

## 2019 Trial Examination

STUDENT  
NUMBER

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Letter

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# BIOLOGY

## Units 3 & 4 – Written examination

Reading time: 15 minutes

Writing time: 2 hours and 30 minutes

### QUESTION AND ANSWER BOOK

#### Structure of book

<i>Section</i>	<i>Number of questions</i>	<i>Number of questions to be answered</i>	<i>Number of marks</i>
A	40	40	40
B	11	11	70
			Total 110

- 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 white out liquid/tape.
- No calculator is permitted in this examination.

#### Materials supplied

- Question and answer book of 29 pages.

#### Instructions

- Print your name in the space provided on the top of this page.
- All written responses must be in English.

**Students are NOT permitted to bring mobile phones and/or any other unauthorised electronic communication 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**

The molecules that are found inside a bacterial cell are described as

- A. extracellular
- B. intracellular
- C. intercellular
- D. unicellular

**Question 2**

Hormones are produced in a cell and then have to be exported before they are transported to their target cell. The mechanism that they must undergo in order to be exported is:

- A. endocytosis
- B. pinocytosis
- C. phagocytosis
- D. exocytosis

**Question 3**

Nucleic acids and proteins are described as

- A. biomacromolecules and are formed by condensation reactions
- B. biomacromolecules and are formed by hydrolysis reactions
- C. monomers and are formed by condensation reactions
- D. polymers and are formed by hydrolysis reactions

**SECTION A - continued**

**Question 4**

The process of synthesising protein molecules can be explained using the 4 different levels of structure. What bonds are present when the secondary structure is achieved?

- A. Peptide bonds and hydrogen bonds
- B. Hydrogen bonds and ionic bonds
- C. Peptide bonds and ionic bonds
- D. Hydrogen bonds and disulphide bonds

**Question 5**

Which of the following statements is **true** of the molecule mRNA?

- A. It contains thymine and adenine bases in equal numbers.
- B. It is confined to the nucleus of cells.
- C. It consists of two linked strands of nucleotides.
- D. It is composed of nucleotides which contain ribose sugar.

**Question 6**

Which sequence describes the correct order for the transcription of eukaryotic DNA?

- A. DNA polymerase attaches, complementary nucleotides are attached, pre-mRNA, introns are removed, mRNA leaves the nucleus.
- B. RNA polymerase attaches, complementary nucleotides are attached, pre-mRNA, introns are removed, mRNA leaves the nucleus.
- C. RNA polymerase attaches, complementary nucleotides are attached, pre-mRNA, exons are removed, mRNA leaves the nucleus.
- D. RNA polymerase attaches, complementary nucleotides are attached, mRNA, introns are removed, pre-mRNA leaves the nucleus.

**Question 7**

Enzyme activity is affected by many factors. The binding of a substance away from the active site can alter the enzyme so that it no longer binds with the substrate. This type of factor is called a:

- A. co-enzyme inhibitor
- B. reversible inhibitor
- C. competitive inhibitor
- D. non-competitive inhibitor

**SECTION A – continued  
TURN OVER**

**Question 8**

The following statements refer to enzymes.

- (i) Most enzymes are proteins
- (ii) Enzymes are biological catalysts
- (iii) Enzymes increase the activation energy of a reaction
- (iv) The active site of an enzyme can be blocked by an inhibitor
- (v) A particular enzyme can catalyse many different types of reactions

- A. Only (i) and (ii) are correct
- B. Only (ii) and (iii) are correct
- C. Only (ii) and (iv) are correct
- D. Only (iv) and (v) are correct

**Question 9**

Cellular metabolism refers to all the chemical reactions that take place in each living cell. It involves some reactions that build more complex molecules and other reactions that break down complex molecules into simpler ones. The latter are described as:

- A. catabolic reactions and they are endergonic
- B. catabolic reactions and they are exergonic
- C. anabolic reactions and they are endergonic
- D. anabolic reactions and they are exergonic

**Question 10**

All biological processes require inputs that are required to react and produce outputs.

