

Answer Summary for Multiple-Choice Questions 2017 Kilbaha VCE Biology Trial Examination

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

ONE ANSWER PER LINE

ONE ANSWER PER LINE

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

Answer distribution:

A: 8

B: 11

C: 8

D: 13

Answers to Multiple Choice Questions

Question 1

Solution: D

Uracil is the name given to one of the 4 RNA nucleotides and so is comprised of a ribose sugar (not deoxyribose), a nitrogenous base and a phosphate.

Study Design Reference

- nucleic acids as information molecules that encode instructions for the synthesis of proteins: the structure of DNA, the three main forms of RNA (mRNA, rRNA and tRNA) and a comparison of their respective nucleotides

Web Links: <https://learn-biology.com/ap-biology/module-13-dna-discovery-structure-and-replication-menu/dna-structure-ap-level-tutorial/>

Question 2

Solution: A

Question 3

Solution: B

An in depth knowledge of DNA structure is important in developing an understanding of how it provides a blueprint for more DNA or protein. The molecule is antiparallel, which means the nucleotides along each polynucleotide strand are oriented in opposite directions. This can be seen in the diagram with the top strand oriented in the 5' to 3' direction and the complementary strand oriented in the 3' to 5' direction. If the top strand is the template, it is always transcribed in the 3' to 5' direction and so the mRNA strand would be 3'GCAU5'.

Study Design Reference (For questions 2 and 3)

- nucleic acids as information molecules that encode instructions for the synthesis of proteins: the structure of DNA, the three main forms of RNA (mRNA, rRNA and tRNA) and a comparison of their respective nucleotides
- the genetic code as a universal triplet code that is degenerate and the steps in gene expression, including transcription, RNA processing in eukaryotic cells and translation by ribosomes

Web Link (For questions 2 and 3)

DNA structure: <http://www.johnkyrk.com/DNAanatomy.html>

Question 4

Solution: B

Question 5

Solution: B

Question 6

Solution: C

These questions relate to being able to use the genetic code to determine an amino acid order or to work backwards to determine a DNA sequence from an amino acid chain. The DNA triplet wheel is a different way to work with the code but students should be confident enough to complete the questions given the information.

Study Design Reference (For questions 4 to 6)

- the genetic code as a universal triplet code that is degenerate and the steps in gene expression, including transcription, RNA processing in eukaryotic cells and translation by ribosomes

Web Links (For questions 4 to 6)

Transcription and translation: <http://learn.genetics.utah.edu/content/basics/transcribe/>

Question 7

Solution: A

Question 8

Solution: B

The regulatory gene produces a gene control protein, in this case a repressor protein that can bind to the operator section of the gene depending (or not), which forms a type of switch. RNA polymerase binds to the promoter and if it is unimpeded by the repressor, the structural genes will be transcribed.

Study Design Reference (For questions 7 and 8)

- the genetic code as a universal triplet code that is degenerate and the steps in gene expression, including transcription, RNA processing in eukaryotic cells and translation by ribosomes

Web Link (For questions 7 and 8)

https://www.labxchange.org/library/items/lb:LabXchange:6d81ca25:lx_simulation:1

Question 9

Solution: A

A recognition of the naming of biomolecules is an important step in developing confidence in biochemistry. Most enzymes end with the suffix 'ase' and so a restriction endonuclease is an enzyme. Most enzymes are protein. Ribonucleic acid is shortened to RNA (a nucleic acid), neurotransmitters may or may not be protein and glucose is a carbohydrate.

Study Design Reference

- the general role of enzymes and coenzymes in facilitating steps in photosynthesis and cellular respiration

Web Links

https://www.tvcc.edu/depts/biology/HotPot/Biol%201406/biomolecule_structure.htm

Question 10

Solution: D

Protein structure exists at potentially four levels. The secondary level is where amino acids within the polypeptide interact with each other in a range of ways. Adjacent amino acids are in a more stable configuration as a twisted coil due to hydrogen bonds (Q: α helix)). Occasionally amino acids form hydrogen bonds with each other forming a sheet like arrangement (R: β sheets). Sometimes cysteine amino acids are close together within the polypeptide chain and a disulphide bond forms, which is a strong covalent link (S: disulphide bonds)

Study Design Reference

- amino acids as the monomers of a polypeptide chain and the resultant hierarchical levels of structure that give rise to a functional protein

Web Link

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

Question 11

Solution: A

This a recall question. To break the links between nucleotides along the polynucleotide chain, restriction enzymes are used. To for the links ligase is required.

