

Biology 2020 – Assessment Guide

Section A – Multiple-choice Questions

VCAA Key
Knowledge

Question

Answer guide

the structure of DNA and the three forms of RNA including similarities and differences in their subunits, and their synthesis by condensation polymerisation

Question 1

Nitrogen is found in which of the following?

- A. amino acids and water
- B. RNA bases but not DNA bases
- C. DNA bases but not RNA bases
- D. both DNA and RNA bases

D Both DNA and RNA are composed of nitrogenous containing bases – adenine, guanine, cytosine, thymine or uracil. Water does not contain nitrogen.

the functional importance of the four hierarchical levels of protein structure

Question 2

There are four levels of protein structure. When two or more polypeptides are joined, this refers to

- A. primary structure.
- B. secondary structure.
- C. tertiary structure.
- D. quaternary structure.

D Quaternary structure is when two or more polypeptides join, most often to form a functional protein.

Use the following information to answer Questions 3 and 4.

1 = viruses	2 = prokaryotic cells	3 = prions	4 = eukaryotic cells
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the structure of DNA and the three forms of RNA including similarities and differences in their subunits, and their synthesis by condensation polymerisation

Question 3

DNA and/or RNA can be found in

- A. 1 only.
- B. 1 and 2 only.
- C. 1, 2 and 4 only.
- D. 1, 2, 3 and 4.

C Prions are made of protein and therefore do not contain DNA and/or RNA. All other options can contain DNA and/or RNA.

the synthesis of a polypeptide chain from amino acid monomers by condensation polymerisation

Question 4

Polypeptides could be found in

- A. 1 only.
- B. 1, 2, 3 and 4.
- C. 3 only.
- D. 1 and 2 only.

B All of the options provided contain polypeptides/proteins.

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

Question 5

In relation to the production, transport and export of a protein from a cell, which of the following organelles correctly matches its function?

	Organelle	Function
A.	golgi body	packages proteins into vesicles
B.	ribosome	modifies proteins
C.	endoplasmic reticulum	synthesises proteins
D.	cell membrane	transports proteins around the cell

A *Ribosomes synthesise proteins, endoplasmic reticula transport and modify proteins, and the cell membrane is involved in the export of a protein out of the cell.*

Use the following information to answer Questions 6 and 7.
Thelma and Louise were discussing movement through the plasma membrane of an animal cell. Louise suggested that there are many molecules that can move through the phospholipid bilayer without requiring energy and also do not require the use of protein channels.

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

Question 6

The correct processes that the molecules Louise was referring to may utilise include

- A. osmosis, simple diffusion and active transport.
- B. osmosis and simple diffusion.
- C. osmosis and exocytosis.
- D. simple diffusion, exocytosis and endocytosis.

B *All other options include processes that require energy – active transport, exocytosis and endocytosis.*

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

Question 7

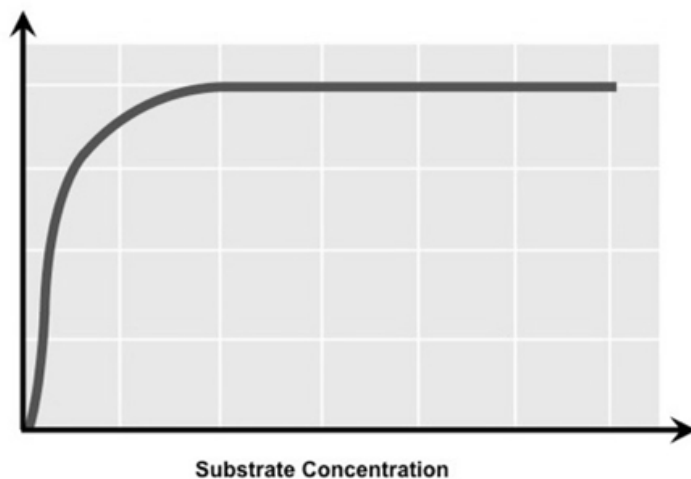
Examples of molecules that can move through the phospholipid bilayer and do not require protein channels include

- A. water only.
- B. water and oxygen only.
- C. water, oxygen and carbon dioxide.
- D. oxygen and carbon dioxide only.

C *All three of these molecules can move through the phospholipid bilayer and do not require a protein channel.*

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

Question 8



Source: <https://www.nagwa.com/en/worksheets/702178634958/>

The y-axis variable in the enzyme graph above is most likely to be

- A. rate of reaction.
- B. temperature.
- C. pH.
- D. substrate concentration.

A *With the x-axis labelled substrate concentration, this is not an appropriate option. Temperature and pH are not appropriate factors for the y-axis for a graph such as this.*

the role of enzymes as protein catalysts in biochemical pathways

Question 9

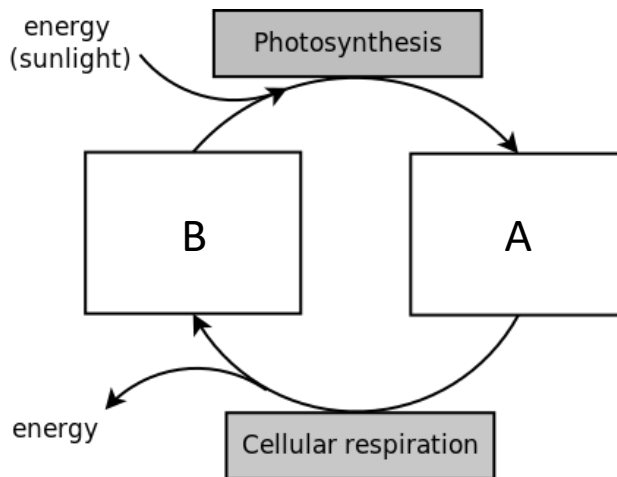
Enzymes _____ activation energy.

- A. increase
- B. neutralise
- C. lower
- D. remove

C *Enzymes are organic catalysts that lower activation energy and assist reactions to proceed.*

Use the following information to answer Questions 10 and

11.



Source: <https://www.siyavula.com/read/science/grade-8/photosynthesis-and-respiration/01-photosynthesis-and-respiration>

inputs and outputs of the light dependent and light independent (Calvin cycle) stages of photosynthesis in C3 plants

the main inputs and outputs of the Krebs (citric acid) cycle and electron transport chain including ATP yield

Question 10

The molecules that best align with A and B are:

	A	B
A.	Oxygen Glucose	Carbon dioxide Water
B.	Carbon dioxide Water	Oxygen Glucose
C.	Oxygen Carbon dioxide	Glucose Water
D.	ATP Oxygen	Carbon dioxide ATP

A *Oxygen and glucose are both an output of photosynthesis and an input for cellular respiration. Both carbon dioxide and water are an output of cellular respiration and an input for photosynthesis.*

the purpose of photosynthesis

Question 11

Photosynthesis is a/n _____ reaction and cellular respiration is a/n _____ reaction.

- A. catabolic; anabolic
- B. anabolic; anabolic
- C. catabolic; catabolic
- D. anabolic; catabolic

D *Photosynthesis combines small molecules to create a larger molecule, which is anabolic. Cellular respiration breaks a large molecule into smaller molecules, which is catabolic.*

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

Question 12

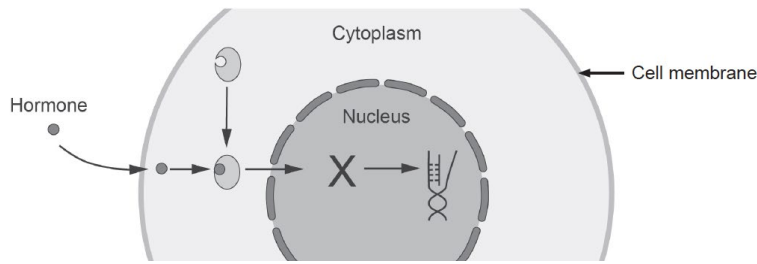
Coenzymes

- A. perform the same function as enzymes in cellular respiration.
- B. are not made of protein.
- C. perform no role in photosynthesis.
- D. that are involved in photosynthesis are only ATP and NADH.