Which option below lists the inputs required for photosynthesis to take place?

- A.  $O_2$ ,  $H_2O$ . ADP and NADH
- B.  $O_2$ ,  $H_2O$ . ATP and  $NAD^+$
- C.  $CO_2$ ,  $H_2O$ . ATP and NADPH
- D.  $CO_2$ ,  $H_2O$ . ADP and  $NADP^+$

**Question 11**

Many organisms can undergo both aerobic and anaerobic respiration. During prolonged periods of exercise the organism's cells will switch to performing anaerobic respiration when the oxygen available becomes limiting. What usually limits the length of time that this anaerobic respiration can continue for?

- A. the cells would run out of energy and not be able to sustain life.
- B. the supply of oxygen would run out.
- C. the cells will only have enough energy to sustain them for a short time.
- D. the products are toxic at high concentrations.

**SECTION A - continued**

**Question 12**

Which of the following terms is NOT involved with apoptosis?

- A. caspases
- B. phagocytosis
- C. blebs
- D. programmed

**Question 13**

Glucagon is a small peptide hormone. When glucagon binds to the glucagon receptors on liver cells, it promotes the conversion of glycogen into individual glucose molecules and releases them into the bloodstream. The process is known as glycogenolysis. Which statement below best describes the sequence of events at a cellular level?

- A. Glucagon moves into the cell where it is involved in DNA transcription of genes associated with the enzymes needed for conversion.
- B. Glucagon binds to a receptor inside the nucleus causing certain genes needed for the manufacture of the conversion enzymes.
- C. Glucagon binds to a receptor located on the plasma membrane initiating a conformational change and the activation of G proteins which then activate other enzymes necessary for the conversion.
- D. Glucagon binds to a receptor on the glycogen molecule and causes conformational change resulting in hydrolysis of the bonds to produce glucose.

**Question 14**

Which of the following is NOT a strategy used by plants to avoid invaders likely to cause disease?

- A. presence of spikes on leaves or stems
- B. presence of a thick or waxy cuticle on leaves.
- C. production of molecules that will kill pathogens
- D. production of molecules similar to antibodies.

**Question 15**

Which of the following are NOT involved in the innate immune response?

- A. Lysosomes
- B. Macrophages
- C. Antibodies
- D. Complement proteins

**SECTION A – continued  
TURN OVER**

**Question 16**

*“a toxin or other foreign substance which induces an immune response in the body”*

The definition above refers to:

- A. antigen
- B. pathogen
- C. antibody
- D. antibiotic

**Question 17**

Autoimmune diseases occur when the immune system:

- A. does not recognise “self” from “non-self” cells.
- B. the chemical signature of individuals is recognised and stimulates an immune response.
- C. the MHC II markers are no longer active.
- D. recognises all cells as antigens.

**Question 18**

If the allele frequencies in a population remain constant across generations, it can be said that the population is,

- A. evolving
- B. not evolving
- C. becoming extinct
- D. balanced in terms of immigration and emigration

**Question 19**

Many factors can affect the allele frequency within a gene pool. Which of these factors is least likely to cause a rapid change?

- E. selection pressure
- F. gene flow
- G. genetic drift
- H. mutation

**Question 20**

If a population suffered a bottleneck effect, it may have:

- A. been subjected to gene flow
- B. an increased genetic diversity
- C. an increased risk of extinction
- D. all of the above

**SECTION A** - continued

**Question 21**

There are some circumstances in which a mutation can be inherited, such as when the mutation is:

- A. a missense mutation
- B. a chromosomal type
- C. an autosomal type
- D. in a germ cell

**Question 22**

Mutations can be advantageous, neutral or deleterious. Which type of mutation is likely to be the most deleterious?