Study Design Reference

- the use of enzymes to manipulate DNA, including polymerase to synthesise DNA, ligase to join DNA and endonucleases to cut DNA

Web Link

https://www.labxchange.org/library/items/lb:LabXchange:a21a9b48:lx_simulation:1

Question 12

Solution: D

A linear strand cut in 3 places and so will liberate 4 smaller fragments of DNA. The plasmid, which is circular, will be cut into 2 fragments of DNA if there are 2 cutting sites. Collectively this will produce a total of 6 fragments.

Study Design Reference

- the use of enzymes to manipulate DNA, including polymerase to synthesise DNA, ligase to join DNA and endonucleases to cut DNA

Web Link

https://www.labxchange.org/library/items/lb:LabXchange:783397ff:lx_simulation:1

Question 13

Solution: D

Question 14

Solution: C

The guide RNA is a single stranded molecule. Part joins to the Cas9 enzyme (the scaffold) and the other part binds to the target DNA in a complementary fashion. The protospacer adjacent motif (or PAM for short) is a short DNA sequence (usually 2-6 base pairs in length) that follows the DNA region targeted for cleavage by the CRISPR system, such as CRISPR-Cas9. The PAM is required for a Cas nuclease to cut and is generally found 3-4 nucleotides downstream from the cut site.

Study Design Reference (For questions 13 and 14)

- the function of CRISPR-Cas9 in bacteria and the application of this function in editing an organism's genome

Web Link (For questions 13 and 14)

<https://www.synthego.com/guide/how-to-use-crispr/pam-sequence>

Question 15

Solution: C

PCR (Polymerase Chain Reaction) is a form of biotechnology that amplifies small samples of DNA into large concentrations of target DNA from the original sample. It does this by doubling the amount of DNA in cycles of reactions that are controlled by temperature changes. 1 to 2 to 4 to 8 to 16 to 32.

Study Design Reference

- amplification of DNA using polymerase chain reaction and the use of gel electrophoresis in sorting DNA fragments, including the interpretation of gel runs for DNA profiling

Web Link

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

Question 16

Solution: D

The purpose of the plasmid is as a method of transferring genes from one organism to another. Genes of interest can be integrated into the plasmid genome and then the plasmid can be inserted into a bacterium. The reason for the antibiotic resistance gene is for identification; however, this question is referring to the plasmid as a vector.

Study Design Reference

- the use of recombinant plasmids as vectors to transform bacterial cells as demonstrated by the production of human insulin

Web Link

http://labcenter.dnalc.org/labs/transformation/transformation_h.html

Question 17

Solution: B

A competitive inhibitor is one that has a similar shape to the substrate. Both are able to bind to the enzyme. Irreversible binding means that the active site is no longer available permanently: like jamming a similar key into the same lock.

Study Design Reference

- the general factors that impact on enzyme function in relation to photosynthesis and cellular respiration: changes in temperature, pH, concentration, competitive and non-competitive enzyme inhibitors

Web Link

<https://www.google.com.au/webhp?sourceid=chrome-instant&ion=1&espv=2&ie=UTF-8#q=competitive+and+noncompetitive+inhibition+enzyme+interactive>

Question 18

Solution: C

Plants are constantly respiring and so give out carbon dioxide. At low light intensities plants will also photosynthesise which will absorb carbon dioxide. There will be a point where the rate of respiration is equal to the rate of photosynthesis and so the gas exchange will be zero.

Study Design Reference

- the factors that affect the rate of photosynthesis: light availability, water availability, temperature and carbon dioxide concentration
- the factors that affect the rate of cellular respiration: temperature, glucose availability and oxygen concentration

Web Link

<https://scratch.mit.edu/projects/10067390/>

Question 19

Solution: B

The light independent reaction of photosynthesis occurs in the stroma of a chloroplast and so this is where RUBISCO would also be located

Study Design Reference

- the role of Rubisco in photosynthesis, including adaptations of C₃, C₄ and CAM plants to maximise the efficiency of photosynthesis

Web Link

<https://www.google.com.au/webhp?sourceid=chrome-instant&ion=1&espv=2&ie=UTF-8#q=photosynthesis+interactive>

Question 20

Solution: B

The locations of the steps in photosynthesis as well as respiration should be known. The location of the electron transport chain is along the cristae of the mitochondria.