B *Coenzymes are non-protein molecules that assist enzymes to catalyse reactions. For example, ATP and NADPH are the loaded coenzymes involved in photosynthesis.*

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

Question 13



Source: <https://www.sciencedirect.com/topics>

At point X in the diagram, the

- A. hormone binds with the receptor.
- B. secondary messenger binds to DNA.
- C. hormone-receptor complex binds to DNA.
- D. cell response is complete.

C *At point X, the hormone-receptor complex has entered the nucleus and would combine with DNA.*

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

Question 14

Receptor proteins

- A. always bind with molecules on the surface of a cell to cause changes within that cell.
- B. cannot initiate the process that leads to cell death.
- C. enable communication between cells to stimulate change in target cells.
- D. always bind with molecules inside a cell to cause changes within that cell.

C *There are receptors on cells that can initiate apoptosis, so B is incorrect. A and D are incorrect as receptors may be found on the cell membrane or in the cytosol. C is correct as receptors play a role in signal transduction, allowing cells to communicate with one another which can lead to a cellular response.*

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

Question 15

The presence of mitochondria in the axon terminal of a neuron assists with cellular signalling, because the mitochondria can provide energy for

- A. the movement of neurotransmitters across the synapse through diffusion.
- B. the release of neurotransmitters from the axon terminal via exocytosis.
- C. the movement of neurotransmitters across the synapse through active transport.
- D. the release of neurotransmitters from the axon terminal via endocytosis.

B *Neurotransmitters move across the synapse via diffusion which does not require energy as this is a passive process. Neurotransmitters are released from the pre-synaptic terminal via exocytosis, an energy requiring process.*

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

Question 16

In relation to active and passive immunity, which of the following options correctly matches the type of immunity with its function?

	Passive immunity	Active immunity
A.	can result in a long-lasting memory of pathogens	involves complement proteins and neutrophils
B.	involves the production of antibodies	involves the production of B memory cells
C.	can result in the inflammatory response being activated	involves the same general response for each pathogen encountered
D.	involves complement proteins and neutrophils	can result in a long-lasting memory of pathogens

D *Passive immunity involves complement proteins and neutrophils, however no antibodies are produced, nor is there any memory of a pathogen. Active immunity initiates a specific response for each pathogen, and this typically results in the body remembering this pathogen and initiating a faster response upon future reencounter.*

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

Question 17

Herd immunity

- A. can be obtained through both natural infection and vaccination.
- B. can be obtained only through natural infection.
- C. cannot be obtained through either vaccination or natural infection.
- D. can be obtained only through vaccination.

A *Both vaccination and natural infection can lead to the production of B memory cells. When a significant number of individuals in a population possess these, herd immunity exists.*

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

Question 18

The following is a list of the main steps in the life cycle of a virus in no particular order.

Step A: Viral proteins and nucleic acids are assembled in the host cell.

Step B: The virus binds to the host cell.

Step C: The virus injects its nucleic acid into the host cell.

Step D: The host cell releases viral particles.

Step E: The host cell produces viral nucleic acids and proteins.

Which of the following lists these steps in the order in which they occur in the life cycle of a virus?

- A. D – A – E – C – B
- B. C – A – B – D – E
- C. B – C – E – D – A
- D. B – C – E – A – D

D *The steps outlined in option D outline the typical steps in viral replication.*

the characteristics and roles of components of the adaptive (specific) immune response including...the actions of T helper and T cytotoxic cells in cell-mediated immunity.

Question 19

T helper cells

- A. directly attack cells infected with viruses.
- B. release cytokines which stimulate B cells.
- C. produce antibodies.
- D. interact with antigens presented on cytotoxic T cells.

B T helper cells 'help' to regulate the immune response by releasing cytokines which stimulate B cells.

the use of monoclonal antibodies in treating cancer.

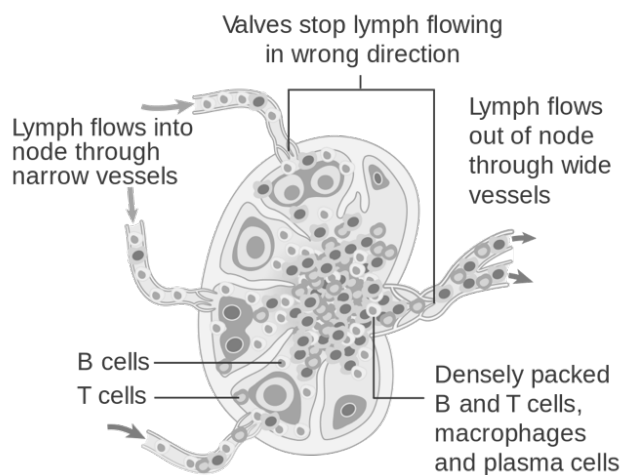
Question 20

Monoclonal antibodies

- A. directly attack cancer cells.
- B. can deliver radiation to cancer cells.
- C. can deliver chemotherapy to cancer cells.
- D. all of the above.

D Monoclonal antibodies can be designed to target cancer cells in many ways, including all options listed.

Use the following information to answer Questions 21 and 22.



Source: https://en.wikipedia.org/wiki/Lymph_node#/media/File:Diagram_of_a_lymph_node_CRUK_022.svg

the role of the lymphatic system in the immune response including the role of secondary lymphoid tissue (with reference to lymph nodes) as the site of antigen recognition by lymphocytes

Question 21

The diagram above is where

- A. antigen recognition occurs by lymphocytes.
- B. pumping occurs to move fluid through vessels.
- C. fluid drains back into the circulatory system.
- D. the allergic response is initiated.

A Lymph nodes are where antigen recognition occurs by lymphocytes. There is no pump in the lymphatic system.

the role of the lymphatic system in the immune response including the role of secondary lymphoid tissue (with reference to lymph nodes) as the site of antigen recognition by lymphocytes

Question 22

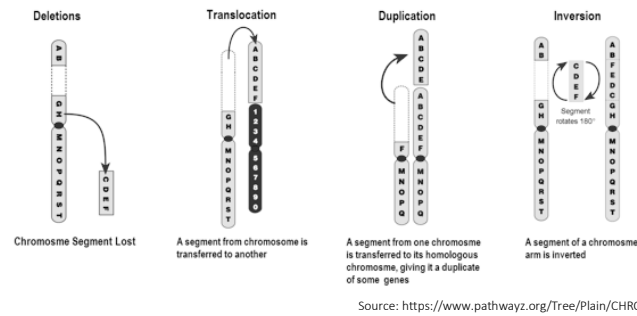
The diagram above represents

- A. quaternary lymphoid tissue.
- B. primary lymphoid tissue.
- C. secondary lymphoid tissue.
- D. tertiary lymphoid tissue.

C Lymph nodes are secondary lymphoid tissue (as indicated in the VCAA Biology key knowledge point).

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)

Question 23



The diagram above represents

- A. the polymerase chain reaction.
- B. point mutations.
- C. frameshift mutations.
- D. block mutations.

D The diagram represents different examples of block mutations that may occur to sections of DNA in chromosomes.

the manipulation of gene pools through selective breeding programs.