- A. Chromosomal
- B. Point
- C. Missense
- D. Frameshift

**Question 23**

It has been noticed that siblings often have similar phenotypes and look alike. This is because they may share genotypic characteristics. The popularity of the “Goth” fashion movement also means that a number of unrelated individuals may look similar. This can be used as an analogy to help understand the difference between:

- A. natural and artificial selection
- B. genetic drift and gene flow
- C. convergent and divergent evolution
- D. homologous and analogous

**Question 24**

The best technique to accurately determine the age of a fossil would be:

- A. carbon dating
- B. using index fossils
- C. radiometric dating
- D. comparative dating

**SECTION A – continued**  
**TURN OVER**

**Question 25**

Over geological time, there have been many changes in the types of life forms on Earth. There are many reasons why these life forms have changed. Which of the following is NOT a possible reason?

- A. the fossil record is not complete.
- B. a movement of land masses in the Earth's crust.
- C. mass extinctions leaving niches for other organisms.
- D. a change from an anaerobic to an aerobic atmosphere.

**Question 26**

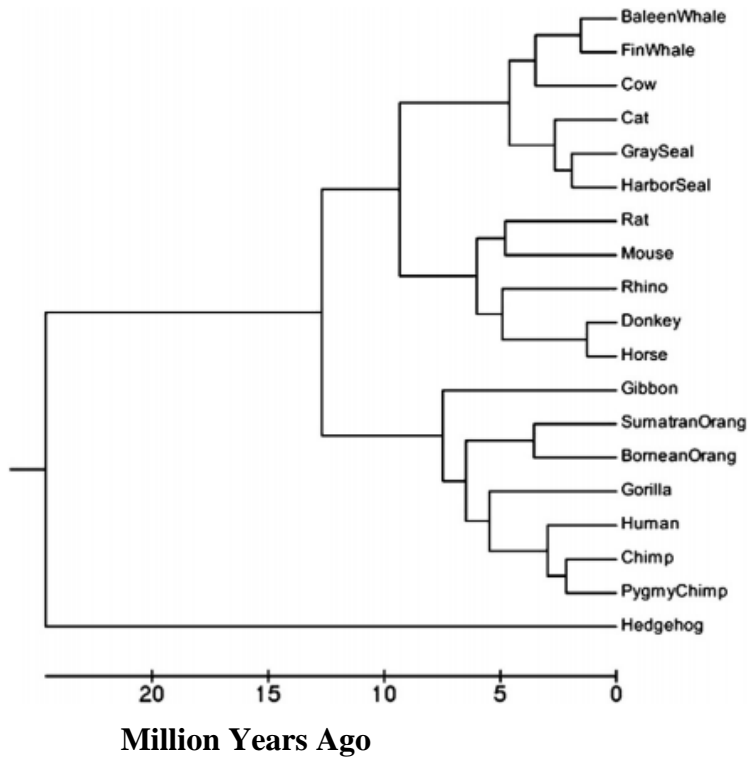
There have been 5 well recorded mass extinctions in Earth's history so far. What is often a consequence of a mass extinction?

- A. All life forms disappear.
- B. Evolution pauses for a while.
- C. Biological diversity is markedly reduced.
- D. Only animals are affected.

**SECTION A – continued**



Use the following information to answer questions 27 -29



**Question 27**

Which two species most recently had a common ancestor?

- A. Human and Chimp
- B. Rat and Mouse
- C. Gray seal and Harbor seal
- D. Donkey and Horse

**Question 28**

Using the scale above when did Gibbons and Chimps last have a common ancestor?

- A. 2.5 mya
- B. 7.5 mya
- C. 12.5 mya
- D. 25 mya

**SECTION A – continued  
TURN OVER**

**Question 29**

The most appropriate name for this diagram is:

- A. Unrooted phylogenetic tree
- B. Rooted phylogenetic tree
- C. Phylogram
- D. Cladogram

**Question 30**

The best description of a master gene is:

- A. A gene that controls the production of a protein that is important in the development of an organism.
- B. A gene that controls the activation of a series of other genes that are important in the development of an organism.
- C. The first type of gene discovered in biology.
- D. A gene that is common to all organisms.

**Question 31**

What term is best used to describe the group made up of only ancient and modern humans?

