

One original species from South America dispersing to the islands that now have 2 distinct species (species 2 and 3) is an example of allopatric speciation. This means a geographical barrier was between the migrating group and as a result of different environmental conditions, 2 species eventuated.

Question 24**Solution: C**

Species 1 has a larger thicker beak meaning the BMP4 gene would be active for longer (compared to species 4) over time leading to a difference in beak shape between the 2 birds. The master regulatory gene allows more keratin (beak) to be formed if the gene is active for a longer time.

Study Design Reference (for Questions 23 - 24)

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

the evolution of novel phenotypes arising from chance events within genomes, specifically sets of genes that regulate developmental processes and lead to changes in the expression of a few master genes found across the animal phyla, as demonstrated by the expression of gene BMP4 in beak formation of the Galapagos finches and jaw formation of cichlid fish in Africa.

Web Link

Natural Selection: <https://www.khanacademy.org/science/biology/her/heredity-and-genetics/a/natural-selection-in-populations>

BMP4: <https://hras.org/sw/swjan07.html>

Question 25**Solution: C**

When a population significantly drops in numbers due to human impact it is referred to as a genetic bottleneck (population bottleneck). All descendants from Old Blue would carry less genetic variety than the original larger populations prior to 1980.

Study Design Reference

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 26**Solution: B**

As the eye groove in the blind tetra is still present but nonfunctional it is referred to as a vestigial structure. It still provides evidence of its ancestral past even though it does not carry out a function.

Study Design Reference

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://ed.ted.com/featured/ypjumUC3>

Question 27**Solution: C**

Sedimentary layers of rock can be used to date fossils relative to each other. Also known as stratigraphic correlation and the layers above are younger, which makes A and B incorrect. There is not enough evidence to conclude the spider is transitional (making D incorrect). For fossilization, it would be expected that a cold environment with low oxygen would limit decomposition and therefore be more conducive to fossils forming.

Study Design Reference

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.sciencelearn.org.nz/labelling_interactives/4-relative-rock-layers

Question 28**Solution: D**

Primates are mammals that would also be grouped as 'monkeys'. The primates all have an opposable 5th digit as well as stereoscopic vision. Only some are hominins (the line leading to modern humans), which did involve the development of bipedalism. Only a few lack tails ((the hominids).

Study Design Reference

Shared characteristics that define primates, hominoids and hominins

Web Link

https://en.wikipedia.org/wiki/Evolution_of_primates

Question 29**Solution: C**

The current evidence is that *Homo neanderthalensis* left Africa and colonized northern Europe prior to *Homo sapiens* leaving Africa. However, they were still able to successfully breed when they crossed paths in Europe. This left some *Homo sapiens* sharing some of their genome with *Homo neanderthalensis*.

Study Design Reference

The human fossil record as an example of a classification scheme that is open to interpretations that are contested, refined or replaced when new evidence challenges them or when a new model has greater explanatory power, including whether *Homo sapiens* and *Homo neanderthalensis* interbred and the placement of *Homo denisovans* into the *Homo* evolutionary tree.

Web Link

<https://www.theverge.com/2017/10/9/16448412/neanderthal-stone-age-human-genes-dna-schizophrenia-cholesterol-hair-skin-loneliness>

Question 30**Solution: B**

DNA sequence comparisons would be the most reliable as a change in a nucleotide occurs at a predictable rate and so the number of differences compared to a modern sequence could give a date of existence. Proteins would be less reliable due to the redundancy in the code. Comparing the location is irrelevant and K/Ar dating is for fossils/rocks that are a lot older than the length of time that organic material lasts

Study Design Reference

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://en.wikipedia.org/wiki/Ancient_DNA#:~:text=The%20majority%20of%20human%20aDNA,a rchaeological%20record%20%E2%80%93%20bone%20and%20teeth.&text=Ancient%20pathogen%20DNA%20has%20been,years%20ago%20in%20other%20species.

Question 31**Solution: B**

To correctly use a gel electrophoresis tank, it would be expected to add the gel to the tank first and then to carefully add the electrolyte to the tank. Before turning on the power, the DNA should be added to the wells. After 20min or so the power should be turned off prior to analyzing the results.