Study Design Reference

- the main inputs, outputs and locations of glycolysis, Krebs Cycle and electron transport chain including ATP yield (details of biochemical pathway mechanisms are not required)

Web Link

<https://www.youtube.com/watch?v=eB13U-T5Nvk>

Question 21

Solution: B

Question 22

Solution: D

Both of these questions use the graphs. The LHS graph relates to males and the RHS graph relates to females. The bars can be used to determine the proportion of the particular bacteria in the gut. The Firmicutes are about 42% of the gut flora in 30-39 year old women. The ratio of Firmicutes to Bacteroidetes is equal (1:1) in 30-39 year old males and females.

Study Design Reference (For question 21 and 22)

- physical, chemical and microbiota barriers as preventative mechanisms of pathogenic infection in animals and plants

Web Link (For question 21 and 22)

<https://www.genome.gov/about-genomics/teaching-tools/Teaching-Microbiome>

Question 23

Solution: D

Non-self antigens are those antigens that stimulate an immune response within the body. The surface of pathogens contain these markers; however, normal body cells of all types do not contain these markers, they contain self-markers. Cancerous cells are still body cells and although they are recognised as foreign (NK cells) they still carry the self markers of normal body cells

Study Design Reference

- initiation of an immune response, including antigen presentation, the distinction between self-antigens and non-self antigens, cellular and non-cellular pathogens and allergens

Web Link

<https://www.verywell.com/understanding-the-immune-system-3232658>

Question 24

Solution: A

Pathogens come in all shapes and sizes. A prion is a protein that can cause disease. HIV and influenza are both viral diseases, which are referred to as pathogenic agents. Meningitis bacillus is a bacterial disease, which is a cell.

Study Design Reference

- initiation of an immune response, including antigen presentation, the distinction between self-antigens and non-self antigens, cellular and non-cellular pathogens and allergens

Web Link

<http://study.com/academy/lesson/pathogens-and-disease-definitions-types-causes.html>

Question 25

Solution: D

Naïve B and T cells differentiate into specific immune cells. The B cell response includes plasma cells and memory cells. The T cell response includes cytotoxic cells, memory cells and helper cells.

Study Design Reference

- the characteristics and roles of the components of the adaptive immune response against both extracellular and intracellular threats, including the actions of B lymphocytes and their antibodies, helper T and cytotoxic T cells

Web Link

<http://www.biology-pages.info/C/ClonalSelection.html>

Question 26

Solution: D

Antibodies function at a quaternary level with 2 light chains and 2 heavy chains. Each antibody has 2 antigen binding sites, each one identical. Two different antibodies would be required and the light chains are on the lower side of each of the Y antibody structures

Study Design Reference

- the characteristics and roles of the components of the adaptive immune response against both extracellular and intracellular threats, including the actions of B lymphocytes and their antibodies, helper T and cytotoxic T cells

Web Link

<http://www.biology.arizona.edu/immunology/tutorials/antibody/structure.html>

Question 27

Solution: D

Each antigen will activate a different naïve B cell and so there are a total of 12 antigens in the four vaccines; hence 12 naïve B cells activated.

Study Design Reference

- the characteristics and roles of the components of the adaptive immune response against both extracellular and intracellular threats, including the actions of B lymphocytes and their antibodies, helper T and cytotoxic T cells
- vaccination programs and their role in maintaining herd immunity for a specific disease in a human population

Web Link

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

Question 28

Solution: B

Inflammation is one of the bodies response to infection. In an allergic reaction, mast cells release histamines (not antibodies). Complement proteins gather on the surface of pathogens and make it easier for recognition by immune cells. Apoptosis is followed by macrophages eating the cellular fragments left over. When macrophages come in contact with a pathogen one response is for them to release cytokines. Some of the cytokines lead to inflammation, which will enhance healing. There are many kinds of cytokines but knowledge of specific ones is not necessary.

Study Design Reference

- the innate immune response including the steps in an inflammatory response and the characteristics and roles of macrophages, neutrophils, dendritic cells, eosinophils, natural killer cells, mast cells, complement proteins and interferons

Web Link

<http://www.microbiologybook.org/mobile/m.immuno-13.htm>

Question 29

Solution: A

Antibodies pass across the placenta or are obtained from breast milk as a result of the mother developing active immunity against pathogens she has been exposed to. This provides short term protection against likely threats the baby might be exposed to. It is naturally acquired and is passive because the immune system has not been activated.

Study Design Reference

- the difference between natural and artificial immunity and active and passive strategies for acquiring immunity

Web Link

<https://www.biologyonline.com/tutorials/passive-and-active-types-of-immunity>

Question 30

Solution: D

The gene pool is the sum of all the alleles present in a particular population and so a change in allele frequency will lead to a change in the gene pool. A mutation has occurred, which is a change in the DNA sequence of a particular gene (in this case). A frameshift mutation usually leads to a large change in the resultant protein.