- A. hominoid
- B. hominin
- C. human
- D. hominid

**Question 32**

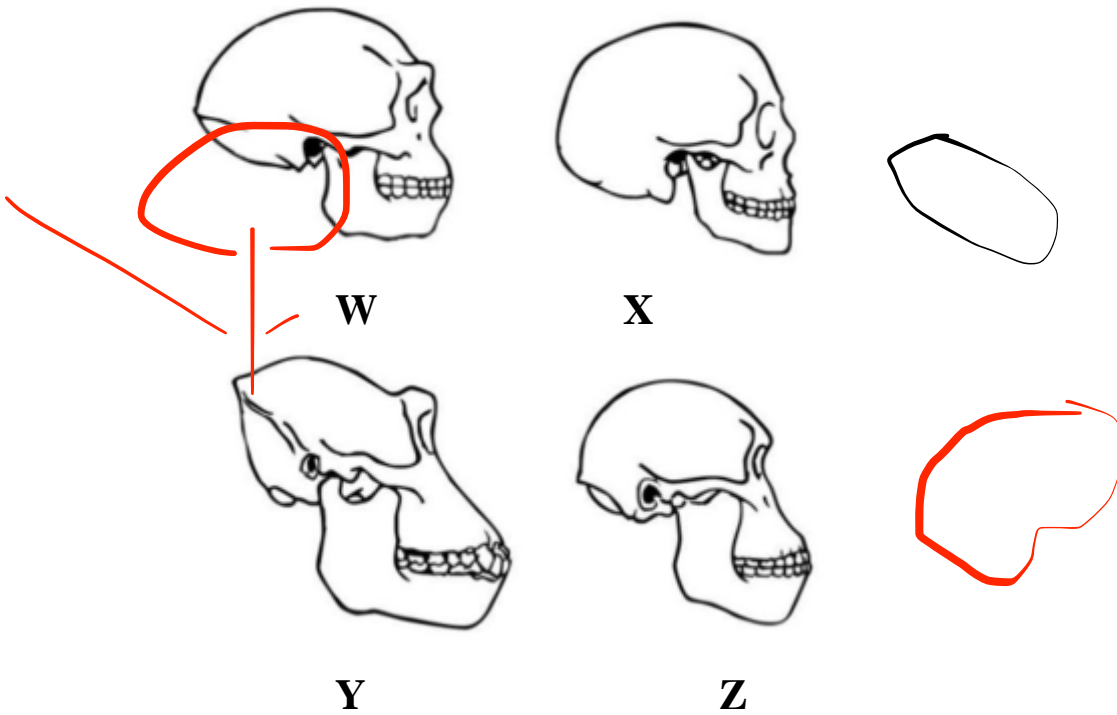
The evolution of humans can be described as biological, cognitive and cultural. What would be the best way to categorise the evolution of bipedalism?

- A. biological
- B. cognitive
- C. cultural
- D. all of the above

**SECTION A - continued**

**Question 33**

The following diagram shows a comparison of skulls that are important in evolution of the modern human.



The correct order from oldest to most modern is:

- A. Y, W, Z, X
- B. X, Y, Z, W
- C. Y, Z, W, X
- D. Z, Y, X, W

**SECTION A – continued  
TURN OVER**

**Question 34**

Which of the following characteristics is consistent with the evolution of the modern human from other primates?

- A. Development of the opposable thumb
- B. Stereoscopic vision
- C. Development of the precision grip
- D. Use of tools

**Question 35**

In recent years many basic tools for genetic manipulation have been developed. One of these tools is nicknamed “biological scissors”. Which tool does this refer to?

- A. Plasmid identification
- B. Restriction enzymes
- C. Polymerase Chain Reaction
- D. Gel electrophoresis

**Question 36**

Plasmids are often used during genetic modification. Plasmids:

- A. are circular single stranded DNA
- B. can replicate independently of chromosomes
- C. carry genes that have favourable characteristics
- D. can be inserted into viral vectors

**Question 37**

During genetic manipulation, a gene for antibiotic resistance is often included in the engineered DNA. This is because:

- A. antibiotic resistance is an important characteristic.
- B. the modified bacteria need to grow in an antibiotic.
- C. it can be used to determine which plasmids have taken up the modification.
- D. antibiotic resistance is important especially in hospital environments.

