**Victorian Certificate of Education
2019**

Letter

STUDENT NUMBER

BIOLOGY
Written examination

Friday 1 November 2019

**Reading time: 9.00 am to 9.15 am (15 minutes)
Writing time: 9.15 am to 11.45 am (2 hours 30 minutes)**

QUESTION AND ANSWER BOOK

Structure of book

Section	Number of questions	Number of questions to be answered	Number of marks
A	40	40	40
B	11	11	80
			Total 120

- Students are permitted to bring into the examination room: pens, pencils, highlighters, erasers, sharpeners and rulers.
- Students are NOT permitted to bring into the examination room: blank sheets of paper and/or correction fluid/tape.
- No calculator is allowed in this examination.

Materials supplied
- Question and answer book of 36 pages
- Answer sheet for multiple-choice questions

Instructions
- Write your **student number** in the space provided above on this page.
- Check that your **name** and **student number** as printed on your answer sheet for multiple-choice questions are correct, **and** sign your name in the space provided to verify this.
- Unless otherwise indicated, the diagrams in this book are **not** drawn to scale.
- All written responses must be in English.

At the end of the examination
- Place the answer sheet for multiple-choice questions inside the front cover of this book.

Students are NOT permitted to bring mobile phones and/or any other unauthorised electronic devices into the examination room.

SECTION A – Multiple-choice questions

Instructions for Section A

Answer **all** questions in pencil on the answer sheet provided for multiple-choice questions.

Choose the response that is **correct** or that **best answers** the question.

A correct answer scores 1; an incorrect answer scores 0.

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

No marks will be given if more than one answer is completed for any question.

Unless otherwise indicated, the diagrams in this book are **not** drawn to scale.

Question 1

Consider the movement of macromolecules across the plasma membrane, as shown in the diagram below.
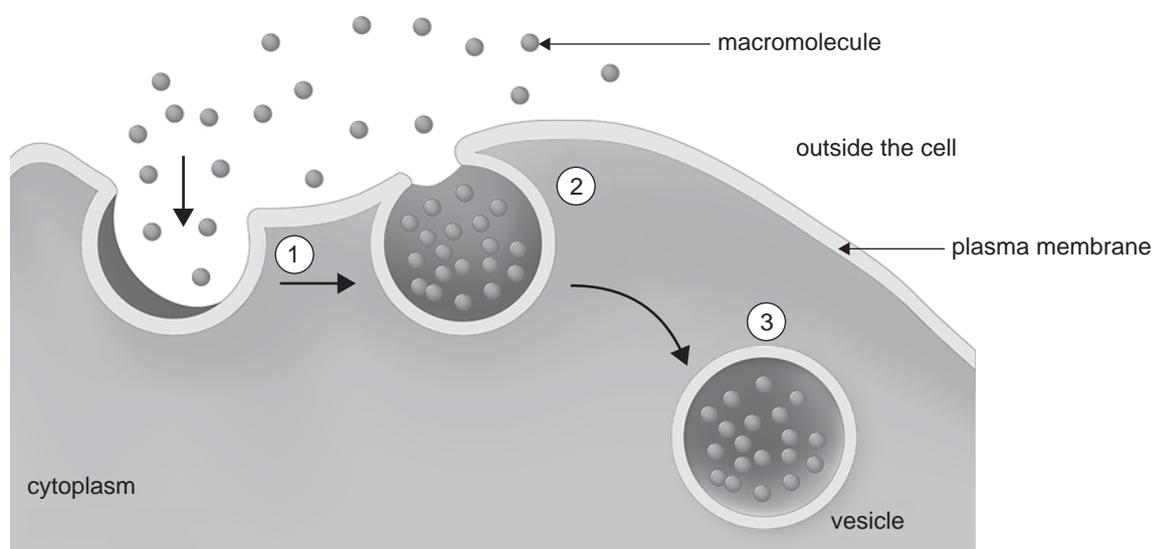
Source: Designua/Shutterstock.com

What type of transport is shown?

A. facilitated diffusion

B. simple diffusion

C. endocytosis

D. exocytosis

Question 2

Which one of the following organelles has the role of synthesising proteins from their monomers?

A. Golgi apparatus

B. ribosomes

C. vesicles

D. nucleus

Use the following information to answer Questions 3 and 4.

Structural genes can be switched off and turned on by transcriptional factors expressed by regulatory genes. In prokaryotes, a group of genes associated with the breakdown of lactose is grouped together in a single operon called the *lac* operon. The diagram below shows the position of the genes on the prokaryotic chromosome.
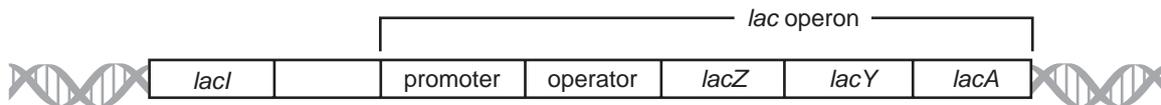
Question 3

Transcription of the structural genes within the *lac* operon will occur when

A. a repressor molecule is attached to the operator.

B. RNA polymerase is attached to the promoter.

C. lactose is absent from the prokaryotic cell.

D. transcription of the *lacI* gene is optimal.

Question 4

Transcription of the structural genes within the *lac* operon results in the production of molecules of

A. a transcription factor.

B. a repressor protein.

C. lactose.

D. mRNA.

Question 5

Which one of the following statements about proteins is correct?

A. The activity of a protein may be affected by the temperature and pH of its environment.

B. The primary structure of a protein refers to its three-dimensional protein shape.

C. Proteins are not involved in the human immune response.

D. A protein with a quaternary structure will be an enzyme.

Question 6

Acetylcholinesterase is an enzyme that catalyses the breakdown of the neurotransmitter acetylcholine into acetate and choline.

Some chemicals used to kill insects contain aldicarb.

Aldicarb is a reversible inhibitor of acetylcholinesterase that

A. permanently blocks the active site of acetylcholinesterase.

B. acts by strongly binding to the active site of acetylcholinesterase.

C. increases the rate at which acetylcholine is broken down into acetate and choline.

D. reduces acetylcholinesterase activity by reducing the number of active sites for acetylcholine to bind to.

Use the following information to answer Questions 7–9.

An experiment was carried out by students to test the effect of temperature on the growth of bacteria. Bacterial cells were spread onto plates of nutrient agar that were then kept at three different temperatures: –10 °C, 15 °C and 25 °C. All other variables were kept constant. The experiment was carried out over four days. The nutrient agar was observed every day at the same time and the percentage of nutrient agar covered by bacteria was recorded. At the conclusion of the experiment, the results were recorded in a table, which is shown below.

Time (days)	Percentage of nutrient agar covered by bacteria at three different temperatures		
	–10 °C	15 °C	25 °C
0	0	0	0
1	0	5	10
2	0	10	20
3	0	15	40
4	0	20	60

Question 7

Which one of the following hypotheses is supported by the results?