Question 24

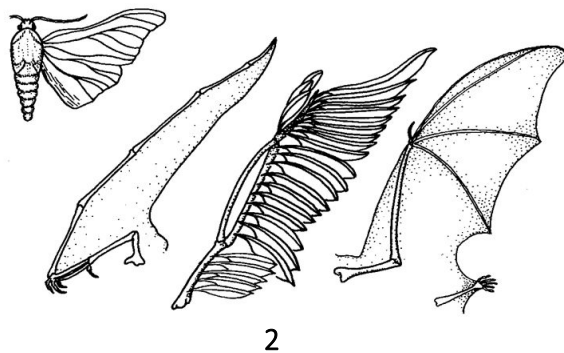
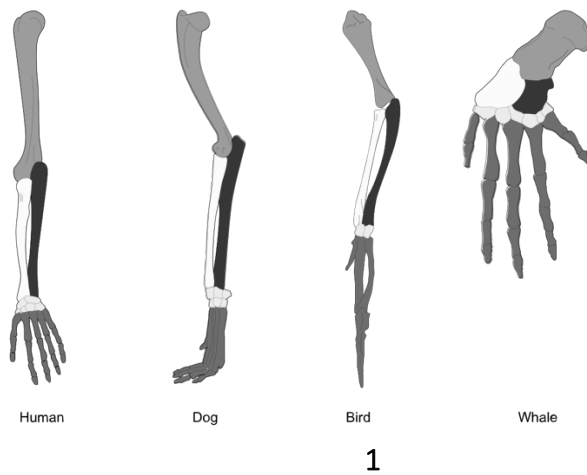
Selective breeding

- A. will always reduce genetic diversity in a population.
- B. will always increase genetic diversity in a population.
- C. can be used as a method to increase the survival chances of an endangered species.
- D. is only used to increase the survival chances of an endangered species.

C Selective breeding is when humans choose which individual organisms mate and pass on their genes to future generations. This approach is often used in captive breeding programs to increase the chances of survival of an endangered species.

evidence of 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), developmental biology and structural morphology

Question 25



Source: [https://en.wikipedia.org/wiki/_/\(biology\)](https://en.wikipedia.org/wiki/_/(biology))

Which of the following is true of the images above?

- A. both 1 and 2 represent analogous structures
- B. both 1 and 2 represent structural morphological evidence of biological change over time
- C. both 1 and 2 represent homologous structures
- D. 1 represents analogous structures and 2 represents homologous structures

B Image 2 represents analogous structures (given the wings of the insect do not contain bones) and image 1 represent homologous structures; both of these are examples of structural morphological evidence of biological change over time.

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

Question 26

Two species of lizards live on separate islands. These two species evolved from a common ancestor by allopatric speciation. The likely order of events in the speciation, from first to last, would have been

- A. geographical isolation, reproductive isolation, natural selection.
- B. geographical isolation, natural selection, reproductive isolation.
- C. natural selection, geographical isolation, reproductive isolation.
- D. natural selection, reproductive isolation, geographical isolation.

B The islands separated the lizards, so the different selection pressures on the islands would contribute to changes in the traits of the lizards on the two islands, and consequently different species evolve, which then would have contributed to reproductive isolation.

molecular homology as evidence of relatedness between species including DNA and amino acid sequences, mtDNA (the molecular clock) and the DNA hybridisation technique

Question 27

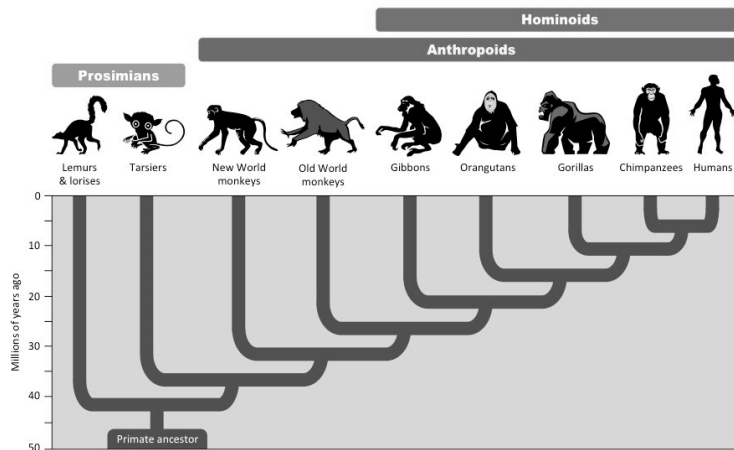
If the rate of gene flow between two populations is high, then it is likely that

- A. speciation will not occur.
- B. speciation will occur.
- C. the selection pressures in the two populations are the same.
- D. there are long distances between the two populations.

A High rates of gene flow between two populations reduces the likelihood that genetic differences will build between the two populations, and this reduces the likelihood of speciation.

shared characteristics that define primates, hominoids and hominins

Question 28



Source: <https://ib.bioninja.com.au/standard-level/topic-5-evolution-and-biod/54-cladistics/clades.html>

According to this cladogram

- A. Old World monkeys evolved after New World monkeys.
- B. Orangutans evolved before Gibbons.
- C. Tarsiers are more closely related to humans than New World monkeys.
- D. Lemurs and lorises are the least closely related.

A Old World monkeys evolved approximately 27 million years ago according to the timeline and New World monkeys evolved approximately 32 million years ago.

shared characteristics that define primates, hominoids and hominins

Question 29

Hominoids and hominins

- A. lack opposable thumbs.
- B. are all bipedal.
- C. lack tails.
- D. could all use tools to make fire.

C Hominoids and humans do not have tails. They both have opposable thumbs. Hominoids such as the gorilla are not bipedal, and they also do not use tools to make fire.

the human fossil record...including whether *Homo sapiens* and *Homo neanderthalensis* interbred and the placement of the Denisovans into the *Homo* evolutionary tree.

Question 30

What evidence would support the notion that interbreeding occurred between *Homo neanderthalensis* and *Homo sapiens*?

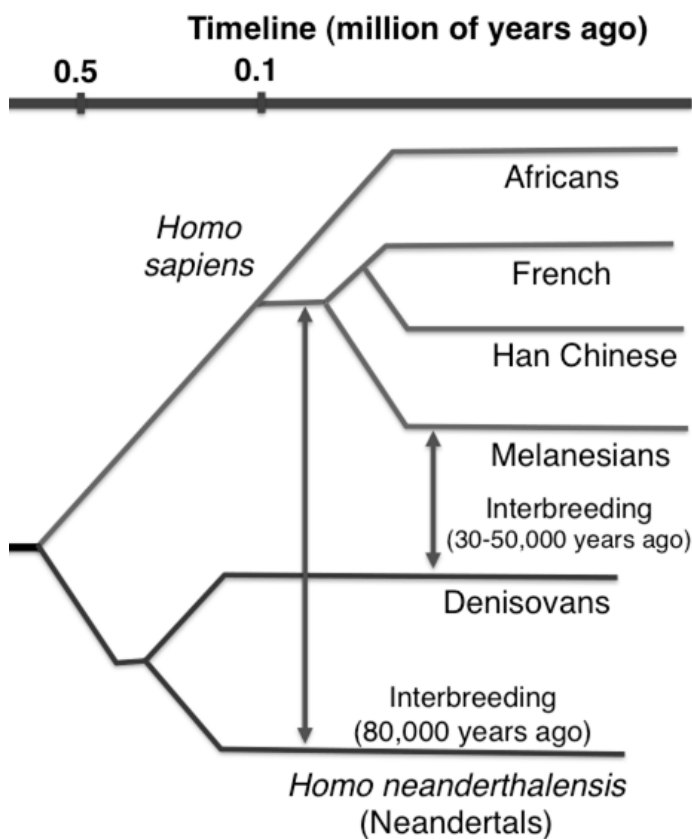
- A. they were both alive during the same period of time
- B. they both shared cultural traditions
- C. they both possess similar structural traits such as a large brain case
- D. modern day *Homo sapiens* possess Neanderthal DNA

D If modern day *Homo sapiens* possess Neanderthal DNA, this would indicate that interbreeding occurred between *Homo neanderthalensis* and *Homo sapiens* as the DNA would have then been passed on through the generations from this interbreeding.