**Question 38**

The development of agriculture over many years has relied on selective breeding. This can be described as:

- A. genetic modification
- B. human assisted evolution
- C. transgenic manipulation
- D. survival of the fittest

**SECTION A - continued**

**Question 39**

Severe acute respiratory syndrome (SARS) is a viral respiratory illness caused by a coronavirus. SARS was first reported in Asia in February 2003. Over the next few months, the illness spread to more than two dozen countries in North America, South America, Europe, and Asia before the SARS global outbreak of 2003 was contained. This was made difficult due to the rapid global movement of people by air travel. This outbreak could be called:

- A. an epidemic
- B. a pandemic
- C. a plague
- D. an endemic

**Question 40**

Rational drug design involves:

- A. designing new enzymes pathways that do not lead to disease
- B. the design of complementary molecules to inhibit an enzymatic pathway
- C. the design of new enzymes
- D. all of the above

**END OF SECTION A  
TURN OVER**

**SECTION B - Short-answer questions**

**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)

Assume that a hen's egg is a single giant animal cell. In an experiment, the contents of an egg were placed into a dialysis bag, which was partially permeable. It was not possible to keep the natural membrane intact, so the tubing was acting like the cell membrane of the egg cell. The dialysis bag was then placed in a beaker of distilled water and left for a period.

- a. Over the period of the experiment, describe any likely changes in the size of the dialysis bag. Account for the changes you describe.

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2 marks

- b. What evidence would lead you to believe that the dialysis tubing was not permeable to compounds in the egg cell other than water?

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1 mark

- c. If a similar model were used to illustrate the movement of water in a plant cell in distilled water, what structure would have to be included in the model and what would it be representing?

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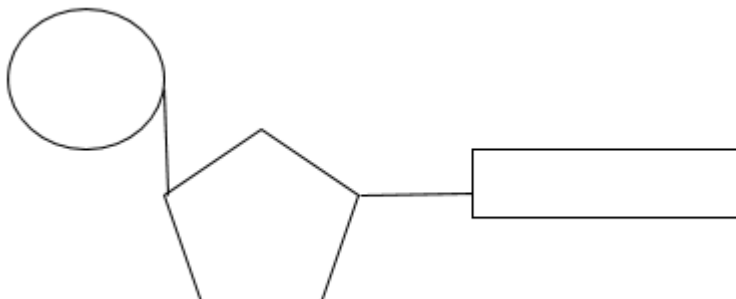
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1 mark

**SECTION B - continued**

**Question 2** (3 marks)

The diagram below shows a monomer of DNA.



**a.** Label the 3 main components on the diagram.

1 mark

**b.** What is the name of the sugar found in this monomer?

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1 mark

**c.** On the diagram, indicate the 5' and 3' ends of the molecule.

1 mark

**SECTION B** - continued  
**TURN OVER**

**Question 3** (4 marks)

The table below shows a sequence of DNA nucleotides from a gene.  
Complete the table, using the chart of mRNA codons.

Double stranded DNA	5' G A T T T A C C G A T C G A A C G C					
	3' C T A A A T G G C T A G C T T G C G					
mRNA sequence						
mRNA codons						
tRNA anticodons						
Amino acid sequence						

**Codons Found in Messenger RNA**

		<i>Second Base</i>				
		U	C	A	G	
<i>First Base</i>	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	

4 marks

**SECTION B** - continued



**Question 4** (4 marks)

An ideal carrier of genetic information in living cells should have the following characteristics be stable; be able to store a very large amount of information; be duplicated exactly and be expressed precisely.

Explain why each characteristic is important with reference to DNA.

**a.** Should be stable:

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1 mark

**b.** Should be able to store a very large amount of information:

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1 mark

**c.** Should be able to be duplicated exactly:

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1 mark

**d.** Should be able to be expressed precisely:

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1 mark

**Question 5** (7 marks)



The simplified diagram above represents the structure of an operon.

