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

<table>
<thead>
<tr>
<th>Section</th>
<th>Number of questions</th>
<th>Number of questions to be answered</th>
<th>Number of marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>40</td>
<td>40</td>
<td>40</td>
</tr>
<tr>
<td>B</td>
<td>11</td>
<td>11</td>
<td>80</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Total 120</td>
</tr>
</tbody>
</table>

• 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.

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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.

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.

![Diagram of lac operon]

**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.

<table>
<thead>
<tr>
<th>Time (days)</th>
<th>Percentage of nutrient agar covered by bacteria at three different temperatures</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>–10 °C</td>
</tr>
<tr>
<td>00</td>
<td>0</td>
</tr>
<tr>
<td>10</td>
<td>0</td>
</tr>
<tr>
<td>20</td>
<td>0</td>
</tr>
<tr>
<td>30</td>
<td>0</td>
</tr>
<tr>
<td>40</td>
<td>0</td>
</tr>
</tbody>
</table>

**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](source1) ![a neuron](source2)

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
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?

<table>
<thead>
<tr>
<th>Produces a rapid response</th>
<th>Can target many cells or organs at once, but are not the most rapid</th>
<th>Can affect another organism at a distance</th>
<th>Targets nearby cells during inflammation</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. neurotransmitters</td>
<td>cytokines</td>
<td>pheromones</td>
<td>hormones</td>
</tr>
<tr>
<td>B. cytokines</td>
<td>pheromones</td>
<td>hormones</td>
<td>neurotransmitters</td>
</tr>
<tr>
<td>C. neurotransmitters</td>
<td>hormones</td>
<td>pheromones</td>
<td>cytokines</td>
</tr>
<tr>
<td>D. hormones</td>
<td>neurotransmitters</td>
<td>cytokines</td>
<td>pheromones</td>
</tr>
</tbody>
</table>

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.

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.

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**

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.

<table>
<thead>
<tr>
<th>Generation 1</th>
<th>Generation 10</th>
<th>Generation 20</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rr Rr Rr</td>
<td>Rr Rr Rr Rr</td>
<td>Rr Rr Rr Rr</td>
</tr>
<tr>
<td>Rr Rr Rr</td>
<td>Rr Rr Rr Rr</td>
<td>Rr Rr Rr Rr</td>
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<tr>
<td>Rr Rr Rr</td>
<td>Rr Rr Rr Rr</td>
<td>Rr Rr Rr Rr</td>
</tr>
<tr>
<td>Rr Rr Rr</td>
<td>Rr Rr Rr Rr</td>
<td>Rr Rr Rr Rr</td>
</tr>
<tr>
<td>heterozygous individual</td>
<td>homozygous individual</td>
<td>homozygous individual</td>
</tr>
</tbody>
</table>

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.

![Dinosaur footprint](image)

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 graph](image)

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

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?

<table>
<thead>
<tr>
<th>Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>A.  decreasing tooth size, increasing size of brow ridges, increasingly bowl-shaped pelvis, increasing size of zygomatic arch</td>
</tr>
<tr>
<td>B.  decreasing tooth size, decreasing size of brow ridges, decreasing arch of feet, more-opposable big toe</td>
</tr>
<tr>
<td>C.  increasing jaw size, decreasing size of zygomatic arch, increasing arch of feet, decreasing tooth size</td>
</tr>
<tr>
<td>D.  decreasing size of canines, decreasing size of zygomatic arch, increasingly bowl-shaped pelvis, increasing arch of feet</td>
</tr>
</tbody>
</table>
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.

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?

<table>
<thead>
<tr>
<th>Number of restriction sites cut</th>
<th>Number of DNA fragments produced</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. 3</td>
<td>3</td>
</tr>
<tr>
<td>B. 3</td>
<td>4</td>
</tr>
<tr>
<td>C. 4</td>
<td>4</td>
</tr>
<tr>
<td>D. 4</td>
<td>5</td>
</tr>
</tbody>
</table>

**Question 40**
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
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

<table>
<thead>
<tr>
<th>Difference 1</th>
<th>Molecule 1</th>
<th>Molecule 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Difference 2</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
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.

![Diagram of chloroplast and Region R](https://www.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

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[Note: The image contains a diagram of a chloroplast with a region labeled R, and a reference to a source: Kazakova Maryia/Shutterstock.com.]
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.