Question 32**Solution: B**

The electrode nearest to the power supply in the diagram should be the positive electrode so that the DNA added to the wells are pushed away from the negative electrode on the right side of the diagram because DNA is negative and will be repelled from this electrode. Then the DNA can be spread according to size on the gel slab.

Study Design Reference (for Questions 31 - 32)

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 33**Solution: A**

A point mutation is a substitution of one nucleotide within a gene. This leads to the change on one amino acid in the polypeptide chain that could lead to a protein that does not function normally. D is incorrect because the point mutation is not caused by the change, but the opposite is correct.

Question 34**Solution: A**

Based on the information provided a sickle allele would not be cut by the restriction enzyme; however, the normal allele would be cut into 2 fragments of unequal size. A sickle sufferer would only have one band, and this would not move far in the gel compared to other fragments

Study Design Reference (for Questions 33 - 34)

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

The use of enzymes including endonucleases (restriction enzymes), ligases and polymerases

The use of gel electrophoresis in sorting DNA fragments, including interpretation of gel runs

Web Link

Mutations: <https://media.hhmi.org/biointeractive/click/geneticmutations/>

Gel reading: <https://www.khanacademy.org/science/biology/biotech-dna-technology/dna-sequencing-pcr-electrophoresis/a/gel-electrophoresis>

Question 35**Solution: D**

To construct a PCR mix, sample DNA needs to be obtained and then to this primer(s), nucleotides and *taq* polymerase would also be added. They each play an important role in the amplification of a specific section (or sections) of the original DNA sample.

Study Design Reference

Amplification of DNA using the polymerase chain reaction

Web Link

<https://learn.genetics.utah.edu/content/labs/pcr/>

Question 36**Solution: B**

Herd immunity is achieved when 95% of the population is vaccinated (not 85%). Part of the reason for the push for influenza vaccines would be to put less strain on hospitals while a vaccine is being developed for COVID-19. The 2 viral diseases are different and so different vaccines would be required.

Study Design Reference

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 37**Solution: D**

If less antibiotics are consumed overall, it would be expected that less antibiotic resistant bacteria would be present in the population of bacteria because the non-resistant bacteria are going to be present for longer. It would be assumed that the farmer would have lowered productivity and sales would decrease, otherwise farmers would not use them. The question states that less antibiotics are being used which would not impact on the strength needed in the human population, this would depend on other factors (level of illness, body type)

Study Design Reference

The use of chemical agents against pathogens including the distinction between antibiotics and antiviral drugs with reference to their mode of action and biological effectiveness.

Web Link

<https://www.amr.gov.au/>

Question 38**Solution: C**

When conducting clinical trials such as this type the results should measure the effect of the (in this case) bacteriophage on healing and not something else. Knowledge of which group an individual is in should be confidential and ethnicity as well as age should not be a significant factor. However, the concentration of the bacteriophage should remain constant within all the members of the experimental group.

Study Design Reference

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

Question 39**Solution: D**

When constructing hypotheses, the IV and DV should be clearly be stated and the effect the IV will have on the DV (prediction) should also be given. In this case the level of UV radiation is the IV and the chance of developing skin cancer is the DV. The hypothesis state then increasing the IV (mW/cm^2) will increase the DV (USEPA), which is a prediction.

Study Design Reference

Independent, dependent and controlled variables

The nature of evidence that supports or refutes a hypothesis, model or theory

Web Link

<https://www.gtac.edu.au/students/learning-resources/a-guide-to-constructing-a-hypothesis/>

Question 40**Solution: A**

The graph is a scatter plot with a large number of coordinates giving a clear idea of a trend. It would not alter the trend if the 2-3 outliers were removed. The axes are not labelled and should be however, the axes are scaled appropriately. Without knowing the initial hypothesis, a statement in support of it is not appropriate.