- a. Describe what you understand by the term “operon” and state which type of cells operons are primarily found in.

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2 marks

- b. Which part of the operon causes the production of the repressor protein?

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1 mark

- c. Which part of the operon can the repressor protein bind to?

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1 mark

- d. What else can the repressor protein bind to and describe the consequence of this occurring.

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3 marks

**SECTION B** – continued

**Question 6** (5 marks)

Complete the table with the missing terms or descriptions.

Term	Description
	A white blood cell that makes antibodies
Pathogen	
	A blood protein produced in response to, and counteracting a specific antigen
Vaccination	
	Immunity provided when first infected by a pathogen

5 marks

**Question 7** (12 marks)

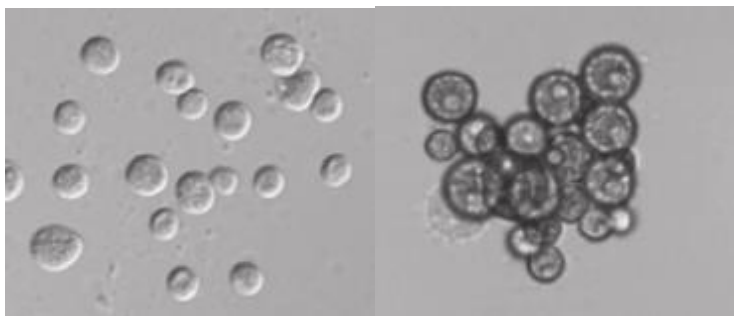
A summary of an article, “Safety in Numbers”, suggested a mechanism for the evolutionary development of multicellular organisms.

For 3 billion years after the appearance of life on Earth, relatively simple single celled organisms dominated. Around 900 million years ago there was a transition to multicellular life. What initiated this transition has been debated. Scientists at University of Milwaukee had already determined that cultures of the green alga *Chlorella vulgaris* would remain single celled as they multiplied except for the occasional loose cluster of the cells, but when the cultures were inoculated with the predatory single celled flagellate *Ochromonas vallescia*, after an initial decline of the algal cells the population recovered. At this stage the alga population consisted of some single cells but also colonies of anything from four to hundreds of cells.

During a second cycle of flagellate inoculation the number of single algal cells declined to less than 1% of all cells in the culture and the number of cells in the colonies declined so that the bulk of them were eight celled.

The researcher’s observations confirmed that while the flagellates could ingest single cells and small colonies, other colonies were too large.

When unicells and colonies were cultured in the absence of the predator, the unicells again became dominant.



**SECTION B – Question 7 - continued**  
**TURN OVER**

- a. Name the algal organism discussed in the article and state how it usually exists.

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1 mark

- b. Give a reason to account for why the alga population went into decline after the initial inoculation?

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1 mark

- c. Suggest why would some of the population survive?

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1 mark

- d. Why would only some of the organisms have this ability?

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1 mark

- e. What is meant by the term “predatory single celled flagellate”?

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1 mark

- f. What selection pressure was applied to this organism?

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2 marks

**SECTION B - Question 7 - continued**

**g.** What was the selection advantage demonstrated by the alga in this research?

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1 mark

**h.** Why do you think the number of cells in the colonies stabilized at eight?

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2 marks

**i.** What can be a disadvantage of a multi celled colony if it is too large and how is this overcome in a multicellular organism?

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2 marks

**j.** What happened when the selection pressure was removed?

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1 mark

**SECTION B – continued**  
**TURN OVER**

**Question 8** (12 marks)

- a.** Polymerase Chain Reaction (PCR) is a technique used by researchers to make multiple copies of a piece of DNA. This is especially important if only a small sample of the DNA is available.

PCR uses an important enzyme called *Taq* polymerase.

- i.** Why is *Taq* polymerase used in PCR?

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PCR requires a pool of spare nucleotides.

- ii.** Why are these needed?

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Primers are also used during PCR

- iii.** Describe the structure and function of a primer.

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The process involves a cycle that is repeated again and again, each time doubling the sections of DNA.