Study Design Reference

- causes of changing allele frequencies in a population's gene pool, including environmental selection pressures, genetic drift and gene flow; and mutations as the source of new alleles

Web Link

<http://learn.genetics.utah.edu/content/selection/recipe/>

Question 31

Solution: A

The founder effect is when a small group of individuals from an original population colonise a new area. A bottleneck is the same idea but the population drops to a small size and then increases. The founders were low in number and the gene pool of the new population is different to the original one.

Study Design Reference

- causes of changing allele frequencies in a population's gene pool, including environmental selection pressures, genetic drift and gene flow; and mutations as the source of new alleles

Web Link

http://evolution.berkeley.edu/evolibrary/article/bottlenecks_01

Question 32

Solution: D

The evolutionary theory is supported by much evidence, such as the development of more complex organisms over time. Prokaryotic cells first appeared in the fossil record about 4 billion years ago followed by eukaryotes about 2 billion years ago. Multicellular individuals first appeared in the fossil record about 1 billion years ago and animals appeared about 500 million years ago. Modern humans have been dated to have first appeared about 150000 years ago

Study Design Reference

- changes in species over geological time as evidenced from the fossil record: faunal (fossil) succession, index and transitional fossils, relative and absolute dating of fossils

Web Link

<http://exploringorigins.org/timeline.html>

Question 33

Solution: C

The correlation between sickle cell disease and malaria is evident in this question. An original mutation (pre-existing) led to some individuals being at a selective advantage and so the gene pool changed to be in tune with the environment. The factor in the environment that led to the changed gene pool is the malarial plasmodium, *Falciparum malaria*, which is the selective agent.

Study Design Reference

- causes of changing allele frequencies in a population's gene pool, including environmental selection pressures, genetic drift and gene flow; and mutations as the source of new alleles
- biological consequences of changing allele frequencies in terms of increased and decreased genetic diversity

Web Link

<http://www.hhmi.org/biointeractive/making-fittest-natural-selection-humans>

Question 34

Solution: B

Phylogenetic trees illustrate how closely organisms are related to each other as well as the time of divergence (if a time line is provided). Species A and B are the most closely related because they had a more recent time of divergence (branch in the phylogenetic tree). This would mean they should have more similarity in their DNA (homology) as there has been less time for mutations to accumulate. All of the species have a single common ancestor at the base of the phylogenetic tree.

Study Design Reference

- the use and interpretation of phylogenetic trees as evidence for the relatedness between species

Web Link

http://evolution.berkeley.edu/evolibrary/article/phylogenetics_02

Question 35

Solution: B

Strata geographic correlation is a means to determine the relative age of fossils. The top layers are the youngest because those sedimentary layers were the last to be formed. The layer with the bone is younger than the layer with the fish as illustrated by the area on the left. The same logic can be applied with the shell, which is the next layer in order of age.

Study Design Reference

- changes in species over geological time as evidenced from the fossil record: faunal (fossil) succession, index and transitional fossils, relative and absolute dating of fossils

Web Link

<https://www.sciencelearn.org.nz/resources/1485-relative-dating>

Question 36

Solution: C

The evolution of modern humans has been well researched and although there are still gaps in our understanding, the evidence is available to tell a convincing story. The homo line is a line that includes hominins that were all bipedal and so the level of intelligence was the driving force, which led to bigger craniums. *Homo habilis* was a prolific tool user (stone tools were located with their fossil remains) and *Homo erectus* was the first associated with mastering fire (remains of them were found with evidence of fire use). *Homo neanderthalensis* was associated with co-existence with *Homo sapiens* but they were more suited to cold environments and were eventually out competed.

Study Design Reference

- evidence for major trends in hominin evolution from the genus *Australopithecus* to the genus *Homo*: changes in brain size and limb structure

Web Link

<http://humanorigins.si.edu/evidence/human-evolution-timeline-interactive>

Question 37

Solution: D

The foramen magnum is more central in the homo line than their ancestors, which infers bipedalism. The pelvis in the homo line is more bowl shaped to support the upper body. The cranium enlargement is related to an increased intelligence. Longer arm to leg ratio is related to climbing.

Study Design Reference

- evidence for major trends in hominin evolution from the genus *Australopithecus* to the genus *Homo*: changes in brain size and limb structure

Web Link

<https://www.pbslearningmedia.org/resource/novat10.sci.life.evo.lucy/fossil-evidence-of-bipedalism/#.WPLBXoiGO00>

Question 38

Solution: A

Question 39

Solution: C

This question is about the interpretation of data. In question 38 there are less than 1000 cases in 2008 and the data from the first graph is American not European. France has a higher use of methicillin than Australia and so would be expected to have more cases of MRSA. The trend appears to be increasing in an exponential manner. The vertical axis in graph 2 is referring to the amount of antibiotic (mg) per kg of meat production.