1. Whole pollen grains get swept up into the cloud as the storm matures.
2. Moisture in the cloud breaks the pollen into smaller pieces.
3. Dry, cold outflows carry pollen fragments to ground level, where people breathe them into their lungs.

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.  

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

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

<table>
<thead>
<tr>
<th>Beak shape (depth and length)</th>
<th>BMP4</th>
<th>CaM</th>
</tr>
</thead>
<tbody>
<tr>
<td>shallow and short</td>
<td>low</td>
<td>low</td>
</tr>
<tr>
<td>deep and short</td>
<td>high</td>
<td>low</td>
</tr>
<tr>
<td>shallow and long</td>
<td>low</td>
<td>high</td>
</tr>
</tbody>
</table>

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?  

ii. What would scientists examine in the woman’s blood sample?  

**b.**

Describe **two** different types of block mutations.  

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

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.

<table>
<thead>
<tr>
<th>5’</th>
<th>AUG</th>
<th>GUG</th>
<th>CAC</th>
<th>CUG</th>
<th>ACU</th>
<th>CCU</th>
<th>GAG</th>
<th>GAG</th>
<th>3’</th>
</tr>
</thead>
</table>

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

<table>
<thead>
<tr>
<th>1st position (5' end)</th>
<th>2nd position</th>
<th>3rd position (3' end)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>U</td>
<td>C</td>
</tr>
<tr>
<td>phe</td>
<td>ser</td>
<td>tyr</td>
</tr>
<tr>
<td>phe</td>
<td>ser</td>
<td>tyr</td>
</tr>
<tr>
<td>leu</td>
<td>ser</td>
<td>STOP</td>
</tr>
<tr>
<td>leu</td>
<td>ser</td>
<td>STOP</td>
</tr>
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<tr>
<td>val</td>
<td>ala</td>
<td>glu</td>
</tr>
<tr>
<td>val</td>
<td>ala</td>
<td>glu</td>
</tr>
</tbody>
</table>

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

Translated sequence

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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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SECTION B – continued

TURN OVER
**Question 7** (7 marks)
Consider the information provided on the three species shown in the table below.

<table>
<thead>
<tr>
<th>Species</th>
<th>rock hyrax</th>
<th>elephant</th>
<th>dugong</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Size</strong></td>
<td>small terrestrial mammal (2–5 kg)</td>
<td>large terrestrial mammal (4500–6000 kg)</td>
<td>mid-sized marine mammal (150–300 kg)</td>
</tr>
</tbody>
</table>

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

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

Give one possible cause of its extinction. 1 mark

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.
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
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

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

<table>
<thead>
<tr>
<th>Stage</th>
<th>What is happening at this stage</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Issue/Implication</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Ethical</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Social</strong></td>
<td></td>
</tr>
</tbody>
</table>
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.  

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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.  

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Question 10 (7 marks)

Neanderthal or Denisovan?

Due to copyright restrictions, this material is not supplied.

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

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

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

<table>
<thead>
<tr>
<th>Site</th>
<th>Name of hominin group</th>
<th>Justification</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 – Africa</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 – South-East Asia and Papua New Guinea</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3 – Europe</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Due to copyright restrictions, this material is not supplied.

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

<table>
<thead>
<tr>
<th>Temperature (°C)</th>
<th>Time taken for solution to become neutral (seconds)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Measurement 1</td>
</tr>
<tr>
<td>5</td>
<td>240</td>
</tr>
<tr>
<td>15</td>
<td>229</td>
</tr>
<tr>
<td>25</td>
<td>200</td>
</tr>
<tr>
<td>35</td>
<td>180</td>
</tr>
</tbody>
</table>

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
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

<table>
<thead>
<tr>
<th>Temperature (°C)</th>
<th>Time taken for solution to become neutral (seconds)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Measurement 1</td>
</tr>
<tr>
<td>5</td>
<td>241</td>
</tr>
<tr>
<td>15</td>
<td>230</td>
</tr>
<tr>
<td>25</td>
<td>201</td>
</tr>
<tr>
<td>35</td>
<td>181</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Temperature (°C)</th>
<th>Time taken for solution to become neutral (seconds)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Measurement 1</td>
</tr>
<tr>
<td>5</td>
<td>141</td>
</tr>
<tr>
<td>15</td>
<td>130</td>
</tr>
<tr>
<td>25</td>
<td>101</td>
</tr>
<tr>
<td>35</td>
<td>81</td>
</tr>
</tbody>
</table>

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

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