A. If the bacteria grow for four days, then the nutrient agar will be completely covered in bacteria.

B. If the bacteria are kept in the dark, then the bacteria will grow more slowly.

C. If the bacteria grow faster, then the temperature of the location will increase.

D. If the temperature increases, then the bacteria will grow more quickly.

Question 8

In this experiment, the dependent variable is

A. time.

B. temperature.

C. the number of bacterial cells.

D. the percentage of nutrient agar covered by bacteria.

Question 9

The students wanted to check the reliability of their data.

The students should

A. repeat the experiment several times to find out if they would obtain the same data.

B. organise their data into a different format to help identify a trend.

C. change the independent variable in the experiment.

D. rewrite the method for completing the experiment.

Question 10

Large hydrophilic molecules cannot easily cross a plasma membrane due to the presence of which one of the following molecules in the membrane?

A. proteins

B. cholesterol

C. glycoproteins

D. phospholipids

Question 11

Two different cells taken from the same human were viewed using a microscope.

The diagrams below show the structure of the two cells, not drawn to the same scale.
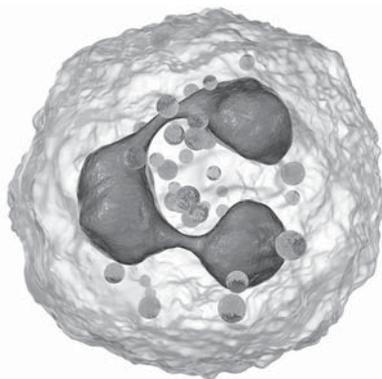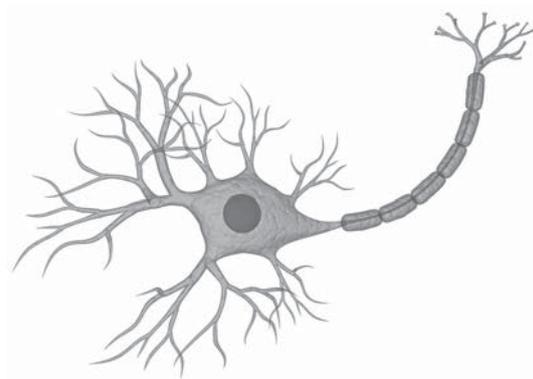
a neutrophil   a neuron

Sources (from left): Kateryna Kon/Shutterstock.com; Sebastian Kaulitzki/Shutterstock.com

Which one of the following is a correct conclusion to reach when comparing the two cells?

A. At any given time, the genes expressed in each cell may be different.

B. All proteins in each cell will have similar tertiary structures.

C. The two cells have the same proteome.

D. The two cells have different genomes.

Question 12

During which process would the production of lactic acid be observed?

A. aerobic cellular respiration

B. fermentation in animals

C. fermentation in yeasts

D. photosynthesis

Question 13

The rate of aerobic cellular respiration in a human cell may increase if the

A. temperature of the cell is lowered from 37 °C to 35 °C.

B. oxygen concentration available to the mitochondria increases.

C. carbon dioxide concentration in the cytosol of the cell increases.

D. rate of facilitated diffusion of glucose into the cytosol of the cell decreases.

Question 14

In glycolysis, the ATP yield per molecule of glucose is

A. 4 ATP produced and 2 ATP used for a net gain of 2 ATP.

B. 2 ATP produced and 4 ATP used for a net loss of 2 ATP.

C. 36 to 38 ATP produced for a net gain of 2 ATP.

D. 36 to 38 ATP used for a net loss of 2 ATP.

Question 15

An experiment was carried out at a constant temperature and with a constant carbon dioxide concentration in order to determine the effect of changing light intensity on the photosynthetic rate. The following is a graph of the results.

The effect of changing light intensity on the photosynthetic rate
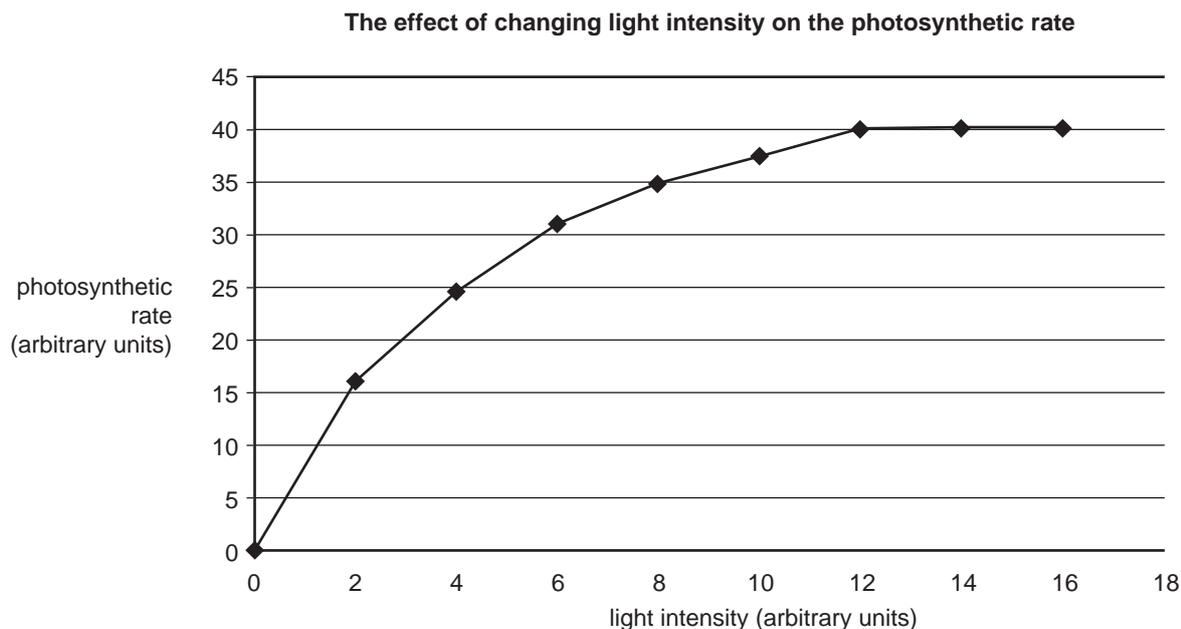
Based on your knowledge and the information in the graph, which one of the following conclusions can be reached?

A. Photosynthesis ceases to occur at a light intensity of 14 arbitrary units.

B. Plants do not undergo photosynthesis at a light intensity of 1 arbitrary unit.

C. Light intensity is a limiting factor when the photosynthetic rate is less than 40 arbitrary units.

D. Increasing the amount of carbon dioxide at a light intensity of 16 arbitrary units would lead to a decrease in the photosynthetic rate.

Question 16

Hydrophobic signalling molecules interact with cells.

In which part of a cell would a receptor that binds to one of these signalling molecules be found?

A. on the mitochondrial membrane

B. in the Golgi apparatus

C. on the cell surface

D. in the cytosol

DO NOT WRITE IN THIS AREA

Question 17

Cells are able to release signalling molecules within the body and outside the body in many different ways. Consider the table below.

Which row correctly matches the signalling molecules to their listed properties?

	Produces a rapid response	Can target many cells or organs at once, but are not the most rapid	Can affect another organism at a distance	Targets nearby cells during inflammation
A.	neurotransmitters	cytokines	pheromones	hormones
B.	cytokines	pheromones	hormones	neurotransmitters
C.	neurotransmitters	hormones	pheromones	cytokines
D.	hormones	neurotransmitters	cytokines	pheromones

Question 18

Changes in cellular apoptotic function can influence the chances of cells becoming cancer cells.