Study Design Reference

- consequences of bacterial resistance and viral antigenic drift and shift in terms of ongoing challenges for treatment strategies and vaccination against pathogens
- ways of organising, analysing and evaluating primary data to identify patterns and relationships including sources of error and uncertainty

Web Link

<http://study.com/academy/lesson/interpreting-graphs-and-charts-of-scientific-data-practice-problems.html>

Question 40

Solution: C

Precision, reliability, accuracy, validity and minimal bias are factors associated with sound experimentation. The bulls eye would illustrate high competency in all of these areas. Experimenter 1 has reliably completed the work as all the data is closely clustered together (precise) but the data generated is not valid as it is way off the mark, which would infer a flaw in following the method. Experimenter 2 has generated data that could have a level of validity as it is equally spread around; however, the data is not reliable (imprecise). Experimenter 3 did not follow the method very well and has generated data that is spread in one direction and so it is neither valid or reliable (imprecise). Experimenter 4 is spot on with validity and reliability (precise).

Study Design Reference

- the accuracy, precision, reproducibility, repeatability and validity of measurements

Web Link

<http://edu.glogster.com/glog/biology-sources-and-interpretign-graphs/2jexm5kn78n>

End of suggested answers to the multiple-choice questions
2017 Kilbaha VCE Biology Trial Examination Units 3 and 4

Edited for the new study design. Units 1–4: 1 January 2022 – 31 December 2026

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Answers to Short Answer Questions

Question 1 (Total 7 marks)

- a) Ribosome: site of protein (insulin) synthesis
Endoplasmic reticulum: site of protein (insulin) transport
Golgi Apparatus: site of protein (insulin) modification and eventual packaging into vesicles for exocytosis **(2 marks)**

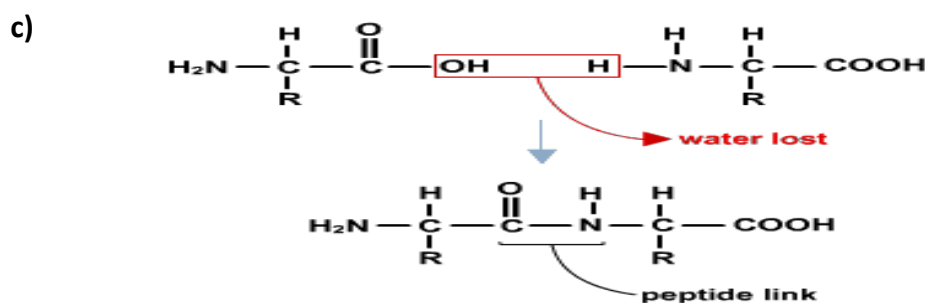
NOTE: All 3 organelles plus role required for 2 marks. Any role or organelle missing students only score 1 mark.

- b) (i) Quaternary **(1 mark)**

(ii) A gene provides a DNA blueprint for the synthesis of specific proteins. The DNA is read in groups of 3 nucleotides giving specificity to the order of amino acids (sequence) in the protein **(1 mark)**

The first codon is a 'start' codons (methionine) and at the conclusion of the synthesis of the protein is a 'stop' codon (not an amino acid). Between the start and stop is the correct number of codons (corresponding to the correct number of amino acids)

(1 mark)



From: <http://www.s-cool.co.uk/a-level/chemistry/aromatic-and-plastics/revise-it/polymerisation>

NOTE: All these points should be included in the diagram

- Diagram should show amino, acid and R group (could be very simple)
- Water should be lost
- A peptide bond should also be shown

All present **(2 marks)**

Study Design Reference

- amino acids as the monomers of a polypeptide chain and the resultant hierarchical levels of structure that give rise to a functional protein

Web Link

<http://www.interactive-biology.com/6711/the-basics-of-protein-structure-and-function/>

Question 2 (Total 7 marks)

a)

Molecule A: pre mRNA

Molecules B, C and D: mRNA

Process E: Alternative splicing

(3 marks)

b) (i) Translation

(1 mark)

(ii) Molecule Y

(1 mark)

c) Conservation of energy because less transcription needs to occur as there are less genes than proteins **(1 mark)**

More variety in proteins which may provide a survival advantage **(1 mark)**

Study Design Reference

- the genetic code as a universal triplet code that is degenerate and the steps in gene expression, including transcription, RNA processing in eukaryotic cells and translation by ribosomes
- the structure of genes: exons, introns and promoter and operator regions

Web Link

<https://dnlc.cshl.edu/resources/3d/rna-splicing.html>

Question 3 (total 10 marks)

a) Component 1: Well; the place where the DNA samples are added to the gel

(1 mark)

Component 2: The negative electrode (anode); pushes the (negatively charged) DNA in the well through the gel towards the positive electrode (cathode).