- iv.** How many copies of a DNA segment will be present after 4 cycles?

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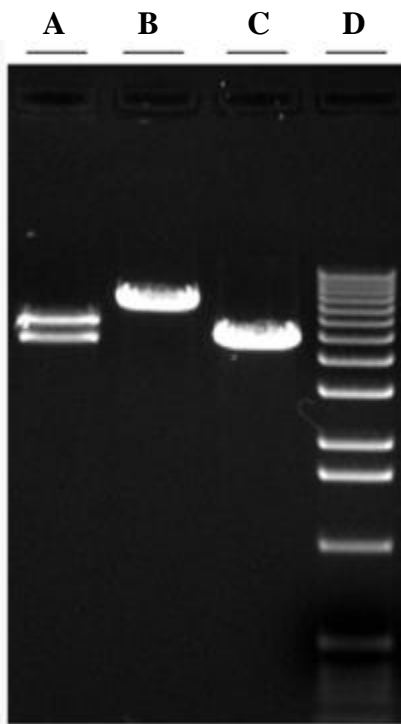
**SECTION B - Question 8 – continued**

- v. Mark arrows on the diagram below to indicate in what direction new nucleotides be added to both strands of DNA.



1 + 1 + 2 + 1 + 1 = 6 marks

- b. Gel electrophoresis is a laboratory method used to separate mixtures of DNA, RNA, or proteins according to molecular size. In gel electrophoresis, the molecules to be separated are pushed by an electrical field through a gel that contains small pores.



Look at the image above depicting a gel used to separate DNA fragments.

**SECTION B – Question 8 – continued**  
**TURN OVER**

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- i. Mark on the image, a + sign to indicate which end of the gel is attached to the positive terminal of the equipment.
- ii. Mark on the image which fragment (A, B or C) would be the largest in size
- iii. Explain why there are two fragments shown in sample A.

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- iv. Explain why the fragment in sample C appears as a thicker band than the others.

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1 + 1 + 2 + 1 = 5 marks

- c. What is meant by recombinant DNA?

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1 mark

**SECTION B** - continued



**Question 9 (6 marks)**

One way to determine the degree of relatedness between species is to examine the sequence on nucleotides on a particular gene. The diagram below shows the sequences from 3 different species that are thought to be related.

Species X	A T A T T T C T A A T T A A C T T A T T
Species Y	A T G T T C G T C A T C A A C C T A C T
Species Z	A T G T T C A T T A T T A A C C T A C T

a. How many nucleotide differences are there in the sequence from

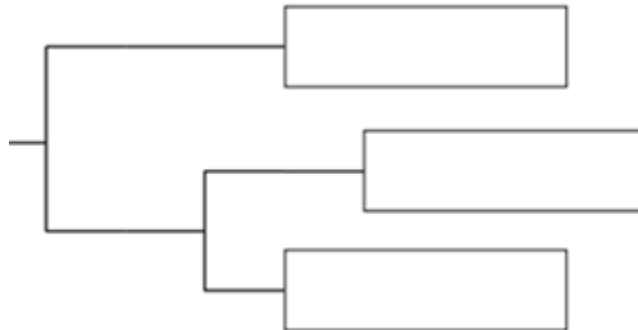
i. Species X and species Y \_\_\_\_\_

ii. Species X and species Z \_\_\_\_\_

iii. Species Y and species Z \_\_\_\_\_

1 + 1 + 1 = 3 marks

b. Use this data to label the branches of this phylogenetic tree



1 mark

c. Which two species are most closely related? Explain your response.

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2 marks

**SECTION B – continued**

**TURN OVER**

**Question 10** (6 marks)

Around 50,000 to 60,000 years ago three species of hominins are thought to have inhabited planet earth, in addition to modern humans. These hominin species comprised Neanderthals living in Europe and Western Asia, Denisovans living in Asia, and *Homo floresiensis* ('hobbits') living on the Indonesian island of Flores.