Which one of the following changes could result in a cancer?

A. an increase in apoptosis, which will activate cancer-detecting immune cells
B. a decrease in apoptosis, resulting in increased survival of pre-cancer cells
C. an increase in apoptosis, which will also increase inflammation
D. a decrease in apoptosis, causing surrounding cells to die

Question 19

In adaptive immunity, which cells directly destroy virally infected cells?

A. B cells
B. plasma cells
C. T helper cells
D. T cytotoxic cells

Question 20

The diagram below shows the process of phagocytosis. This process is vital for immunity against extracellular infections.
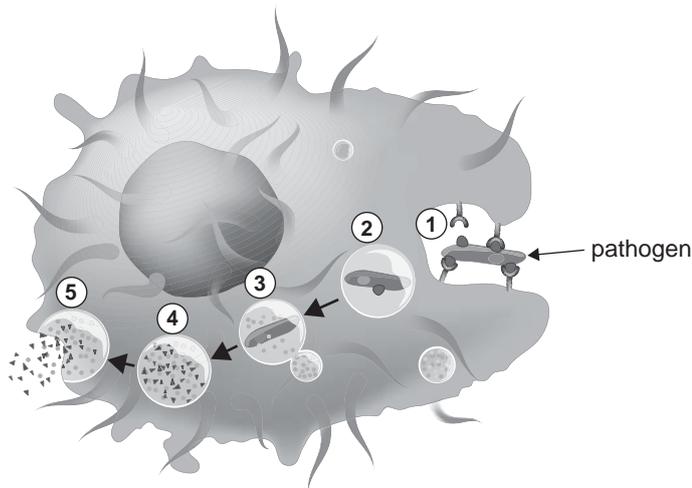

Source: Designua/Shutterstock.com

What is happening at position 3?

A. Enzymes that break down the microorganism are released into the vesicle.

B. Antibodies are added to the vesicle to kill the microorganism.

C. The cell is sampling the vesicle for antigen presentation.

D. Intracellular microbes are attacking the microorganism.

Question 21

Consider the diagram below of clonal selection in B cells.
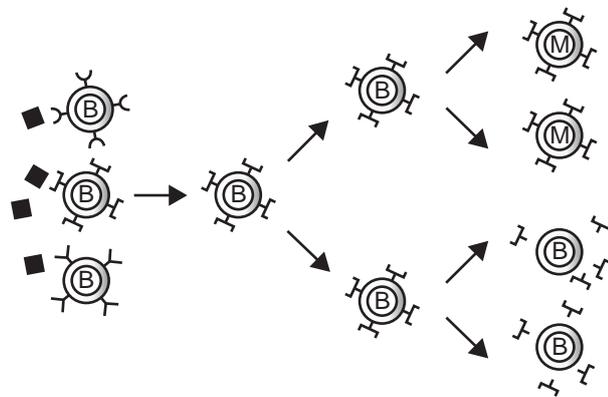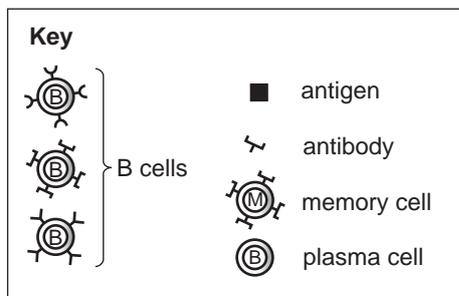
Source: adapted from Tang Zheng et al., 'An Improved Clonal Selection Algorithm and its Application to Traveling Salesman Problems', in *IEICE Transactions on Fundamentals of Electronics, Communications and Computer Sciences*, vol. E90–A, no. 12, December 2007, p. 2931

In adaptive immunity, which part of this process allows long-term (sometimes lifetime) protection against pathogens?

A. recognition of one antigen by one B cell clone

B. production of specific antibodies

C. generation of memory cells

D. production of plasma cells

Question 22

In multiple sclerosis, which specific part of the nervous system do immune cells attack?

A.   the receptors of post-synaptic nerve cells

B.   the myelin sheath around nerve cells

C.   the nuclei of nerve cells

D.   the neurotransmitters

Question 23

**HIV RNA count in the blood and the effect of the virus
on the number of specific immune cells**
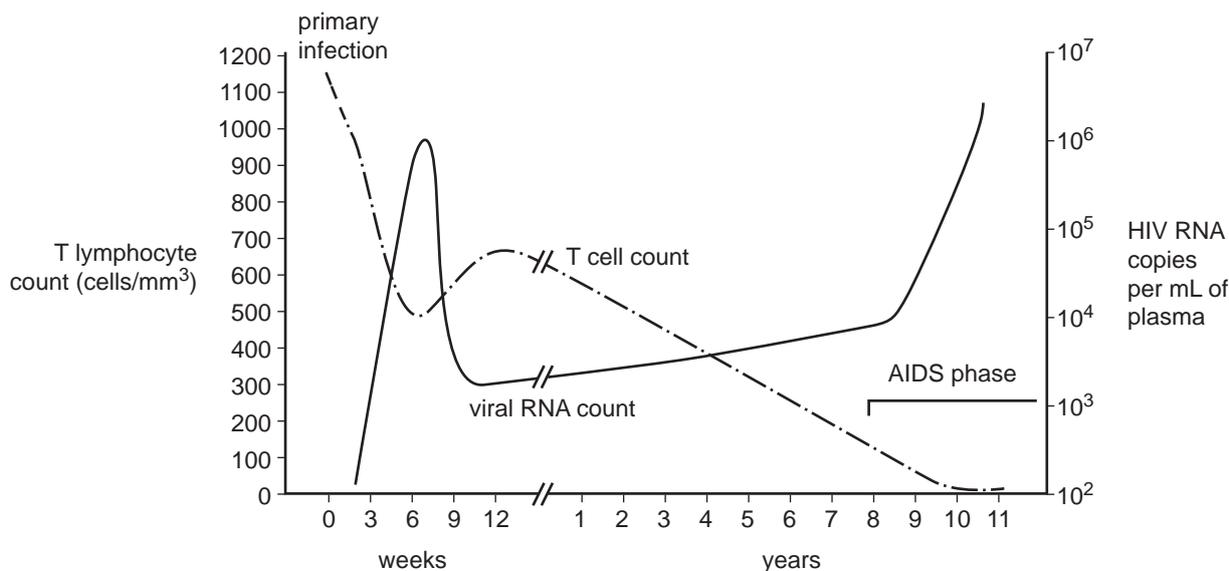
Source: adapted from Paola Paci et al., 'A Discrete/Continuous Model of Anti-HIV Response and Therapy',
conference paper, Tenth International Conference on Computer Modeling and Simulation, May 2008, p. 484

The graph above shows the HIV RNA count in the blood and the effect of the virus on the number of specific immune cells in an untreated patient.

Based on your knowledge and the information in the graph above, what is the effect of the change in the number of T cells over time?