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 the Denisovans into the *Homo* evolutionary tree.

Question 31

The diagram below is one depiction of an aspect of the human family tree.



B As indicated by the timeline, Neanderthals and Denisovans diverged approximately 0.3 million years ago.

The family tree indicates that Neanderthals and Denisovans diverged approximately

- A. 0.5 million years ago.
- B. 0.3 million years ago.
- C. 0.1 million years ago.
- D. 0.6 million years ago.

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

Question 32

DNA polymerase and RNA polymerase

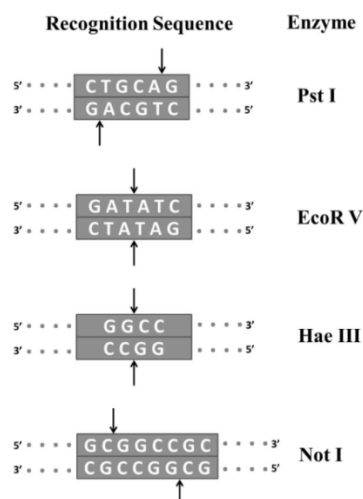
- A. are both involved in DNA replication.
- B. are both involved in transcription.
- C. differ as DNA polymerase is involved in DNA replication and RNA polymerase is involved in translation.
- D. differ as DNA polymerase is involved in DNA replication and RNA polymerase is involved in transcription.

D DNA polymerase is involved in DNA replication and RNA polymerase is involved in transcription.

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

Question 33

The following diagram demonstrates the recognition sequence for four different restriction enzymes.



Source: <https://www.chegg.com/homework-help/questions-and-answers/restriction-enzymes-produce-cohesive-sticky-ends-others-produce-blunt-ends-cut-double-str-q36205359>

Based on the stimulus material, all cuts will lead to

- A. only sticky ends being produced.
- B. two sticky and two blunt ends being produced.
- C. only blunt ends being produced.
- D. neither sticky nor blunt ends being produced.

B The diagram indicates that EcoR V and Hae III will produce blunt ends and Pst I and Not I will produce sticky ends.

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

Question 34

Which of the following is true of gel electrophoresis and the way in which it sorts DNA fragments?

- A. DNA is positively charged and therefore moves towards the positive electrode
- B. DNA is negatively charged and therefore moves towards the negative electrode
- C. DNA is positively charged and therefore moves towards the negative electrode
- D. DNA is negatively charged and therefore moves towards the positive electrode

D DNA is negatively charged and therefore moves towards the positive electrode on a gel electrophoresis machine.

the use of recombinant plasmids as vectors to transform bacterial cells.

Question 35

A recombinant plasmid

- A. can act as a vector.
- B. is only found in eukaryotic cells.
- C. can only contain DNA from the same species.
- D. cannot be used to transform bacterial cells.

A *Recombinant plasmids can act as vectors to transform bacterial cells. Recombinant plasmids are typically found in prokaryotic cells but can be incorporated in eukaryotic cells also. Recombinant plasmids can contain DNA from different species.*

techniques that apply DNA knowledge (specifically gene cloning) including social and ethical implications and issues

Question 36

In relation to gene cloning, heat-shock may be applied to bacteria in order to

- A. prevent them from taking up recombinant DNA.
- B. kill the bacteria.
- C. encourage them to take up recombinant DNA.
- D. encourage the bacteria to replicate.

C *Heat shock encourages bacteria to take up recombinant DNA required for gene cloning.*

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

Question 37

A pandemic

- A. is easier to contain than an epidemic.
- B. typically has a shorter duration than an epidemic.
- C. cannot be prevented through herd immunity.
- D. is the spread of a pathogen and the associated condition that covers several countries or spreads from one continent to another.

D *Option D describes a pandemic. Epidemics are typically localised to a region/smaller number of people within a population and are therefore easier to contain, than pandemics. As pandemics spread widely, they typically are longer in duration than epidemics.*

systematically generate, collect, record and summarise both qualitative and quantitative data

Question 38

Qualitative data

- A. is always numerical in nature.
- B. is often based on an experiment with a measurement tool (e.g. a thermometer).
- C. always involves large sample sizes in studies.
- D. is typically descriptive in nature.

D *Qualitative data is typically based on observation or interviews, and therefore is typically descriptive in nature or involves words.*

take a qualitative approach when identifying and analysing experimental data with reference to accuracy, precision, reliability, validity, uncertainty and errors (random and systematic)

Question 39

Suzie and James were conducting an experiment to determine the effects of carbon dioxide concentration on the rate of photosynthesis in hydrangeas (a type of plant).

They decided to measure the rate of photosynthesis using a newly developed oxygen concentration apparatus. The packet the apparatus came in mentioned that it required calibration before use, to ensure it was making accurate measurements, however, James forgot to calibrate the instrument before he and Suzie started their experiment.

Their experiment involved five separate groups of hydrangeas, and all of the measurements taken involved the uncalibrated apparatus.

The type of error demonstrated in the scenario is

- A. a random error.
- B. a personal error.
- C. a systematic error.
- D. a notational error.

C *A systematic error is a consistent, repeatable error that is often associated with faulty equipment. The measurement error for each group would have been consistent due to the uncalibrated apparatus.*

take a qualitative approach when identifying and analysing experimental data with reference to accuracy, precision, reliability, validity, uncertainty and errors (random and systematic)

Question 40

An increase in the sample size of an experiment will

- A. not affect the reliability or validity of the experiment.
- B. be more likely to increase the reliability of the experiment than its validity.
- C. increase the reliability and decrease the accuracy of the experiment.
- D. increase the validity of the experiment but not the reliability.

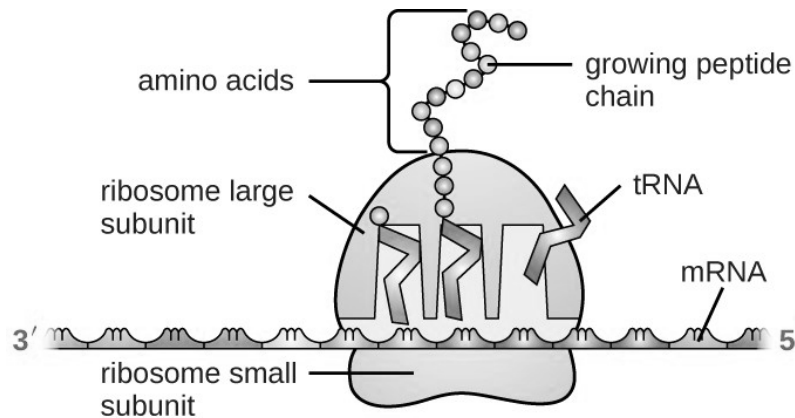
B *Sample size is not directly related to validity; with greater sample size reliability increases, as there is more data that can be collected and compared to determine if consistent results are demonstrated.*

Section B – Short Answer Questions

VCAA Key Knowledge

Question

Answer guide



Source: <https://courses.lumenlearning.com/microbiology/chapter/structure-and-function-of-rna/>

the genetic code as a degenerate triplet code and the steps in gene expression including transcription, RNA processing in eukaryotic cells and translation.

Question 1a (1 mark)

The image above depicts what process involved in protein synthesis?