(1 mark)

Component 3: Buffer solution; provides a source of ions so that when electricity is applied to the gel electrophoresis tank, the circuit is complete

(1 mark)

b) (i) Polymerase Chain Reaction

(1 mark)

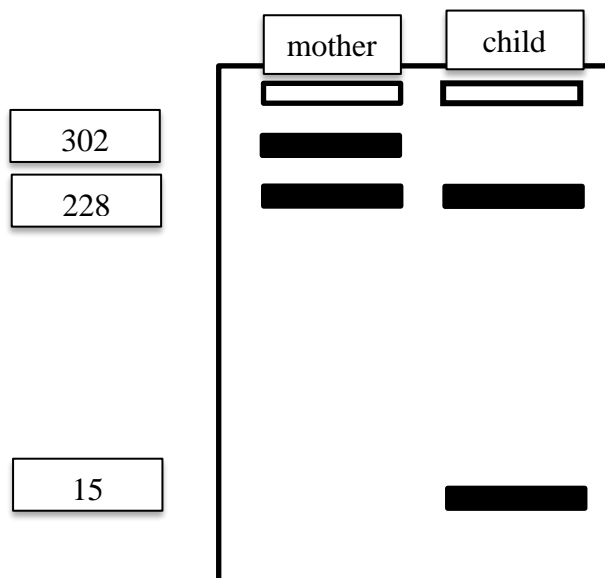
(ii) Primers are a single stranded specific sequence of DNA (usually 20-30 nucleotides in size)

(1 mark)

The primers anneal to a complimentary sequence of DNA in the sample on either side of the target section of DNA

(1 mark)

c) (i)



NOTE: 1 mark for correct banding and 1 mark for correct band labelling

(2 marks)

(ii) Male 2 is the father

(1 mark)

There has to be a common fragment for each allele from each parent. The common fragments from the mother are 228, 12, 87 and the common fragment from male 2 are 15, 24, 240

(1 mark)

Study Design Reference

- amplification of DNA using polymerase chain reaction and the use of gel electrophoresis in sorting DNA fragments, including the interpretation of gel runs for DNA profiling

Web Link

Polymerase Chain Reaction: <http://learn.genetics.utah.edu/content/labs/pcr/>

Gel Electrophoresis: <http://learn.genetics.utah.edu/content/labs/gel/>

Question 4 (Total 10 marks)

a) (i) The IV is the factor being tested so it is different from set up to set up. In this case it is the type of substrate available. **(1 mark)**

(ii) The yeast cells have some glucose within the cells initially. They respire and generate some heat as a product, explaining the 3 degree increase. **(1 mark)**

(iii) Based on the information provided controlled conditions could/should include

- Same initial temperature (25°C)
- Same amount of yeast
- Same type of thermos used

Note: 2 controlled conditions required

(1 mark)

b) There are a variety of methods that could be used. The method below is probably the most obvious.

Volume of carbon dioxide produced **(1 mark)**

Use an inverted measuring cylinder filed with water and connect this to yeast mixture. The gas produced will displace the water enabling the rate of gas production to be quantified

(1 mark)

NOTE: Other methods could be used

- Pressure changes
- Oxygen concentration

Factor and method are both required

c) (i)

	Aerobic respiration	Anaerobic respiration
Cellular location	Mitochondria	Cytosol
ATP production	36/38 ATP (FAQ suggest 30/32)	2 ATP
Speed of process	Slow	Fast

NOTE: 1 or 2 errors 2 marks, 3 or 4 errors 1 mark

(3 marks)

(ii) To ensure the conditions were anaerobic the water the yeast was mixed in could be boiled first and allowed to cool

(1 mark)

This removes the oxygen from the water and when the yeast is placed in it they will respire anaerobically

(1 mark)

Study Design Reference

- characteristics of the selected scientific methodology and method, and appropriateness of the use of independent, dependent and controlled variables in the selected scientific investigation
- the main inputs, outputs and locations of glycolysis, Krebs Cycle and electron transport chain including ATP yield (details of biochemical pathway mechanisms are not required)