A.   a decrease in the viral RNA count during the AIDS phase

B.   loss of effective function of the adaptive immune system

C.   failure of macrophages to engulf HIV

D.   failure of complement proteins

Use the following information to answer Questions 24 and 25.

Consider the following phylogenetic tree, which summarises the evolutionary relationships between certain fish species.
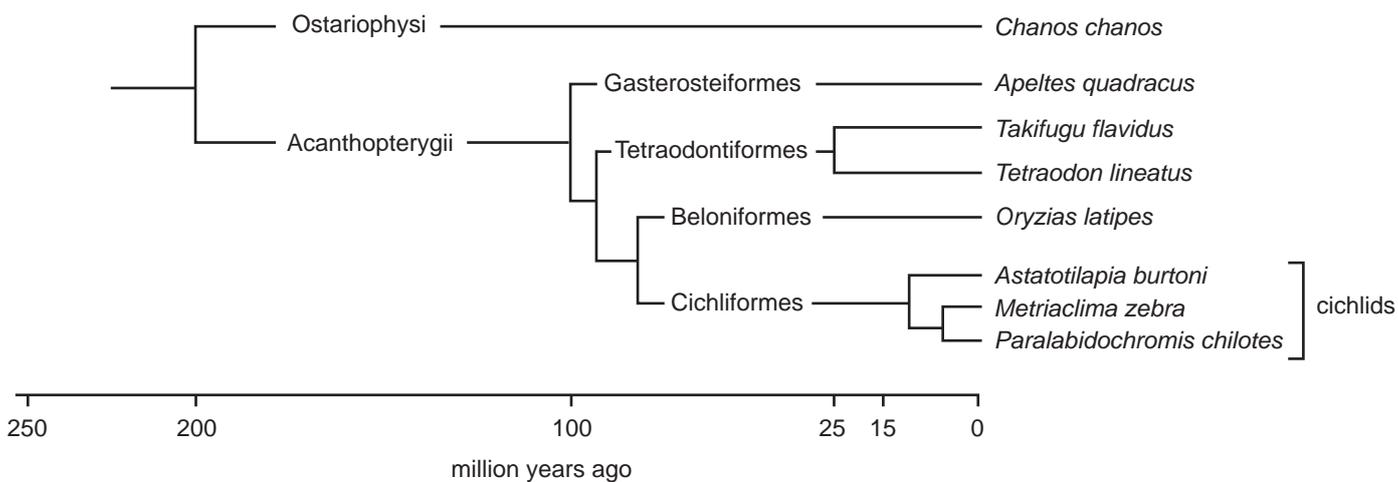
Question 24

O. latipes is most closely related to

A.   *A. quadracus*.

B.   *T. lineatus*.

C.   *P. chilotes*.

D.   *T. flavidus*.

Question 25

Which one of the following statements is correct?

A.   Cichlids diverged to form three distinct species 100 million years ago.

B.   *C. chanos* was the last species to diverge from the most distant common ancestor.

C.   Gasterosteiformes, Beloniformes and Cichliformes do not share a common ancestor.

D.   *T. flavidus* and *T. lineatus* diverged to form two distinct species 25 million years ago.

Question 26

Consider the diagram below showing the gene pool of a population over 20 generations.
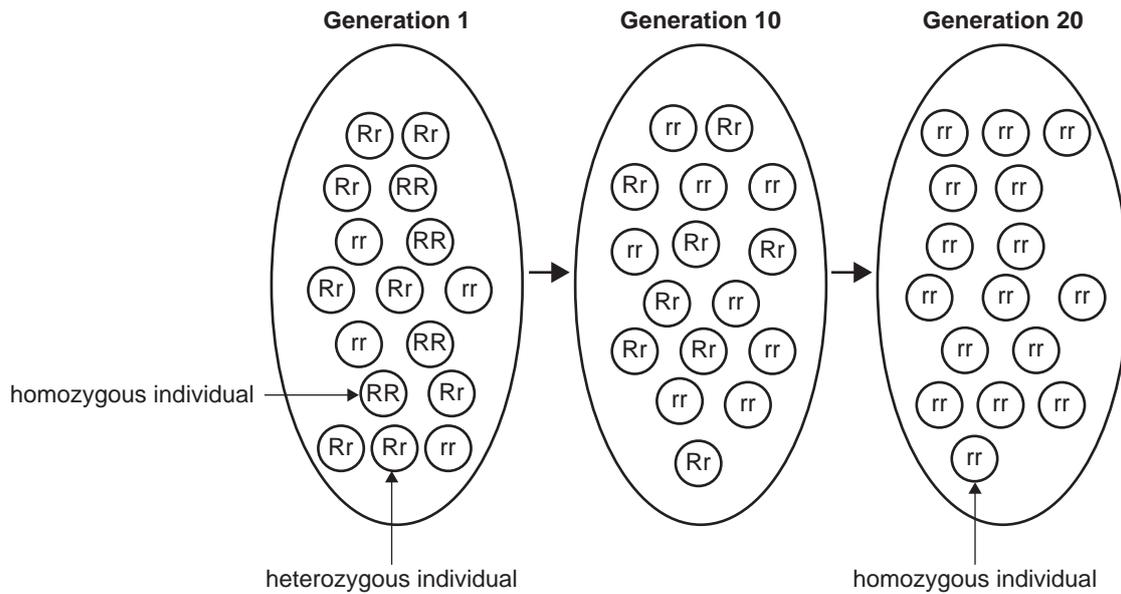
It would be correct to conclude that, over the 20 generations

A.   genetic diversity is increasing in this population.

B.   individuals with the genotype RR had a selective advantage in this population.

C.   the frequency of each allele is equal in Generation 1 but not in other generations.

D.   new advantageous alleles for this gene were introduced as individuals joined this population.

Question 27

Farmers and supermarkets agree that green beans are bought more frequently than yellow beans. A supermarket has asked a farmer to produce only green beans.

One way this could be achieved is by

A.   condensation polymerisation.

B.   DNA hybridisation.

C.   selective breeding.

D.   adaptive radiation.

Question 28

Consider the close-up image below of a dinosaur footprint discovered by scientists.

Source: Marcio Jose Bastos Silva/Shutterstock.com

This type of fossil is best described as

A.   preserved remains.

B.   a petrified fossil.

C.   a trace fossil.

D.   a cast.

Question 29

Refer to the following graph that shows the extinction rate of families.

Extinction rate of families

extinction rate (families per million years)
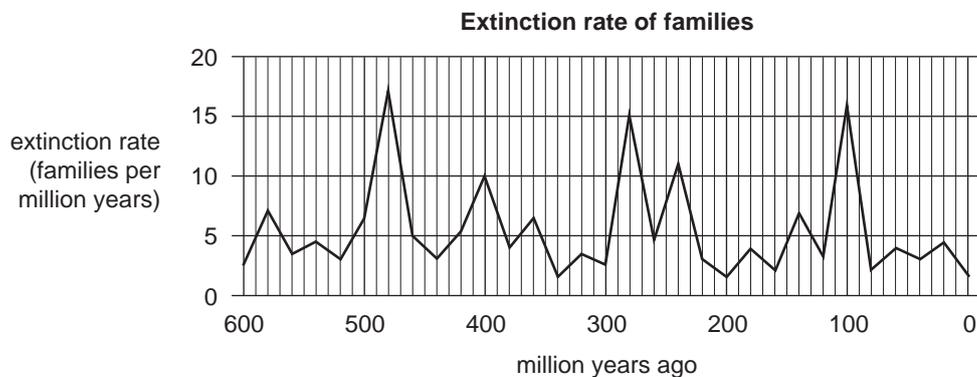
million years ago

Source: adapted from University of California Museum of Paleontology's Understanding Evolution,
<http://evolution.berkeley.edu>

A scientist stated that a mass extinction occurred when the extinction rate was eight families per million years or greater.