Answer:

- *Translation*

Marking protocol:

One mark for the above point.

the structure of DNA and the three forms of RNA including similarities and differences in their subunits, and their synthesis by condensation polymerisation

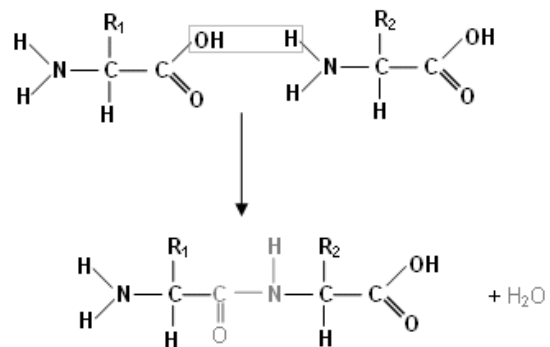
Question 1b (4 marks)

Draw a labelled diagram, in two steps, that demonstrates the process involved in joining two amino acids. Name the process you have drawn.

Answer:

- A diagram with two steps, as outlined below, is required:

(Amino acid 1 joins with Amino acid 2.)



(A dipeptide is formed, and a water molecule is generated.)

- *Condensation polymerisation*

Marking protocol:

One mark for two correctly drawn amino acids in step 1.

One mark for a correctly drawn dipeptide in step 2, and an

additional mark for a water molecule written/drawn in step 2.

A final mark for naming the process condensation polymerisation.

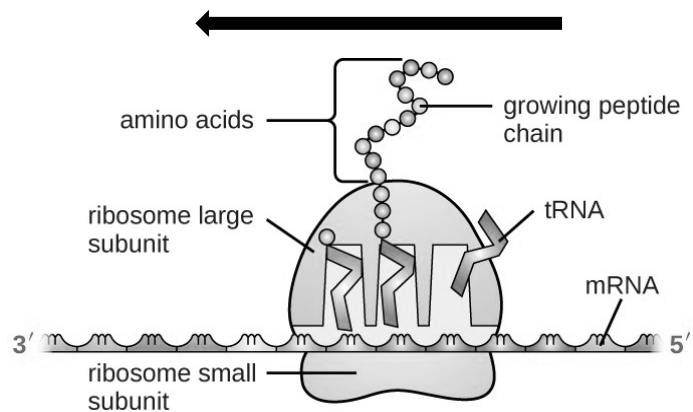
the genetic code as a degenerate triplet code and the steps in gene expression including transcription, RNA processing in eukaryotic cells and translation.

Question 1c (3 marks)

Draw an arrow on the diagram above (in the stimulus material) that indicates the direction in which the ribosome is moving as it reads the mRNA. Explain how the ribosome knows when to stop this movement and the contribution this makes to the polypeptide chain.

Answer:

- *The ribosome will stop when it reaches a stop codon sequence in the mRNA...*
- *...this does not contribute an amino acid to the polypeptide chain.*



Marking protocol:

One mark for an arrow on the diagram that indicates the ribosome is moving in the 5' to 3' direction (from right to left).
One mark for each of the above points.

Cellular respiration is a vital process in humans that facilitates the breakdown of glucose and its conversion into a usable form of cellular energy – ATP. Energy is released from ATP when it is converted to ADP and Pi. Both aerobic and anaerobic respiration are possible in humans, however, the inputs and outputs of these two forms of cellular respiration differ.

the purpose of cellular respiration

Question 2a (2 marks)

Describe the structural difference between ATP and ADP and how energy is released during ATP's conversion to ADP.

Answer:

- *The structural difference is that a molecule of ATP consists of a chain of three phosphates, whereas a molecule of ADP only contains a chain of two phosphates.*
- *Due to the high energy in the bonds between each phosphate in a chain, energy is released when the bond holding the third phosphate group in ATP is broken, leaving a chain of two phosphates in ADP.*

Marking protocol:

One mark for each of the above points.

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

Question 2b (4 marks)

Name two processes by which glucose can enter a cell and describe the difference between these two processes.

Answer:

- *Active transport*
- *Facilitated diffusion*
- *Active transport is the movement of a substance across a membrane from a region of low concentration to high concentration that requires the input of energy, whereas...*
- *...facilitated diffusion is the movement of a substance through a channel protein from a region of high concentration to low concentration that does not require the input of energy.*

Marking protocol:

One mark for each of the above points.

the location of, and the inputs and outputs of, glycolysis including ATP yield

Question 2c (2 marks)

Once glucose has entered the cell, what stage of aerobic cellular respiration is it an input for, and where does this stage take place?

Answer:

- *Stage: Glycolysis*
- *Location: The cytosol*

Marking protocol:

One mark for each of the above points.

the location of anaerobic cellular respiration, its inputs and the difference in outputs between animals and yeasts including ATP yield

Question 2d (2 marks)

Explain why lactic acid may accumulate in the body of a person who exercises vigorously for a period of time.

Answer:

- *Vigorous exercise can contribute to a lack of adequate oxygen to be delivered to the cells to meet energy needs via aerobic cellular respiration; therefore, the cells instead carry out anaerobic respiration.*
- *An output of anaerobic respiration in animals is lactic acid; therefore, vigorous exercise in humans can lead to the accumulation of lactic acid.*

Marking protocol:

One mark for each of the above points.

A microbiologist was testing the effect of antibiotics on several strains of one pathogenic bacterium. She plated out the bacteria on a suitable agar medium and placed small disks soaked in four different antibiotic solutions of equal concentration on the agar. She then incubated the plates under matched conditions and measured the diameter of the zone of inhibition (area of no bacterial growth) surrounding the discs. The following results were obtained.

Antibiotic solution	Diameter of zone of inhibition - mm		
	Strain A	Strain B	Strain C
1	6	8	9
2	15	15	16
3	17	22	19
4	12	14	0

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

Question 3a (2 marks)

Outline a structural feature that distinguish bacteria from viruses.

Answer:

- *Bacteria are surrounded by a cell membrane (and most also have a cell wall), whereas viruses do not contain this structure; they have an outer envelope/capsid/protein coat.*
- *Bacteria typically have a single, circular DNA chromosome that is their genetic material, whereas a virus may contain DNA or RNA as their genome.*

Marking protocol:

Two marks for any of the above points, to a maximum of two. Note, a distinctive feature of both bacteria and viruses should be included in a response to obtain full marks, not simply a statement referring to bacteria being cellular and viruses non-cellular.

identify independent, dependent and controlled variables

Question 3b (3 marks)

The microbiologist incubated the plates under 'matched conditions'. Identify what this matched condition is most likely to have been, and explain the importance of this for such an experiment.

Answer:

- *The matched condition is most likely to be the same temperature for all plates in incubation.*
- *It is important to only alter one variable in such an experiment, in this case the type of antibiotic, and keep all other variables constant. The temperature of incubation should be the same for all strains of antibiotic.*
- *If this does not occur, it is difficult to determine whether altering the independent variable is the likely cause of any changes in the dependent variable, which reduces the validity of the experiment.*

Marking protocol:

One mark for each of the above points.

take a qualitative approach when identifying and analysing experimental data with reference to accuracy, precision, reliability, validity, uncertainty and errors (random and systematic)

Question 3ci (2 marks)

An observer noted that one of the results in the table appeared to be an error. Identify which result is most likely to be an error and justify your response.

Answer:

- Strain C, antibiotic 4 result of 0mm area of bacterial growth.
- This is most likely an error as strain C produced similar results to strain A and B for antibiotics 1-3. Strain A and B had similar results for antibiotic 4, therefore the large difference of 11-12mm for strain C is likely to be an error.

Marking protocol:

One mark for each of the above points.

take a qualitative approach when identifying and analysing experimental data with reference to accuracy, precision, reliability, validity, uncertainty and errors (random and systematic)

Question 3cii (1 mark)

Describe the error that may have led to this result being obtained.