Web Link

<http://www.interactive-biology.com/351/cellular-respiration-in-yeast-lab/>

Question 5 (Total 9 marks)

a) Stroma (of the chloroplast)

(1 mark)

b) C₃ plants in the presence of RUBISCO, combines uses carbon dioxide to make a C₃ compound

(1 mark)

C₄ plants convert the carbon dioxide into a C₄ compound in a different location that maximises the availability of carbon dioxide. The C₄ compound can then be transported to chloroplasts to undergo typical carbon fixation

(1 mark)

c) A CRISPR-Cas9 complex would need to be developed where RNA complementary to the hexokinase gene in rice plants would need to be developed

(1 mark)

The spacer RNA would need to be spliced to scaffold DNA forming guide RNA that would then bind to Cas9

(1 mark)

The CRISPR-Cas9 complex is mixed with rice plant cells so the complex is taken up and the hexokinase gene is disrupted as a result of the action of the CRISPR-Cas9

(1 mark)

Rice cells that show the hexokinase gen is disrupted are propagated and rice plants with drought tolerance may be located

(1 mark)

d) The demand for rice has increased from 2010 to present day (for 450 M tons to 550 M tons) meaning drought resistant rice could be advantageous

(1 mark)

Production of rice from 2010 is going to be less than needed (by about 50%) meaning if more areas could be exploited (drought resistance) then this could be a good thing

(1 mark)

Study Design Reference

- the role of Rubisco in photosynthesis, including adaptations of C₃, C₄ and CAM plants to maximise the efficiency of photosynthesis
- potential uses and applications of CRISPR-Cas9 technologies to improve photosynthetic efficiencies and crop yields

Web Link

C3 and C4: <https://ripe.illinois.edu/blog/difference-between-c3-and-c4-plants>

CRISPR: <https://genomebiology.biomedcentral.com/articles/10.1186/s13059-020-02204-y>

Question 6 (Total 8 marks)

- a) When macrophages come in contact with a non-self antigen such as on the COVID virus (or infected cells) they release cytokines **(1 mark)**
If many macrophages release many cytokines, an inflammatory response could be detrimental as too much blood may be directed to different locations or reduced blood may go to others...cytokine storm **(1 mark)**
- b) Humoral: provides specific B cells such as plasma cells **(1 mark)**
that make antibodies that bind to free floating COVID virus antigens to target them for destruction **(1 mark)**
Cell mediated: provides specific T cells such as cytotoxic cells **(1 mark)**
that target the cells with the virus inside for destruction **(1 mark)**
- c) The COVID virus undergoes antigenic drift, which provide new mutations on the antigens on the virus **(1 marks)**
A different immune response is required against each new variant making an older vaccine against an original variant less effective **(1 mark)**

Study Design Reference

- the innate immune response including the steps in an inflammatory response and the characteristics and roles of macrophages, neutrophils, dendritic cells, eosinophils, natural killer cells, mast cells, complement proteins and interferons
- initiation of an immune response, including antigen presentation, the distinction between self-antigens and non-self antigens, cellular and non-cellular pathogens and allergens
- the characteristics and roles of the components of the adaptive immune response against both extracellular and intracellular threats, including the actions of B lymphocytes and their antibodies, helper T and cytotoxic T cells
- consequences of bacterial resistance and viral antigenic drift and shift in terms of ongoing challenges for treatment strategies and vaccination against pathogens

Web Link

<https://www.karger.com/Article/FullText/516038>

Question 7 (Total 6 marks)

- a) Lymph nodes store white blood cells, particularly lymphocytes. In the case of CLL and overabundance of abnormal lymphocytes will cause swelling in the lymph nodes
(1 mark)
- b) For clinical trials to be conducted the following factors would need to be taken into account
- A large sample of humans suffering CLL would need to be used
 - A placebo group and experimental group would need to be formed (but they shouldn't know which group they are part of)
 - The trial would need to be conducted for the same length of time and each patient taking the same amount of medication
 - Constant monitoring of the health status of each individual would need to be carried out
 - A significant difference in the experimental groups health compared to the placebo group would need to be observed prior to the release of the drug

NOTE: all these factors would need to be taken into account. The first 4 dot points relate to how clinical trials would be carried out and 3 of them should be discussed for full assessment
(3 marks)

- c) When the drug (venetoclax) binds to BCL-2, the shape of the combination is different to the original BCL-2.
(1 mark)
Mitochondrial function is reduced making less ATP available for cell survival
(1 mark)