The number of mass extinction events recorded on the graph above is

A.   eight.

B.   seven.

C.   six.

D.   five.

Use the following information to answer Questions 30 and 31.

Relenza was developed by researchers in Australia in 1999 as a drug that could be used against influenza viruses. The researchers found that one of the influenza virus's surface proteins was resistant to change. Relenza was developed to interact with this surface protein.

Question 30

This surface protein of the influenza virus is an enzyme necessary for ongoing virus replication.

This enzyme is called

A.   haemagglutinase.

B.   neuraminidase.

C.   zanamivirase.

D.   acyclovirase.

Question 31

In 2009, a report stated that influenza viruses resistant to Relenza had been identified. Resistance occurred because of a mutation in the viral DNA. This mutation caused glutamine to replace lysine in a protein.

For Relenza to no longer be effective, this mutation must have caused a change in the shape and charge of

A.   the enzyme needed for ongoing virus replication.

B.   the ribosomes of the influenza virus.

C.   the capsule of the influenza virus.

D.   Relenza.

Question 32

Inferred average brain size in several hominin species
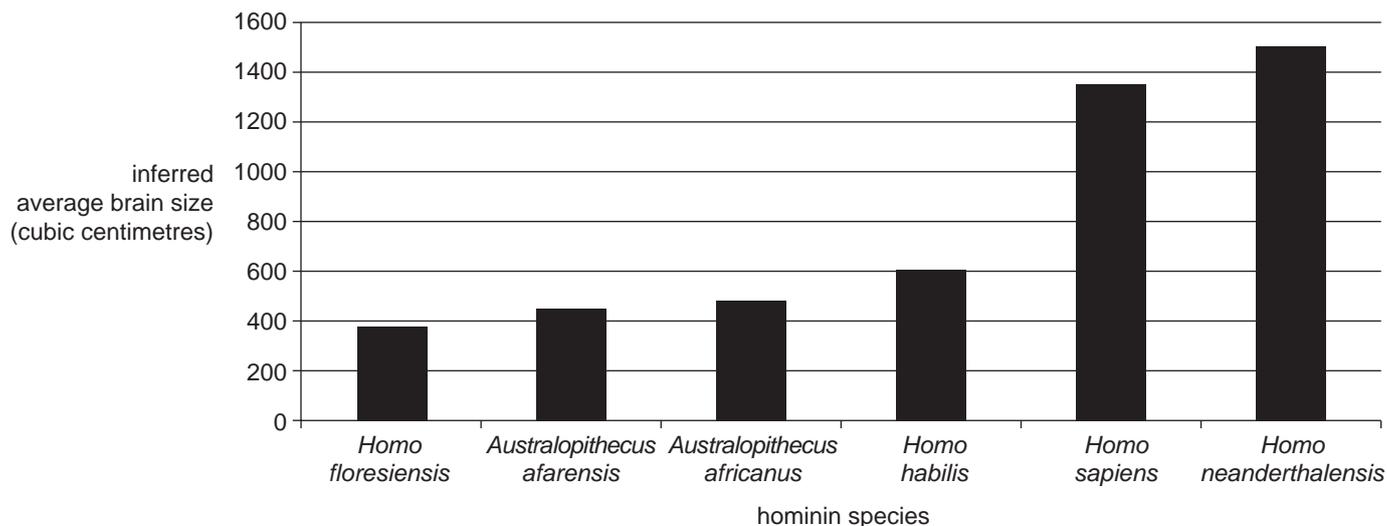
Data: Australian Museum, <https://australianmuseum.net.au>

The graph above shows the inferred average brain size of a number of hominin species.

Based on your knowledge and using the information in the graph, which one of the following species does not follow the general trend in inferred brain size seen in hominin evolution?

A. *H. habilis*

B. *H. sapiens*

C. *A. afarensis*

D. *H. floresiensis*

Question 33

Which row shows the group of characteristics that best reflects the trends in hominin evolution from the *Australopithecus* species to the *Homo* species?

	Characteristics
A.	decreasing tooth size, increasing size of brow ridges, increasingly bowl-shaped pelvis, increasing size of zygomatic arch
B.	decreasing tooth size, decreasing size of brow ridges, decreasing arch of feet, more-opposable big toe
C.	increasing jaw size, decreasing size of zygomatic arch, increasing arch of feet, decreasing tooth size
D.	decreasing size of canines, decreasing size of zygomatic arch, increasingly bowl-shaped pelvis, increasing arch of feet

Question 34

Scientists have been looking for new ways to fight bacterial infections. One of these ways could be using bacteriophages. Bacteriophages are viruses that infect bacteria and cause their membranes to rupture.

This is different from the way that antibiotics like penicillin work because penicillin

A.   slows phospholipid synthesis in bacteria.

B.   stops cell wall synthesis in bacteria.

C.   stops RNA synthesis in bacteria.

D.   destroys bacterial DNA.

Question 35

There is an increasing trend of infectious bacteria showing resistance to antibiotics.

The implication of this resistance in the treatment of bacterial infections is that

A.   antibiotic treatments will be replaced with antiviral drugs.

B.   simple bacterial infections may become life-threatening for patients.

C.   hospital stays for patients with resistant bacteria will become shorter.

D.   a person's immune system will adapt to overcome antibiotic resistance.

Question 36

Certain yeast (*Saccharomyces cerevisiae*) can be modified and made to express a human gene, resulting in the production of insulin.

S. cerevisiae can most accurately be described as a

A.   transgenic organism.

B.   yeast–human hybrid.

C.   genetically mutated organism.

D.   laboratory-produced organism.

Question 37

Bt corn expresses a protein that acts as an insecticide.