Study Design Reference

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

Web Link

<https://www.ck12.org/chemistry/Accuracy-and-Precision/>

End of answers to Section A

Section B**Question 1 (Total 6 marks)**

a) (i)

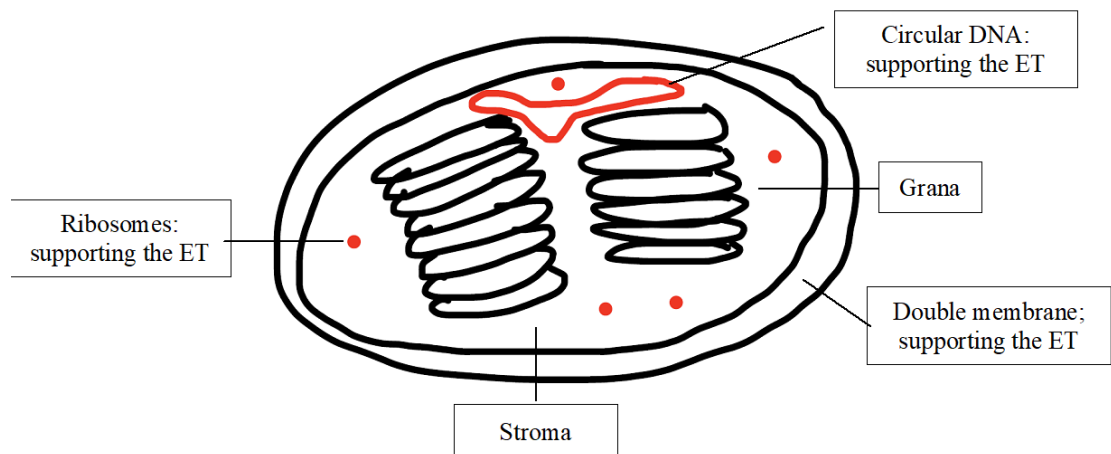
Function	Organelle Name
A.	Vesicle (vacuole)
B.	Golgi (apparatus)
C.	Nucleus
D.	Ribosome
E.	(Rough) endoplasmic reticulum

Note: 1 incorrect 1 mark, 2 incorrect 0 marks (2 marks)

(ii) C D E B A

(1 mark)

b)



Note: Diagram 1 mark

Labelled with minimum grana and stroma 1 mark

Labelled with ribosomes, 2 membranes and circular DNA 1 mark

(3 marks)

Study Design Reference

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

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

Web Link

<https://www.khanacademy.org/science/biology/structure-of-a-cell/tour-of-organelles/a/the-endomembrane-system>

Question 2 (Total 7 marks)

a) (i) RNA polymerase (1 mark)

(ii) Exons are combined together to provide a set of codons that code for a particular polypeptide, this supports the 1 gene 1 protein idea (1 mark)

Exons can combine in different combinations so that 1 gene can code for multiple polypeptides (1 mark)

b)

Coding	G	A	G	T	T	A	C	G	T	A	G	A
Template	C	T	C	A	A	T	G	C	A	T	C	T

(1 mark)

c) (i) 64 (1 mark)

Note: 3 nucleotides per codon, 4 total different nucleotides making 64 combinations

(ii) The table contains anticodons and so to solve the problem the DNA template should be converted to mRNA then the tRNA and finally a polypeptide sequence

Template: CTC AAT GCA TCT

mRNA: GAG UUA CGU AGA

tRNA: CUC AAU GCA UCU

polypeptide: asp – leu – arg – arg

(2 marks)

NOTE: If students do not use the template or use mRNA codons instead of anticodons then they can get 1 mark rather than .2

Study Design Reference

The structure of genes in eukaryotic cells including stop and start instructions, promoter regions, exons and introns

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/gene-expression-14121669/>

Question 3 (Total 10 marks)

a) (i) 8 (1 mark)

(ii) General properties of an enzyme (in this case hydrolase) would be

- Reusable
- Lock and key (specific)
- Catalyst
- Optimal conditions
- Drive metabolism (2*1=2 marks)

Each of the chosen properties relate to the enzyme functioning

Reusable: only small amounts of each enzyme are needed which would conserve energy

Lock and key: each enzyme has an active site that is complementary to the substrate, in the case of hydrolase the substrate fumaryl acetoacetic acid

Catalyst: enzymes lower the activation energy required for a reaction by providing the place (active site) that helps a reaction proceed

Optimal conditions: each enzyme functions in a optimal environment such as temperature (37 degrees) that provides the best environment for the best functioning of the reaction.