Answer:

- The disk placed on strain C may not have been soaked in any of antibiotic 4, therefore, none of the strain C bacteria was killed, leading to a 0mm zone of inhibition.
- The disk placed on strain C may have been contaminated from another source reducing the effectiveness of the antibiotic, therefore, none of the strain C bacteria was killed, leading to a 0mm zone of inhibition.

Marking protocol:

One mark for one of the above points.

identify independent, dependent and controlled variables

Question 3d (2 marks)

List the independent and dependent variables in this experiment.

Answer:

- Independent variable: type of antibiotic (antibiotic solution)
- Dependent variable: zone of inhibition (area of no bacterial growth)

Marking protocol:

One mark for each of the above points.

take a qualitative approach when identifying and analysing experimental data with reference to accuracy, precision, reliability, validity, uncertainty and errors (random and systematic)

Question 3e (2 marks)

Which antibiotic solution produced the most precise results? Justify your response.

Answer:

- Antibiotic solution 2.
- The zone of inhibition varied the least across the three strains of bacteria, from 15-16mm (or only 1mm difference), compared to the other antibiotic solutions, therefore solution 2 produced the most precise results.

Marking protocol:

One mark for each of the above points.

Gene structure and expression regulation mechanisms are the research hotspots and focus of modern life sciences. The lac operon is a cluster of genes through which *Escherichia coli* (a type of bacteria) catabolises lactose. It was first proposed by F. Jacob and J. Monod, who were also awarded the Nobel Prize in Physiology or Medicine in 1965 for their contributions. Thereafter, the lac operon became the classic teaching case of the gene regulation mechanism in microbiology, genetics, and molecular biology.

Source: <https://www.ncbi.nlm.nih.gov/pubmed/31257202>

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.

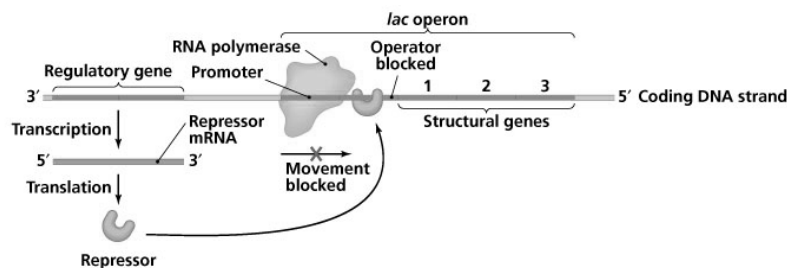
Question 4a (4 marks)

Draw and label a diagram that demonstrates what occurs at the lac operon in the absence of lactose. The following should be included in your diagram:

- Operator
- Promoter
- RNA polymerase
- Repressor molecule
- Structural genes
- Regulatory gene

Answer:

- A diagram similar to the one below should be produced by students.



Source: <https://www.biologicscorp.com/blog/iptg-induction-protein-expression/>

Marking protocol:

One mark for every two of the terms stated in the question that are included in the correct position on the diagram, to a maximum of three marks. A final mark is allocated to the student indicating in their diagram that either the movement of RNA Polymerase is blocked or a statement indicating that the structural genes are not expressed.

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.

Question 4b (2 marks)

With reference to the lac operon, why is it beneficial for prokaryotic cells to regulate gene expression?

Answer:

- Gene regulation assists organisms to only express genes when the product of this expression is required; this contributes to reducing unnecessary energy expenditure for organisms such as prokaryotic cells.
- For example, in regard to the lac operon, the enzymes that are required to break down lactose are only expressed when lactose is present.

Marking protocol:

One mark for each of the above points.

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.

Question 4c (2 marks)

If a significant mutation was to occur in the regulatory gene associated with the lac operon, how could this be detrimental to the bacteria cell?

Answer:

- *A significant mutation in the regulatory gene may lead to a repressor molecule being produced that is no longer complementary to the operator on the lac operon.*
- *If the repressor molecule can no longer bind to the operator, RNA polymerase will express the structural genes indefinitely, meaning the bacterial cell could be expending energy unnecessarily which could be detrimental to its survival.*

Marking protocol:

One mark for each of the above points.

Although scientists have been working on developing a vaccination for HIV for many years, this has not yet been created, unlike a condition such as measles where an effective vaccination exists. People who contract HIV are required to take anti-retroviral medication in an attempt to prevent HIV from developing into AIDS, a form of immunodeficiency disease.

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

Question 5a (3 marks)

Are vaccinations an active or passive strategy for acquiring immunity? Justify your answer.

Answer:

- *Vaccinations are an active strategy.*
- *Vaccinations lead to the activation of an individual's own immune system, (leading to the formation of antibodies and the development of memory cells,) whereas...*
- *...passive strategies involve antibodies being introduced into the body that were created from a source outside an individual's body (and no memory cells are created by the body).*

Marking protocol:

One mark for each of the above points.

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

Question 5b (3 marks)

Describe how a vaccination contributes to developing immunity to a health condition such as measles.

Answer:

- *When a vaccination is given to a person, antigens from the pathogen that causes a particular disease (such as the virus that causes measles) are introduced into a person's body. (This can take various forms, such as an attenuated virus.)*
- *The introduction of the antigens triggers an immune response in the body, leading to the production of specific antibodies and memory cells.*
- *These memory cells remain in the body, potentially for life, and contributes to a rapid immune response in the case of future reinfection by the pathogen that causes the disease, which stops that health condition from developing. Therefore, a vaccination can lead to a person having immunity from a health condition such as measles.*

Marking protocol:

One mark for each of the above points.

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)

Question 5c (2 marks)

Outline why it may be difficult for scientists to develop an effective vaccination for a virus such as HIV.

Answer:

- *As some viruses replicate, there are mutations in their genome. This can contribute to new antigens forming on the surface of these viruses.*
- *A single vaccination may find it difficult to account for such mutations and antigenic variants, therefore making it difficult to develop an effective vaccination, as is the case for HIV.*

Marking protocol:

One mark for each of the above points.

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)

Question 5d (3 marks)

How does HIV contribute to a person developing an immune deficiency disease if antiretroviral treatment (ART) is not available? In your answer, reference the following:

- Helper T cells
- Host cell
- Viral replication
- Weakened immune response

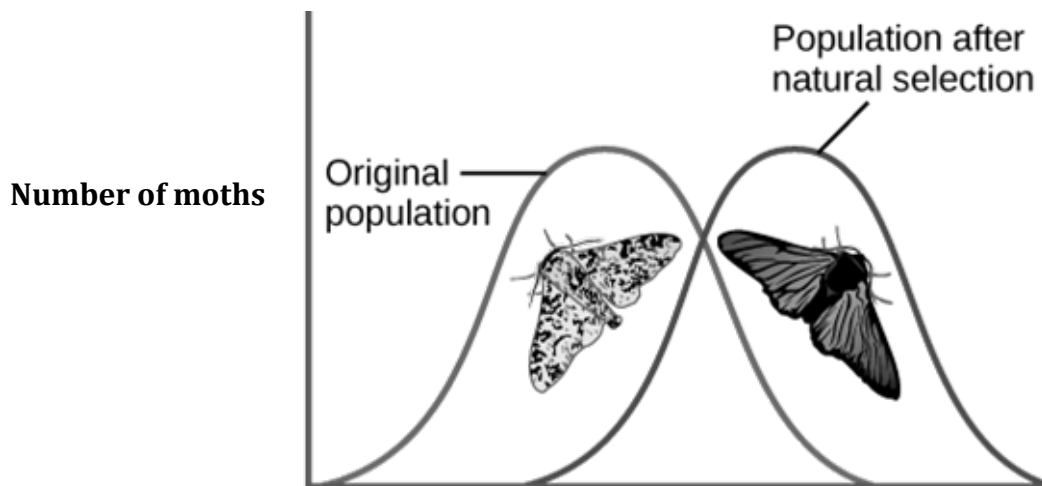
Answer:

- *Viruses such as HIV are required to infect a host cell in order to undergo viral replication.*
- *A specific type of Helper T cell is the host cell that HIV infects. As part of the replication process, these Helper T cells are destroyed.*
- *Helper T cells assist the immune system to respond to infection by activating other immune cells. Therefore, if ART is not taken, and they are reduced in numbers due to infection by HIV, the body has a weakened immune response at its disposal.*

Marking protocol:

One mark for each of the above points. For each term that is not referenced, a mark is deducted – if only one term is referenced, no marks are awarded.