Bt corn uptake and insecticide use in cornfields
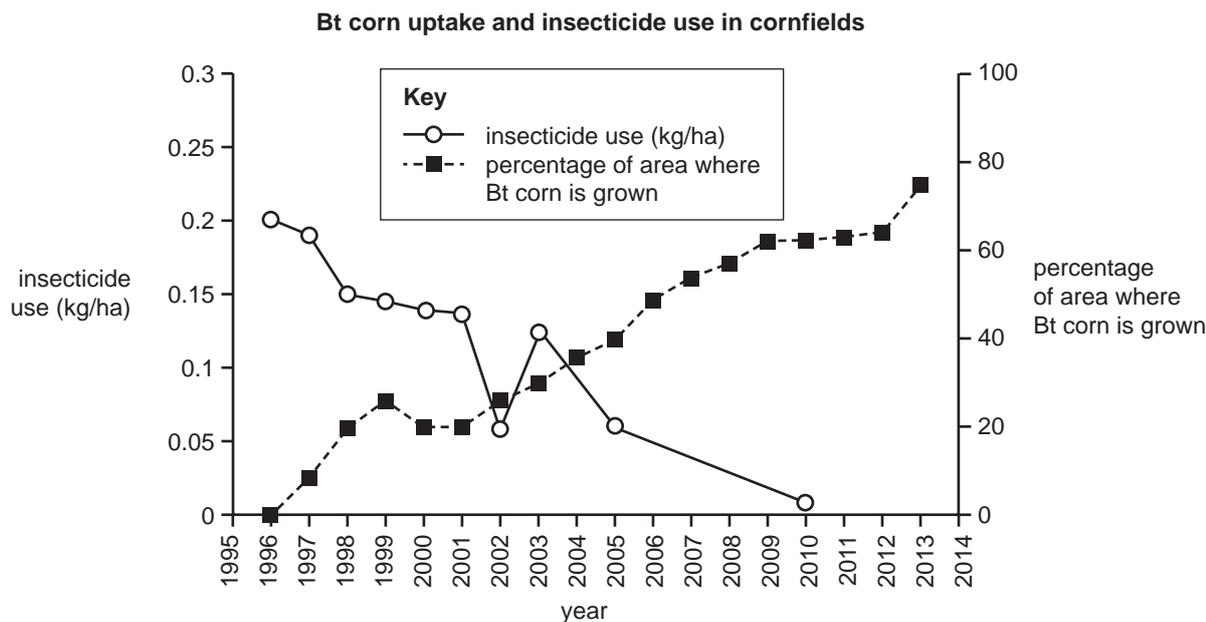
Source: 'Smarter Pest Control', special section, *Science*, vol. 341, 16 August 2013, p. 731

Based on your knowledge and the data in the graph above, what is a benefit of using Bt corn?

A.   More insecticide is used with Bt corn crops.

B.   Bt corn is cheaper to produce than non-Bt corn.

C.   Negative impacts on ecosystems could be reduced.

D.   Fewer farmers are predicted to plant Bt corn in the future.

Question 38

DNA ligase

A.   joins two DNA fragments together by forming phosphodiester bonds between the two fragments.

B.   acts as molecular scissors, cutting DNA molecules at specific nucleotide sequences.

C.   separates two DNA strands during transcription so that a copy can be made.

D.   is an enzyme involved in protein synthesis.

Question 39

The diagram below is a map of a bacterial plasmid showing ORI, the origin of DNA replication, and selected restriction endonuclease sites.
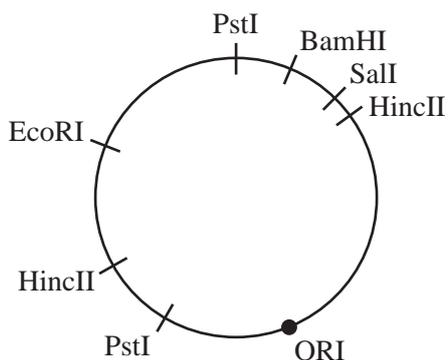
One plasmid was mixed with the restriction enzymes EcoRI, BamHI and HincII.

Which of the following shows the number of restriction sites that have been cut and the resulting number of DNA fragments produced?

	Number of restriction sites cut	**Number of DNA fragments produced**
A.	3	3
B.	3	4
C.	4	4
D.	4	5

Question 40

Source: Smallcreative/Shutterstock.com

What evidence in the image above enables the primate shown to be classified as a hominoid?

A.   the presence of an opposable thumb
B.   the absence of claws on the toes
C.   the presence of hair
D.   the absence of a tail

END OF SECTION A
TURN OVER

SECTION B

Instructions for Section B

Answer **all** questions in the spaces provided. Write using blue or black pen.

Unless otherwise indicated, the diagrams in this book are **not** drawn to scale.

Question 1 (4 marks)

Diagrams of two molecules that are required for the production of proteins within a cell are shown below.
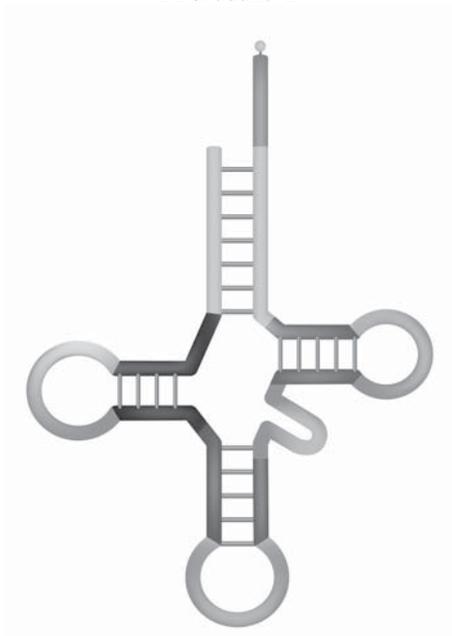
Molecule 1   **Molecule 2**
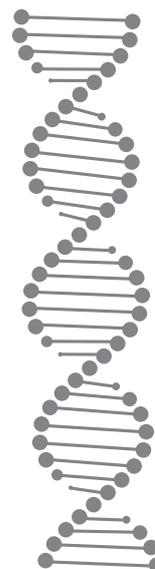
Sources (from left): Designua/Shutterstock.com; PannaKotta/Shutterstock.com

a. Complete the table below to describe two differences between the monomers of the two molecules.   2 marks

	Molecule 1	Molecule 2
Difference 1		
Difference 2		

DO NOT WRITE IN THIS AREA

b.   Ten amino acids that form part of a protein are shown below.

                  -phe-val-asn-gln-his-leu-cys-gly-ser-his-

The section of an RNA molecule found in the nucleus of the cell associated with the translation of these 10 amino acids was found to contain over 300 monomers.

Explain how there can be over 300 monomers in this section of the RNA molecule but only 10 amino acids translated.   2 marks

_____

_____

_____

_____

Question 2 (5 marks)

a. A chloroplast is surrounded by a double membrane.

    i. Name **two** molecules, as inputs for photosynthesis, that would need to diffuse from the cytosol of the plant cell across the chloroplast membranes and into the chloroplast.   1 mark

    ii. Under high magnification, the internal structure of a chloroplast is visible. The diagram below shows part of this structure.
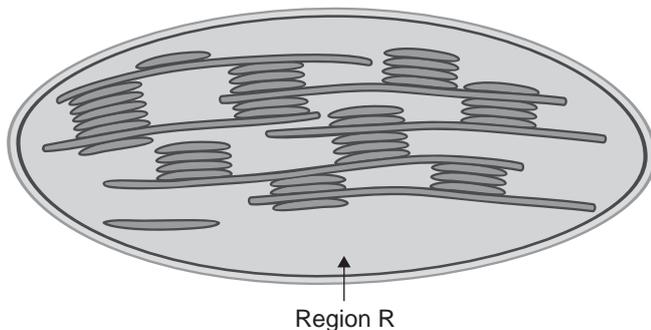
Region R

Source: Kazakova Maryia/Shutterstock.com

A higher concentration of oxygen is found in Region R when a plant is photosynthesising compared to when it is not photosynthesising.