Drive metabolism: Enzymes usually change substrates in small ways which minimizes loss of energy and maximizes any outcomes of the pathway the enzyme is part of (2*1=2 marks)

b) If too much phenylalanine is consumed it would be converted into phenyl pyruvic acid (1 mark)

c) Both phenylalanine and tyrosine are obtained from the protein consumed and as phenylalanine hydroxylase is present, there is no build up of phenyl pyruvic acid but a surplus of tyrosine available (1 mark)

Since tyrosinase is missing in albinism, tyrosine cannot convert eventually to melanin, which is the pigment missing in albinism. (1 mark)

d) The cytosol is a mixture of enzymes and substrates that are involved in a variety of coordinated chemical reactions (1 mark)

Each enzyme is specific in its role and relies on collisions between the correct enzyme and the correct substrate for a reaction to occur (1 mark)

Study Design Reference

The role of enzymes as protein catalysts in biochemical pathways

Web Link

<https://biomanbio.com/HTML5GamesandLabs/LifeChemgames/enzymatichtml5page.html>

Question 4 (5 marks)

- a) Stroma (1 mark)
- b) Both ATP and NADPH are coenzymes involved in Carbon fixation (1 mark)
ATP transfers energy and NADPH transfers hydrogen into G3P (1 mark)
- c) RuBP is a 5-carbon molecule which combines with carbon dioxide (a 1 carbon molecule). 3 RuBP combine with 3 carbon dioxide to make 6 3-PGA (1 mark)
The 6 3-PGA are converted into 6 G3P and 1 of these is used to become part of glucose. The remaining G3P are converted into 3RuBp which is the same number that was originally used. This makes it a cycle (1 mark)

Study Design Reference

The cycling of coenzymes (ATP, NADH, and NADPH) as loaded and unloaded forms to move energy, protons and electrons between reactions in the cell.

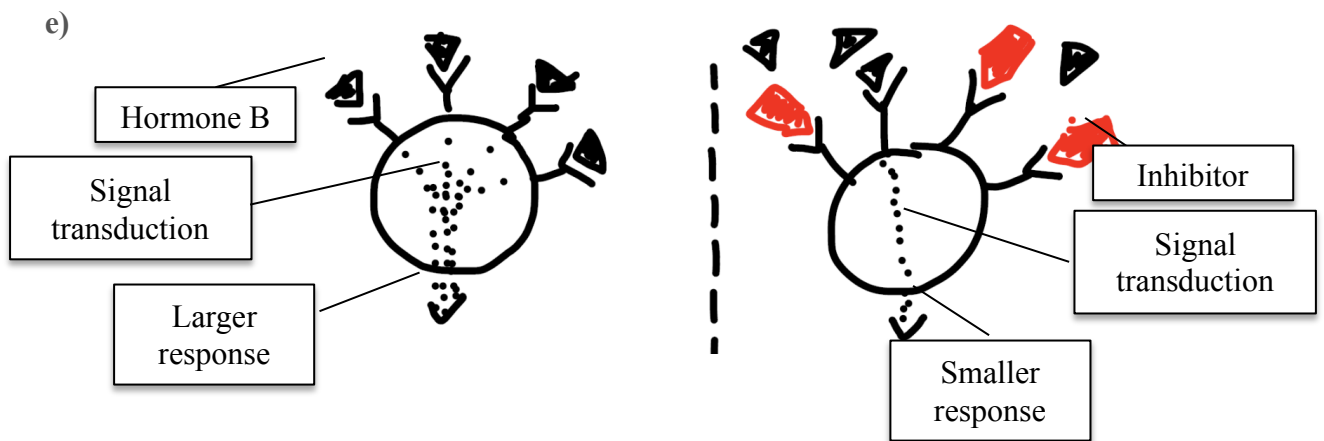
Inputs and outputs of the light dependent and light independent (Calvin cycle) stages of photosynthesis in C3 plants (details of the biochemical pathway mechanisms are not required)

Web Link

<https://biomanbio.com/HTML5GamesandLabs/PhotoRespgames/photointeractivehtml5page.html>

Question 5 (7 marks)