In eighteenth and nineteenth-century England, the peppered moth evolved due to natural selection. Prior to the Industrial Revolution, before factories began polluting the air with dark soot, there were dark and light peppered moths. At this time, the moths were predominately light in colour, similar to the light-coloured trees and lichens in their environment. During the Industrial Revolution, there was a change in the predominant colour of the peppered moth population, as indicated in the diagram below.



Shade of moths before and after the Industrial Revolution (light to dark)

Source: <https://courses.lumenlearning.com/wm-biology2/chapter/adaptive-evolution/>

environmental selection pressures on phenotypes as the mechanism for natural selection

Question 6a (1 mark)

Describe natural selection.

Answer:

- *A process where some individuals in a population are better suited to survive and reproduce, as a result of their phenotypes being better adapted to existing selection pressures.*

Marking protocol:

One mark for the above point.

environmental selection pressures on phenotypes as the mechanism for natural selection

Question 6b (3 marks)

Outline how natural selection contributed to the changes observed in the graph for the peppered moth population.

Answer:

- *At the start of the Industrial Revolution, there was variation in the peppered moth phenotypes; there were light and dark peppered moths. However, as indicated in the graph, there was a greater number of light-coloured moths.*
- *The Industrial Revolution led to factories polluting the air with dark soot (and as a consequence, trees developed a darker appearance), therefore, the light moths were more likely to be visible to predators and selected against. The dark moths were given a selective advantage, such as camouflage on the darker trees, and were more likely to survive and reproduce.*
- *The offspring of the dark moths were likely to inherit the allele for dark pigmentation, and over many generations, the number of moths that were darker in colour increased (and the number of light-coloured moths decreased), as indicated in the graph.*

Marking protocol:

One mark for each of the above points.

Martha's Vineyard is an island off the east coast of the United States. It was first settled in the seventeenth century by a group of English immigrants. During the 1700s and 1800s, the island had an extraordinarily large proportion of individuals with genetically inherited deafness. At this time, the US mainland had approximately a 1 in 6000 deaf population, while Martha's Vineyard had approximately a 1 in 155 deaf population.

In the last century, the difference between the proportion of the deaf population in Martha's Vineyard and mainland USA has diminished. Today, Martha's Vineyard does not have a significantly large deaf population.

Source: <https://www.verywellhealth.com/deaf-history-marthas-vineyard-1046546#citation-1>

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

Question 7a (2 marks)

Identify and describe the type of genetic drift that was likely to have contributed to the disproportional number of people with deafness on Martha's Vineyard in the 1700s and 1800s.

Answer:

- *Founder effect.*
- *The reduction in genetic variation that occurs when a new population is established by a very small number of individuals from a larger population.*

Marking protocol:

One mark for each of the above points.

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

Question 7b (3 marks)

Explain how your answer to Question 7a would have contributed to the extraordinarily large proportion of individuals with genetically inherited deafness on Martha's Vineyard.

Answer:

- *Within the English immigrant population who settled Martha's Vineyard, there was likely to have been a high number of individuals with the allele for genetically inherited deafness.*
- *Reproduction on the island was likely to have been restricted to individuals who settled there...*
- *...therefore, this would have contributed to an increase in frequency of the allele, and over time, led to the extraordinarily large proportion of individuals with genetically inherited deafness on Martha's Vineyard.*

Marking protocol:

One mark for each of the above points.

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

Question 7c (2 marks)

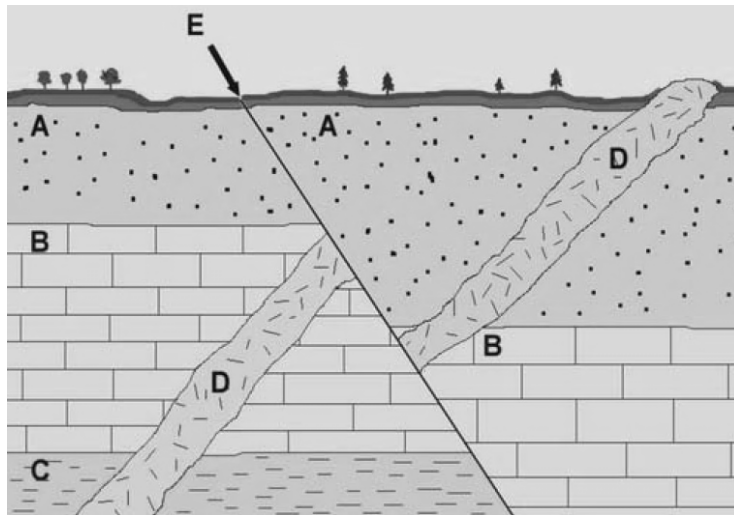
Outline what may have contributed to the reduction in the difference in the numbers of people with genetically inherited deafness on Martha's Vineyard and the USA mainland over the last century.
Reference gene flow in your answer.

Answer:

- *Over the last century there is likely to have been increased gene flow from the USA mainland, where fewer people have genetically inherited deafness when compared to Martha's Vineyard.*
- *This interbreeding, between the mainland and island population, is likely to have reduced the numbers of people with genetically inherited deafness on Martha's Vineyard, reducing the difference between these populations.*

Marking protocol:

One mark for each of the above points.



Source: <https://www.iris.edu/hq/inclass/downloads/optional/235>

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

Question 8a (2 marks)

What is stratigraphy, and how is this linked to the relative dating of fossils?

Answer:

- Stratigraphy is concerned with studying rock layers.
- This is associated with relative dating of fossils which is also associated with rock layers. This assumes that fossils found in layers of rock deeper underground are older than fossils found in layers of rock closer to the surface.

Marking protocol:

One mark for each of the above points.

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

Question 8b (2 marks)

Based on the diagram above, from oldest to youngest, list the order of the likely age of the layers of rock A, B, C, and D. Justify your response.

Answer:

- C, B, A, D
- As D cuts through C, B and A, it is likely to be the youngest layer of rock. The principle of superposition, states that the oldest layer of rock, C, is at the bottom.

Marking protocol:

One mark for each of the above points.

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

Question 8c (3 marks)

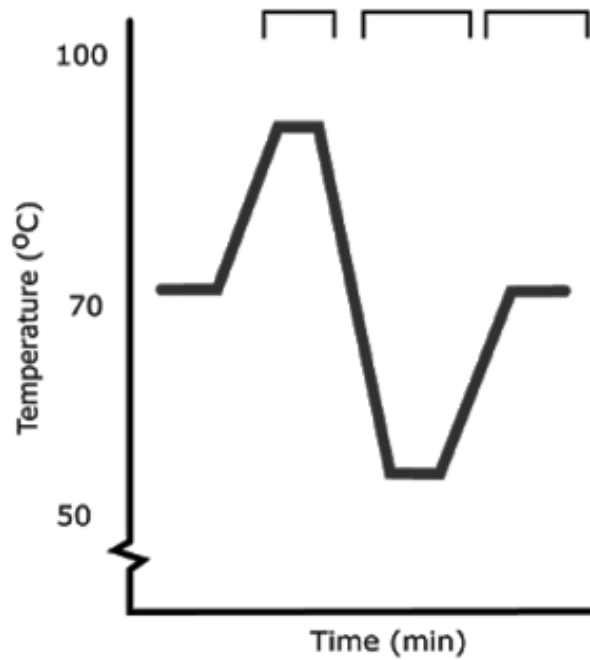
With reference to E in the stimulus material, describe a limitation of dating fossils using relative dating. Suggest a fossil dating technique for overcoming this limitation.