Account for the differences in oxygen concentrations found in this region.   2 marks

b. Describe the role played by each of the coenzymes NADPH and ATP in photosynthesis.   2 marks

Question 3 (7 marks)

The human immune system consists of a series of defensive barriers that protect the body from infection. When bacteria come into contact with the body, they immediately encounter these defences and must bypass each barrier if they are to survive and infect the body.

a.   When bacteria come into contact with the body, they must gain access to the living tissues to become pathogens.

List **two** possible routes the bacteria could use to access the living tissues of the body.   2 marks

_____

_____

_____

b.   Once bacteria are within or have access to the living tissues of the body, but before cells are aware of their presence, the bacteria will encounter chemical barriers.

List **one** of these chemical barriers and explain its function.   2 marks

_____

_____

_____

c.   When an inflammatory response starts, the first cellular responders will be cells from the innate immune system. One of these cells releases histamine.

How does histamine contribute to the inflammatory response?   1 mark

_____

_____

_____

d.   If bacteria are not destroyed by innate immune responses, adaptive immune responses become involved.

Describe how an adaptive immune response is initiated during a bacterial infection.   2 marks

_____

_____

_____

Question 4 (6 marks)

The diagram below illustrates how 'thunderstorm asthma' occurs. Thunderstorm asthma is an allergic condition that can be very serious. In 2017 it led to a number of deaths in Victoria. The condition is a combination of hay fever and asthma. People who suffer from either can be susceptible to thunderstorm asthma.

2 Moisture in the cloud breaks the pollen into smaller pieces.

1 Whole pollen grains get swept up into the cloud as the storm matures.

3 Dry, cold outflows carry pollen fragments to ground level, where people breathe them into their lungs.

flowery grasses

whole grain fragments
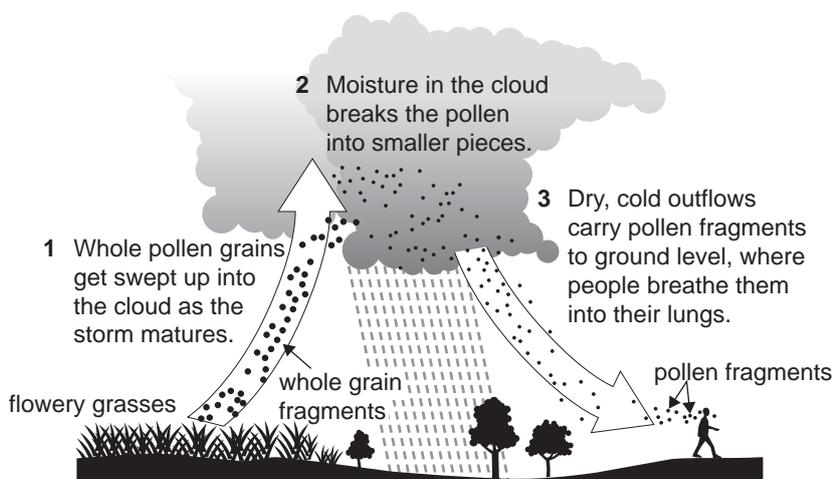
pollen fragments

Source: adapted from Asthma Australia, <www.asthmaaustralia.org.au/national/home>

a. Pollen fragments cause allergic reactions when they enter the body by interacting with a specific type of cell and a protein of the immune system.

Name the cell and the protein involved. 2 marks

_____

_____

b. List **two** strategies that a person could take to reduce their risk of developing thunderstorm asthma. 2 marks

_____

_____

_____

_____

c. Explain if it could be possible to develop a vaccine against thunderstorm asthma. 2 marks

_____

_____

_____

_____

SECTION B – continued

Question 5 (6 marks)

The table below shows the beak shapes (depth and length) of several Galapagos finches.

The expression of the BMP4 gene affects beak depth. The expression of another gene, CaM, affects beak length, as illustrated in the table.

Beak shape (depth and length)	Gene expression	
	BMP4	**CaM**
shallow and short	low	low
deep and short	high	low
shallow and long	low	high

Source: beak images based on Chegg Study, <www.chegg.com/study>

a. Using the information in the table, identify the beak shape (depth and length) expected in a Galapagos finch where BMP4 and CaM were both highly expressed.   1 mark

_____

b. Another gene found in birds, the Gremlin gene, inhibits the expression of BMP4 in the cells of the feet.

Using your knowledge and the information above, explain what would happen to beak shape (depth and length) if the Gremlin gene also had an effect on the cells of the beak.   2 marks

_____

_____

_____

c. Explain why a mutation that affects the expression of the BMP4 gene can lead to rapid changes in the phenotypes of Galapagos finches.   3 marks

_____

_____

_____

_____

_____

Question 6 (9 marks)

From 10 weeks into pregnancy, a woman can decide to have a non-invasive prenatal test that detects fetal aneuploidies. A blood sample is taken from the woman for the test.

a.   **i.**   What does aneuploidy refer to?   1 mark

_____

ii.   What would scientists examine in the woman's blood sample?   1 mark

_____

_____

If there is a requirement to look for other genetic abnormalities, such as block mutations, different procedures can be conducted.

b.   Describe **two** different types of block mutations.   2 marks

_____

_____

_____

_____

Some procedures can detect single gene mutations. Sickle-cell anaemia is produced by a single gene mutation that affects the production of the beta chain of the haemoglobin protein (the oxygen-carrying protein that makes blood cells red). Beta haemoglobin is a single chain consisting of 147 amino acids.

Shown below is a small section of the mRNA nucleotide sequence found in an individual without the mutation.

5′	AUG	GUG	CAC	CUG	ACU	CCU	GAG	GAG	3′

The codon table below can be used to determine amino acids coded for by a nucleotide sequence.

1st position (5′ end) ↓	2nd position				3rd position (3′ end) ↓
	U	C	A	G	
U	phe	ser	tyr	cys	U
	phe	ser	tyr	cys	C
	leu	ser	STOP	STOP	A
	leu	ser	STOP	trp	G
C	leu	pro	his	arg	U
	leu	pro	his	arg	C
	leu	pro	gln	arg	A
	leu	pro	gln	arg	G
A	ile	thr	asn	ser	U
	ile	thr	asn	ser	C
	ile	thr	lys	arg	A
	met	thr	lys	arg	G
G	val	ala	asp	gly	U
	val	ala	asp	gly	C
	val	ala	glu	gly	A
	val	ala	glu	gly	G

c. Use the section of mRNA provided on page 24 and the codon table above to complete the table below. 2 marks

Translated sequence	

d. i. The gene for sickle-cell anaemia produces misshapen red blood cells that do not carry oxygen efficiently. In an individual with sickle-cell anaemia, the twentieth nucleotide has changed to uracil in the transcribed mRNA provided on page 24.

How would this alter the amino acids coded for in this sequence?   1 mark

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ii. If this twentieth nucleotide was deleted, how could this mutation alter the structure and function of the haemoglobin protein produced?   2 marks

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Question 7 (7 marks)

Consider the information provided on the three species shown in the table below.