- a) Hormone A has a shape that is complementary to the receptors on the surface of the target cell. There are no receptors for hormone B on the surface of the same cell (1 mark)
- b) Each receptor will activate a different combination of intracellular receptors that can lead to a different response to the cells that are sensitive to either hormone (1 mark)
The cell with the 2 receptors may produce 2 responses that interact with each other that lead to a different overall response compared to the other 2 cells (1 mark)
- c) Hormone A and B are both hydrophilic because they both bind to extracellular receptors (1 mark)
- d) All signalling molecules bind to complementary receptors at their target cells so they can elicit a specific response (1 mark)



NOTE: Fully labelled diagram (1 mark) demonstrative of lowered response in the presence of the inhibitor (1 mark)

(2 marks)

Study Design Reference

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
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)

Web Link

<https://www.khanacademy.org/science/ap-biology/cell-communication-and-cell-cycle/signal-transduction/v/cellular-mechanism-hormone-action>

Question 6 (8 Marks)

- a) For both transmission as well as incubation period a large number of people would need to be sampled. **(1 mark)**

Transmission related to the number of uninfected individuals an infected individual passes the disease onto and the incubation rate is the length of time an individual takes to display symptoms from the time of exposure. **(1 mark)**

- b) Virus' contain a protein shell (capsid) that surrounds a nucleic acid (DNA or RNA) core **(1 mark)**

c) Humoral response produces B plasma cells that secrete specific antibodies that bind to the antigens on the surface of the virus **(1 mark)**

Cell mediated response produces cytotoxic T cells that bind to receptors on the surface of viral infected cells and destroy them (apoptosis) **(1 mark)**

- d) (i) Vaccines contain influenza antigens or an attenuated form of the virus (that activate both the humoral and cell mediated immune system against the antigen) **(1 mark)**

(ii) Some of the antigens on a new influenza virus may be similar to previous antigens on older versions of the influenza virus making the immune response less severe. (it is not just 1 antigen on each virus) **(1 mark)**

A new virus has a complete set of new antigens the body has to fight against each one and so the response is more severe **(1 mark)**

Study Design Reference

Invading cellular and non-cellular pathogens as a source of non-self antigens

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.

Vaccination programs and their role in maintaining herd immunity for a particular disease in the human population

Web Link

Virus immunity: <https://www.immunology.org/public-information/bitesized-immunology/pathogens-and-disease/immune-responses-viruses>

Vaccine: <https://www.historyofvaccines.org/content/how-vaccines-work>

Question 7 (6 marks)

- a)** Organisms do not change over time. It is better to say the gene pool of a population changes over time **(1 mark)**
Organisms do not adapt to their environment. It is better to say members of populations with advantageous features survive in a changing environment **(1 mark)**
- b)** Genetics is the study of heritable features **(1 mark)**
Advantageous features are passed onto their offspring thus enabling that lineage a better chance of survival **(1 mark)**
- c)** Developmental biology: The embryos of whales and hippos have similarities which would be consistent with them both having a common ancestor **(1 mark)**
Geological evidence: The ancestral hippo with nostrils further back would be found lower in strata layers than whales or hippos **(1 mark)**

Study Design Reference

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
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.khanacademy.org/science/biology/her/evolution-and-natural-selection/a/lines-of-evidence-for-evolution>

Question 8 (5 marks)

- a) (i) Amniota and Lissasmphibia (1 mark)
(ii) 450 million years ago (1 mark)
(iii) Allopatric speciation (accept adaptive radiation) (1 mark)
- b) Samples of the volcanic rock near the fossil would be analysed for the amount of uranium 235 within the samples (1 mark)
The half-life of uranium 235 is 700my and so within the sample there would be slightly more than a half the amount of uranium 235 present compared to the amount present if the volcanic rock was fresh (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

Web Link

Phylogenetic trees: https://media.hhmi.org/biointeractive/click/Phylogenetic_Trees/01.html

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

Question 9 (7 marks)