Study Design Reference

- the role of the lymphatic system in the immune response as a transport network and the role of lymph nodes as sites for antigen recognition by T and B lymphocytes
- ways of organising, analysing and evaluating primary data to identify patterns and relationships including sources of error and uncertainty

Web Link

<http://www.merckmanuals.com/professional/hematology-and-oncology/leukemias/overview-of-leukemia>

Question 8 (Total 6 marks)

- a) (i) Mutations provide a change in the DNA of an individual not originally present within the population, which leads to differences within the population's gene pool
(1 mark)
- (ii) Biologists would need to have a way of determining the proportion of alleles within a gene pool, such as counting individuals with particular phenotypes within a population
(1 mark)
This would need to be measured before and after a particular environmental change. If there is a difference in the gene pool then it could be determined that evolution has occurred
(1 mark)
- b) 3, 4, 1, 2 **(1 mark)**
Warmth promotes better growth compared to cold. **(1 mark)**
The presence of grazers will reduce growth even though the grazing increases cyanide production. **(1 mark)**

Study Design Reference

- causes of changing allele frequencies in a population's gene pool, including environmental selection pressures, genetic drift and gene flow; and mutations as the source of new alleles

Web Link

<http://faculty.virginia.edu/evolutionlabs/clover%20lab.html>

Question 9 (Total 9 marks)

- a) (i) A species is a group of organisms that are able to reproduce to produce fertile offspring
(1 mark)
(ii) Howae plants have come about due to sympatric speciation **(1 mark)**
The isolation event has occurred in the same geographic area (island); however each area has a difference (soil type) that offers a selective advantage to some variants (seeds)
(1 mark)
Galapagos finches have come about due to allopatric speciation **(1 mark)**
Organisms are geographically isolated and the different areas provide different selection pressures for speciation **(1 mark)**
- b) Howae palms: Fossils in the same area showing different phenotypes between modern and ancestral palms, dated the same age **(1 mark)**
Galapagos finches: Fossils on the different islands showing phenotypes between the modern form and the ancestor, dated between the migration of the ancestor and modern day
(1 mark)
- c) Index fossils are distinctive, found in many areas, only lived for a short time and their date is usually known **(1 mark)**
Fossils are often difficult to date but if they are found in the same strata layers as an index fossil their date of existence might be known **(1 mark)**

Study Design Reference

- evidence of speciation as a consequence of isolation and genetic divergence, including Galapagos finches as an example of allopatric speciation and *Howea* palms on Lord Howe Island as an example of sympatric speciation

Web Link

<https://www.khanacademy.org/science/ap-biology/natural-selection/speciation/a/species-speciation#:~:text=In%20allopatric%20speciation%2C%20groups%20from,species%20with%20any%20geographical%20separation.>

Question 10 (Total 8 marks)

- a) Radioisotopic dating/absolute dating (1 mark)
Compare the amount of an isotope is present in the fossil (or surrounding volcanic rock) compared to the amount that would be present when the animal was alive. Isotopes have a known half-life and the absolute date can be determined. (1 mark)
- b) (i) Mitochondrial DNA only shows variation due to mutation and mutations accumulate at a set rate (1 mark)
By comparing the migrated individuals (who would show less variation in their mtDNA like Australian aboriginals) to their origin (who should show more variation in their mtDNA like African groups) migratory patterns can be hypothesised (1 mark)
- (ii) Find groups along the route that show more variation in their DNA compared to aboriginals yet are genetically ancestral to the group
OR
Find fossil evidence of individuals along the hypothesised route that are older than the oldest evidence of aboriginals in Australia
OR
Find cultural evidence in older groups along the route that could be homologous (2 marks)
- 2 pieces of evidence for 2 marks*
- c) mtDNA shows variation due to mutation and they accumulate at a set rate over time (1 mark)
Indigenous Australians would show more differences in their mtDNA when compared to each other whereas the indigenous Americans would show less differences (1 mark)

Study Design Reference

- ways of using fossil and DNA evidence (mtDNA and whole genomes) to explain the migration of modern human populations around the world, including the migration of Aboriginal and Torres Strait Islander populations and their connection to Country and Place.

Web Link

Absolute Dating:

<https://www.sciencelearn.org.nz/resources/1486-absolute-dating>

Mitochondrial DNA: <http://www.pbs.org/wgbh/nova/neanderthals/mtdna.html>

Human migrations (click on the link under genetic map...brilliant)

<http://www.bradshawfoundation.com/stephenoppenheimer/index.php>

End of suggested answers for the 2017 Kilbaha VCE Biology Trial Examination Units 3 and 4

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