Answer:

- As indicated by E in the stimulus material, faults can form in the earth's crust, moving layers of rocks as a result.
- Such faults could move rocks to an extent that they are no longer in their correct chronological age from bottom to top, thus, relative dating techniques may no longer become reliable.
- To overcome this, absolute dating of a fossil could be used instead, where a more accurate age of a fossil could be determined using radiometric dating.

Marking protocol:

One mark for each of the above points.



Source: <https://virologydownunder.blogspot.com/2015/05/the-mechanics-of-polymerase-chain.html>

amplification of DNA using the polymerase chain reaction

Question 9a (1 mark)
Name the process used to amplify DNA that is represented in the graph above.

Answer:

- *Polymerase chain reaction.*

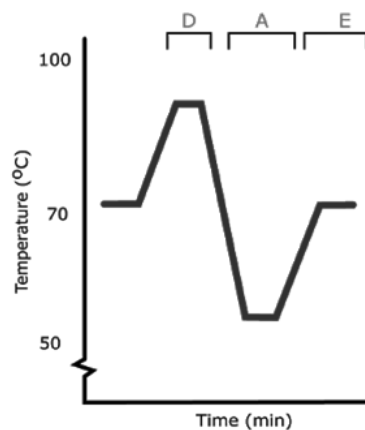
Marking protocol:

One mark for the above point.

amplification of DNA using the polymerase chain reaction

Question 9b (1 mark)
There are three stages that make up the process used to amplify DNA in Question 9a. The first letter of these stages is represented by the letters A, D and E. In chronological order, label these on the graph.

Answer:



Marking protocol:

One mark for the correct labelling, as above.

amplification of DNA using the polymerase chain reaction

Question 9c (4 marks)

With reference to the graph and your labelling, describe each of the stages in this process.

Answer:

- *Denaturing (D): The polymerase chain reaction (PCR) mix is exposed to a temperature of approximately 90°C - 100°C (92°C), as demonstrated in the graph, in order to separate (the hydrogen bonds between) the two template strands of DNA.*
- *Annealing (A): The PCR mix is cooled to 50°C - 60°C (55°C), as demonstrated in the graph, which enables the primers to bond to the ends of the DNA template.*
- *Extension or elongation (E): The PCR mix is heated to 72°C, as demonstrated in the graph. This enables taq polymerase to bind to the primers, read the template strands, and assemble the complementary strands.*

Marking protocol:

One mark for the description in each of the above points. A fourth mark for correctly linking labels from the graph to each description.

Note: if a student can describe the process of PCR, but does not make any reference to the graph, or incorrect references, the maximum marks they can achieve is three.

Golden bananas high in pro-vitamin A developed

Ugandan bananas that are high in pro-vitamin A have recently been developed by researchers. The decade-long research, led by Professor James Dale, involved extensive laboratory tests, as well as field trials in north Queensland.

Professor Dale said the genetic modification process had resulted in the identification and selection of banana genes that could be used to enhance pro-vitamin A in banana fruit. The research ultimately aims to improve the nutritional content of bananas in Uganda, where the fruit is a major staple food in their diet. The consequences of vitamin A deficiency are severe, and it has been estimated that approximately 700,000 children world-wide die from pro-vitamin A deficiency each year, with a further several hundred thousand going blind.

"What we've done is take a gene from a banana that originated in Papua New Guinea and is naturally very high in pro-vitamin A but has small bunches, and inserted it into a Ugandan banana," Professor Dale said.

Source: <https://www.sciencedaily.com/releases/2017/07/170707095806.htm>

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

Question 10a (3 marks)

Based on the information provided, identify whether the Ugandan bananas high in pro-vitamin A are best described as genetically modified organisms or transgenic organisms. Justify your response.

Answer:

- *Genetically modified organisms*
- *The Ugandan bananas high in pro-vitamin A have been enhanced through the introduction of a gene from the same species...*
- *...unlike transgenic organisms, where a new gene is introduced into an organism from another species.*

Marking protocol:

One mark for each of the above points.

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

Question 10b (2 marks)

Outline a potential positive and negative social implication of growing bananas high in pro-vitamin A for distribution in Uganda.

Answer:

Positive implications:

- *Bananas contribute to more adults having adequate nutrition to attend work, contributing to an increased standard of living.*
- *Bananas improve socioeconomic levels because of a reduction in death and disease.*
- *Bananas contribute to more children having adequate nutrition to attend schools, which would improve levels of education.*

Negative implications:

- *Traditional banana growers may lose business, and this may lead to them earning a reduced income and a reduced standard of living.*
- *Unintended health consequences may result from the new bananas which may lead to decreased socioeconomic levels due to disease.*
- *The growth and consumption of these new bananas may lead to concern and stress in the community regarding the potential job losses/health consequences.*

Marking protocol:

One mark for each of the above points. One positive and one negative social implication are required for a maximum of two marks.

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

Question 10c (2 marks)

Describe how the Ugandan bananas high in pro-vitamin A could potentially lead to a reduction in crop productivity.

Answer:

- *There is the potential for these new bananas to be more susceptible to predation or disease...*
- *...therefore, crops of these bananas may not yield as much fruit as the previous crops, reducing crop productivity.*

OR

- *There is the potential for these new bananas to require greater amounts of water/soil nutrients that may not be available in Uganda...*
- *...therefore, crops of these bananas may not yield as much fruit as the previous crops, reducing crop productivity.*

Marking protocol:

One mark for each of the above points.

**STUDENT
NAME:**

Use a **PENCIL** for **ALL** entries. For each question, shade the box which indicates your answer.

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

NO MARK will be given if more than one answer is completed for any question.

If you make a mistake, **ERASE** the incorrect answer – **DO NOT** cross it out.

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16	<input type="checkbox"/> A	<input type="checkbox"/> B	<input type="checkbox"/> C	<input checked="" type="checkbox"/> D	36	<input type="checkbox"/> A	<input type="checkbox"/> B	<input checked="" type="checkbox"/> C	<input type="checkbox"/> D
17	<input checked="" type="checkbox"/> A	<input type="checkbox"/> B	<input type="checkbox"/> C	<input type="checkbox"/> D	37	<input type="checkbox"/> A	<input type="checkbox"/> B	<input type="checkbox"/> C	<input checked="" type="checkbox"/> D
18	<input type="checkbox"/> A	<input type="checkbox"/> B	<input type="checkbox"/> C	<input checked="" type="checkbox"/> D	38	<input type="checkbox"/> A	<input type="checkbox"/> B	<input type="checkbox"/> C	<input checked="" type="checkbox"/> D
19	<input type="checkbox"/> A	<input checked="" type="checkbox"/> B	<input type="checkbox"/> C	<input type="checkbox"/> D	39	<input type="checkbox"/> A	<input type="checkbox"/> B	<input checked="" type="checkbox"/> C	<input type="checkbox"/> D
20	<input type="checkbox"/> A	<input type="checkbox"/> B	<input type="checkbox"/> C	<input checked="" type="checkbox"/> D	40	<input type="checkbox"/> A	<input checked="" type="checkbox"/> B	<input type="checkbox"/> C	<input type="checkbox"/> D