- a)** A hominin is a classification group that includes modern humans and all their bipedal ancestors **(1 mark)**
Hominoids include hominins as well as all the modern tailless apes (chimpanzees, gorillas) and all their ancestors **(1 mark)**
- b)** Mutations are measureable changes in the DNA between individuals **(1 mark)**
Many individuals are measured to calculate the average mutation rate to ensure the data used to make conclusions has more reliability **(1 mark)**
- c)** With 1 nucleotide change every 20,000 years then the modern African and individual 1 had a common ancestor about $20 \times 20,000$ years ago = 400,000 years ago **(1 mark)**
- d)** **(i)** If a single nucleotide mutated leading to 1 difference then this would have occurred 20,000 years ago. However, if the same nucleotide mutated again back to the original nucleotide then the divergence would be 0 years ago rather than the 40,000 years ago it should be. The more mutations, the greater the chance of saturation phenomenon occurring. **(1 mark)**
- (ii)** Less recently **(1 mark)**

Study Design Reference

Molecular homology as evidence of relatedness between species including DNA and amino acid sequences

Web Link

<https://www.pbs.org/wgbh/nova/neanderthals/mtdna.html>

Question 10 (9 marks)

- a) Polymerase Chain Reaction **(1 mark)**
- b) A restriction enzyme is used to cut the linear DNA in region A and B as well as once along the plasmid in a region away from the ARG. **(1 mark)**
The restriction enzyme used should liberate sticky ends so that annealing of DNA fragments is possible **(1 mark)**
The restricted DNA fragments from both the human and the plasmid are mixed together with DNA ligase **(1 mark)**
The restricted fragment containing the insulin gene may anneal with the restricted plasmid, forming a larger transformed plasmid **(1 mark)**
- c) The transformed plasmids are mixed with bacteria and exposed to conditions that may lead to the uptake of the plasmid into the bacteria **(1 mark)**
The bacteria are cultured on an agar plate mixed with ampicillin because the transformed bacteria will be resistant to the antibiotic and so only those bacteria will grow in those conditions **(1 mark)**
- d) Social: The treatment of type I diabetes will lower the overall trauma imposed on sufferers as well as families **(1 mark)**
Economic: The cost of medical intervention will be less due to the use of genetically engineered insulin **(1 mark)**

Study Design Reference

The use of recombinant plasmids as vectors to transform bacterial cells. Techniques that apply DNA knowledge (specifically gene cloning, genetic screening and DNA profiling) including social and ethical implications and issues

Web Link

https://www.teachengineering.org/activities/view/uoh_genetic_lesson01_activity1

Question 11 (10 marks)

- a) If the temperature (Celsius) is increased, then the darkness of solution (AU) will increase. **(1 mark)**
- b) Flaws include:
- No mention of concentration of starch. This is the substrate for the reaction and so it is important for it to be a controlled variable.
 - Temperatures used should be stated otherwise the experiment is unable to be reproduced
 - The diastase should also be incubated at the various temperatures because it is the effect of the temperature on the enzyme not on the substrate
 - The concentration of iodine should be stated otherwise other experimenters may get different levels of colour change, making the experiment unrepeatable
 - The colorimeter should have been calibrated otherwise systematic errors could occur **(2 flaws discussed for 2 marks)**
- c) (i) The experiment needs to be repeated giving multiple results. The similarity of results gained for each temperature is a measurement of precision **(1 mark)**
- (ii) A control would be the same set up for each temperature with no enzyme added. This enables the effect of temperature on the enzyme to be measured **(1 mark)**
- d) Validity relates to ensuring that there is only 1 IV being measured **(1 mark)**
Factors such as
- Ambient temperature
 - Size of test tubes
 - Length of incubation time
 - The size of the drop of iodine
 - The settings of the colorimeter **(3 factors for 1 mark)**

Question 11 (continued)

e) Agree, both axis are quantitative and (even though there are only 2 data points) so a line graph should be used to display the data. **(1 mark)**

f) With increasing temperature, from 30 to 50 degrees, the darkness of the solution (AU) has increased from 22 to 82AU. This means the enzyme is less active at the higher temperature **(1 mark)**

The enzyme at 50 degrees is unable to convert the starch to maltose because it has denatured (changed shape) because the higher temperature has broken chemical bonds needed to retain the shape of the active site. **(1 mark)**

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 2020 Kilbaha VCE Biology Trial Examination Units 3 and 4
Detailed Answers**

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