

YEAR 12 *Trial Exam Paper*

2016

BIOLOGY

Written examination

STUDENT NAME

Reading time: 15 minutes

Writing time: 2 hours 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	12	12	70
			Total 110

- Students are permitted to bring pens, pencils, highlighters, erasers, sharpeners and rulers into the examination.
- Students are NOT permitted to bring blank sheets of paper and/or white-out liquid/tape into the examination.
- Calculators are not allowed in this examination.

Materials provided

- Question and answer book of 43 pages.
- Answer sheet for multiple-choice questions.

Instructions

- Write your **name** in the box provided and on the multiple-choice answer sheet.
- 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** for the question.

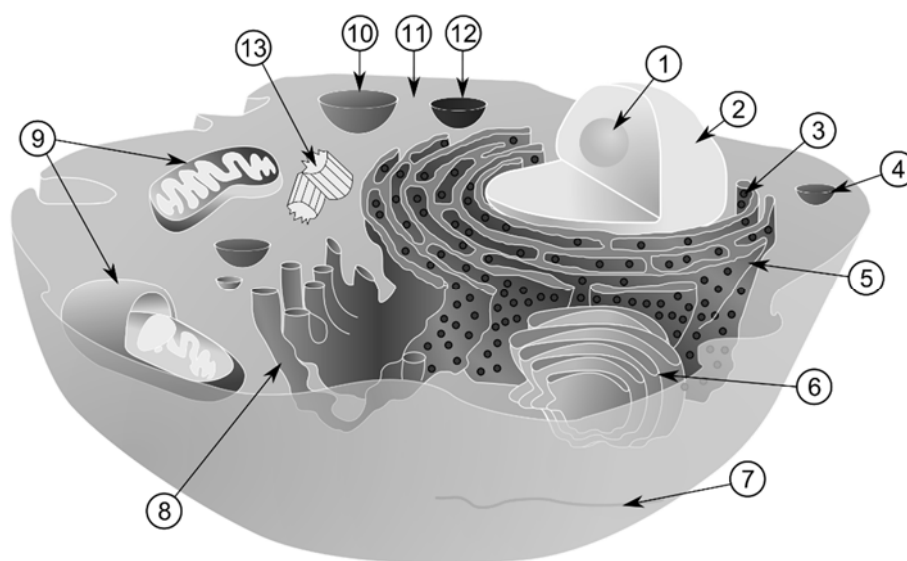
A correct answer scores 1; an incorrect answer scores 0.

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

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

Question 1

The diagram below represents a cross-section of a cell.

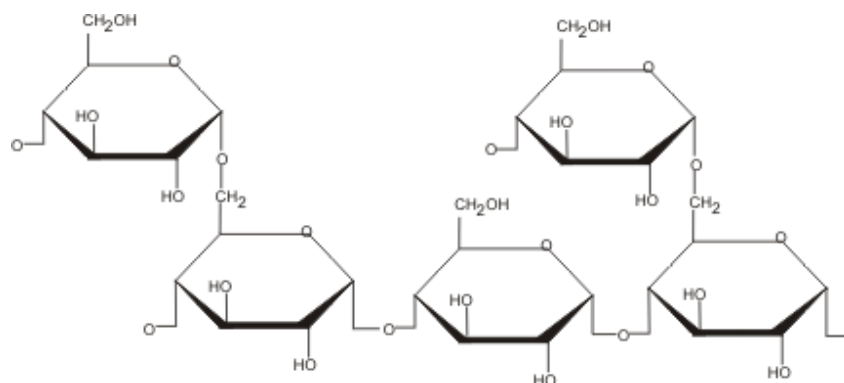


Which of the structures in the cell contains non-nuclear DNA?

- A. structure 1
- B. structure 2
- C. structure 5
- D. structure 9

Question 2

The diagram below shows a section of a compound that is responsible for energy storage and is only found in animal cells.

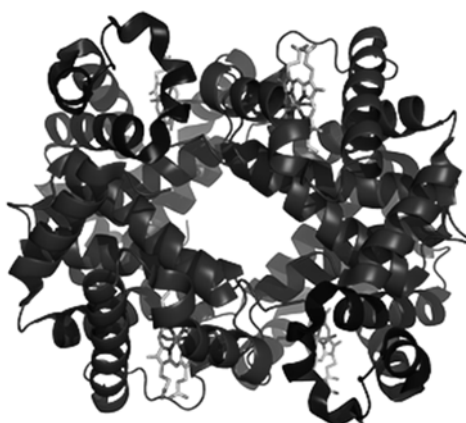


This substance is most likely to be

- A. ATP.
- B. starch.
- C. glycogen.
- D. glucagon.

Question 3

The following diagram shows an example of an organic macromolecule.

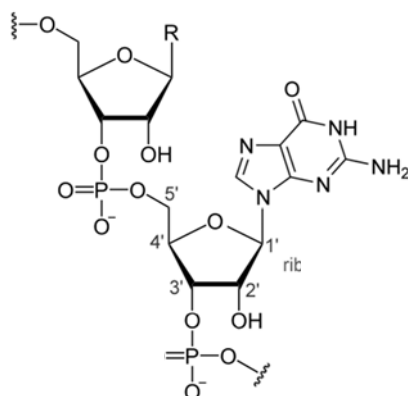


Cells that are specialised to secrete this type of molecule are expected to

- A. lack Golgi bodies.
- B. have large numbers of ribosomes.
- C. contain large numbers of chloroplasts.
- D. have an extensive smooth endoplasmic reticulum.

Question 4

The diagram below shows a small segment of the structure of an organic macromolecule.