Species	rock hyrax	elephant	dugong
Size	small terrestrial mammal (2–5 kg)	large terrestrial mammal (4500–6000 kg)	mid-sized marine mammal (150–300 kg)

Sources (from left): Bartosz Budrewicz/Shutterstock.com; Patryk Kosmider/Shutterstock.com; vkilikov/Shutterstock.com

a. These three species are closely related, sharing a relatively recent common ancestor, but have different features.

Identify the type of evolution involved. Justify your response. 2 marks

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In 2014 palaeontologists discovered a frozen, well-preserved, complete specimen of an extinct species, the steppe bison, in Siberia. The intact specimen was dated at 9300 years old.

b. Scientists are debating the cause of the steppe bison's extinction.

Give **one** possible cause of its extinction. 1 mark

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c. Though steppe bison are extinct, palaeontologists know a lot about them as they have found several frozen, intact steppe bison bodies.

Describe what would have occurred to lead to the preservation of the animal from when the steppe bison died to when the frozen, well-preserved remains were discovered.   4 marks

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Question 8 (9 marks)

The Genomics Health Futures Mission will run a $32 million trial, starting in 2019, to screen over 10 000 couples who are in early pregnancy or who are planning to have a baby. Using a blood test, individuals will be screened for 500 severe or deadly recessive gene mutations.

Couples will be told they have a genetic mutation if both individuals in the couple carry the same mutation. The trial may lead to a population-wide carrier screening program. The researchers will evaluate cost effectiveness, psychological impact, ethics and barriers to screening. It is anticipated that future tests will be free of charge.

a. Give an example of a disorder or disease that can be detected by genetic screening.   1 mark

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b. The blood sample from an individual will provide researchers with only a small amount of DNA. Polymerase chain reaction (PCR) will be used to amplify the DNA.

Describe what happens in each of the three stages of PCR. The stages must be given in the order in which they occur.   3 marks

Stage	What is happening at this stage
1	
2	
3	

c. Once the DNA has been amplified, it can be loaded into a well of an agarose gel.

Discuss **three** factors that affect the migration of DNA fragments through the agarose gel during gel electrophoresis.   3 marks

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d. The test may find that a couple who were planning to have a baby or who were already pregnant both carry the same severe or deadly mutation.

Describe one ethical and one social issue/implication that could arise from this finding.   2 marks

	Issue/Implication
Ethical	
Social	

Question 9 (9 marks)

Zika fever is a rapidly emerging viral disease. It is most commonly transferred from one person to another by the Aedes species of mosquito.

Zika fever in people was discovered in Uganda in 1947. It was thought that a bite from a mosquito had transferred the virus from monkeys to humans.

The symptoms of Zika fever are usually mild and 80% of infected humans do not show symptoms. Infection of pregnant women, however, can cause severe defects in their babies.

a.   One way that diseases, such as Zika fever, are thought to occur is when a pathogen infects humans from an animal host.

Identify **one** social or economic factor that could lead to this transfer between hosts.   1 mark

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b.   When scientists attempt to identify a particular disease, they can look for specific antibodies in infected humans. Scientists trying to identify Zika fever infections found that testing for the antibodies produced against the Zika virus often gave them incorrect results. This was because the antibody tests that had been developed could not always identify the difference between the antibodies produced against the Zika virus and the antibodies produced against other viruses.

Explain why making a correct identification of a viral pathogen is important in the control of a disease.   3 marks

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c. Explain why the antibody tests could not identify the difference between the antibodies produced against the Zika virus and the antibodies produced against other viruses. In your response, refer to the structure of the antibody.   2 marks

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d. Aedes mosquitoes are not found on every continent. They cannot fly great distances.

Vaccines are currently being trialled for the Zika virus.

Describe **three** different approaches, other than vaccination, that government health officials could use to reduce the spread of the Zika virus.   3 marks

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Question 10 (7 marks)

Neanderthal or Denisovan?

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a. Based on the information given in the article, would it be possible to classify Denisovans as a separate group from Neanderthals without using DNA analysis? Justify your response. 2 marks

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b. Scientists could have extracted mitochondrial DNA from the young girl's finger bone sample but, instead, extracted and sequenced nuclear DNA.

Explain why the scientists chose to sequence the nuclear DNA for this sample. 2 marks

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Source: adapted from Genographic Project, <https://genographic.nationalgeographic.com/human-journey/>;
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c.   Using the information in the article and by referring to the map above, name which hominin group would most likely have been found living at each site between 300 000 and 60 000 years ago. Justify your response.   3 marks

Site	Name of hominin group	Justification
1 – Africa		
2 – South-East Asia and Papua New Guinea		
3 – Europe		

Question 11 (11 marks)

Three students wanted to investigate the activity of the enzyme lipase for a practical investigation.

Student 1 made the following notes before designing her experiment.

Lipase catalyses the breakdown of fats into glycerol and fatty acids.

Fatty acids can neutralise an alkaline solution.

Sodium carbonate is an alkaline solution.

Student 1 set up four test tubes each containing 5 mL of a fatty solution and 10 mL of sodium carbonate solution. Each test tube was suspended in a water bath. Each water bath was set at a different temperature. pH probes were placed into each test tube. Each solution had a pH of 8.

After setting up the four test tubes in the water baths, Student 1 waited until the solution in the test tube was the same temperature as the water in the water bath. Student 1 then added 5 mL of lipase solution to each test tube. Student 1 timed how long it took for the pH of the solution to become neutral (pH of 7).

Student 1 repeated the experiment so that she had three measurements for each temperature. She obtained the data shown in Table 1.

Table 1. Results from Student 1

Temperature (°C)	Time taken for solution to become neutral (seconds)		
	Measurement 1	**Measurement 2**	**Measurement 3**
5	240	238	241
15	229	230	226
25	200	201	202
35	180	181	180

a. Student 1 was concerned about the precision of her measurements.

Analyse the data above and state the temperature at which the measurements are the most precise. Justify your response.   2 marks

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b. State whether Student 1 obtained qualitative or quantitative data. Outline a difference between the two
types of data.   2 marks

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c. Student 2 repeated the experiment designed by Student 1 the next day and obtained the data shown in
Table 2.

Table 2. Results from Student 2

Temperature (°C)	Time taken for solution to become neutral (seconds)		
	Measurement 1	**Measurement 2**	**Measurement 3**
5	241	239	242
15	230	155	230
25	201	202	170
35	181	181	181

Student 2 indicated that he had errors in his measurements.

Identify which of his measurements have errors. Give **two** examples of sources of error for these
measurements.   3 marks

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d. Later that day, the third student performed the experiment. Student 3's data is shown in Table 3.

Table 3. Results from Student 3

Temperature (°C)	Time taken for solution to become neutral (seconds)		
	Measurement 1	Measurement 2	Measurement 3
5	141	139	142
15	130	130	130
25	101	102	102
35	81	81	81

After comparing his results with the other students' results, Student 3 realised he had made an error.

Name the type of error that was made by Student 3 and identify **one** source of error that may account for the results obtained by this student.   2 marks

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e. Identify a limitation of the experiment that was carried out by all three students. What could the students do to address this limitation?   2 marks

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END OF QUESTION AND ANSWER BOOK