The 'hobbits' were short in stature standing at around 1.1 metres tall. They are thought to have died out more than 18,000 years ago but today a tribe of short statured people standing around 1.45 metres tall inhabits the area around the village of Rampasasa on Flores near the site where the evidence of 'hobbit' remains were found. Scientists recently tested DNA from a number of these 'Rampasasans' in order to investigate if 'hobbits' were distant ancestors of theirs. The scientists found modern human genes and evidence of some Neanderthal and Denisovan genes but no traces of other unusual genes from other ancient hominins. Samples of Neanderthal and Denisovan DNA have been isolated and analysed by modern science but no DNA from *Homo floresiensis* ('hobbits') has yet been isolated. From these data the scientists concluded that modern 'Rampasasans' are not descended from *Homo floresiensis* ('hobbits') but, in common with most of the rest of the modern human population, they do have some Neanderthal and Denisovan ancestry.

- a. Explain how the scientists reached their conclusion from the evidence provided.

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2 marks

**SECTION B - Question 10-** continued

- b. What critical piece of information is missing at present, and if found, discuss how this may affect our understanding of how the hobbits fit into the human evolutionary story.

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2 marks

- c. In addition to short statured humans and hominins, evidence of a pygmy elephant species existing on Flores has also been found. Explain what aspects of the Flores environment might contribute to the evolution of mammals with a diminished size.

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2 marks

**SECTION B – continued**  
**TURN OVER**

**Question 11** (7 marks)

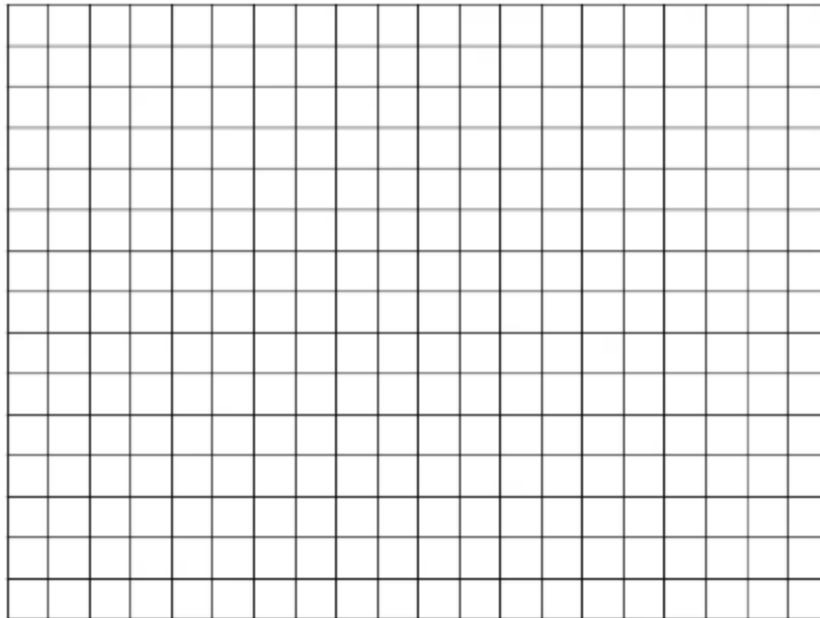
Some biology students weighed samples of potato and placed them into beakers containing distilled water, 1% salt solution, 5% salt solution and 10% salt solution. After 20 minutes the students re-weighed the potato samples and obtained the following results.

Salt Solution	Mass before experiment (g)	Mass after experiment (g)	Change in mass (g)
Distilled water	1.0	1.3	
1%	1.0	1.1	
5%	1.0	0.9	
10%	1.0	0.7	

- a. Calculate the change in mass of the potato samples. Write your answers into the table above.

1 mark

- b. Plot these results onto the following graph and draw a straight line of best fit through the points.



2 marks

**SECTION B - Question 11-** continued

c. Explain in detail why the changes in mass were observed. Make sure you use correct terminology and/or simple diagrams to clarify your response.

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2 marks

d. What do you estimate the internal concentration of the potato cells was? Explain how you estimated this number.

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2 marks

**END OF QUESTION AND ANSWER BOOK**