Which of the following statements correctly identifies what occurs when this segment is joined to other similar structures?

- A. The reaction is catabolic.
- B. A net output of energy occurs.
- C. A condensation reaction would occur.
- D. An input of water is required for this reaction to occur.

Question 5

Which of the following forms of material transport both require an input of energy?

- A. osmosis and active transport
- B. facilitated diffusion and osmosis
- C. active transport and bulk transport
- D. facilitated diffusion and active transport

Question 6

A potato cylinder was weighed and then placed into a glucose solution for several hours. At the end of this time the potato cylinder was dried off and weighed again. There was no change in the mass of the potato cylinder.

The most likely reason for this is

- A. there was no movement of solute molecules.
- B. there was no net movement of water molecules.
- C. the cell walls of the plant cells are impermeable to all substances.
- D. the solute molecules do not move due to the lack of a concentration gradient.

Question 7

Substance X is an organic molecule that has bound to the regulatory region of an enzyme. This substance causes the shape of the enzyme to change and enables it to carry out its function. Substance X is most likely to be a

- A. cofactor.
- B. coenzyme.
- C. competitive inhibitor.
- D. non-competitive inhibitor.

Question 8

Lipase is an enzyme that is present in all raw milk and is also secreted by the mammalian digestive system. The function of lipase is to catalyse the reaction in which milk fats are broken down into fatty acids and glycerol.

Based upon the information provided and your understanding of enzyme catalysed reactions, which of the following statements is correct?

- A. Milk is refrigerated in order to prevent the spontaneous action of lipase.
- B. Fatty acids and glycerol are produced as the result of a catabolic reaction.
- C. The presence of lipase does not affect the activation energy of the reaction.
- D. The amount of the products produced depends upon the amount of lipase present

Question 9

Which of the following is the best definition of the process of photosynthesis?

- A. Water and oxygen are converted into glucose.
- B. Light energy is directly converted into chemical energy.
- C. Carbon dioxide and water are combined to produce chlorophyll.
- D. Chemical energy is used to combine hydrogen ions and carbon dioxide.

Question 10

Which of the following correctly describes events relating to the photolysis of water?

- A. It occurs in the grana during the light-dependent stage.
- B. It occurs in the stroma during the light-independent stage.
- C. Outputs of the Calvin cycle provide the energy necessary to split water molecules.
- D. It occurs as a result of the electron transport chain during the light-dependent stage.

Question 11

During the ATP cycle, ADP is phosphorylated to produce ATP.

Which of the following statements is correct?

- A. This reaction only occurs in eukaryotic cells.
- B. This reaction only occurs in the mitochondria.
- C. This reaction can occur in the presence or absence of oxygen.
- D. This reaction occurs spontaneously, so doesn't involve enzymes.

Question 12

Which of the following products are the result of anaerobic respiration in a human skin cell?

- A. lactic acid only
- B. ethanol and ADP
- C. lactic acid and carbon dioxide
- D. ethanol, carbon dioxide and ATP

Question 13

Peptide hormones usually interact with receptors that are located

- A. in the cytosol of a target cell.
- B. in the nucleus of a target cell.
- C. in the mitochondria of a target cell.
- D. on the external surface of a target cell.

Question 14

The speed of conduction in an axon can be increased by

- A. increasing the diameter of the axon and a thicker layer of insulation.
- B. increasing the diameter of the axon and a thinner layer of insulation.
- C. decreasing the diameter of the axon and a thicker layer of insulation.
- D. decreasing the diameter of the axon and a thinner layer of insulation.

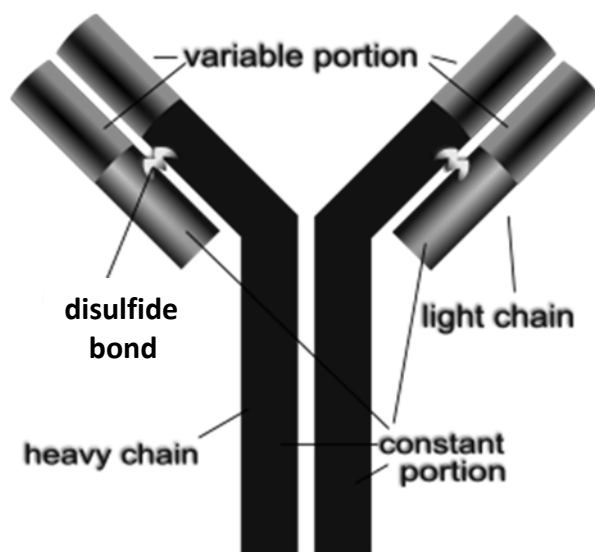
Question 15

Which of the following ions are responsible for the transmission of an action potential along an axon?

- A. calcium and sodium
- B. sodium and potassium
- C. potassium and calcium
- D. sodium, potassium and calcium

Question 16

The diagram below represents an antibody.



The area responsible for binding to an antigen is the

- A. light chain.
- B. heavy chain.
- C. variable portion.
- D. constant portion.

Question 17

An example of the first line of defence of the immune system is

- A. mast cells releasing histamine after exposure to a toxin.
- B. the production of tears when a foreign object enters the eye.
- C. platelets producing clotting factors after a wound is sustained.
- D. T helper cells releasing cytokines to stimulate cytotoxic T cells.

Question 18

Several days after undergoing a kidney transplant, a patient experienced symptoms associated with rejection of the donor kidney.

The most likely reason for this was

- A. the transplanted kidney was identified as non-self.
- B. immunosuppressive drugs acted against the kidney tissue.
- C. the surface antigens on the kidney were identical to that of the patient.
- D. the presence of foreign antigens caused the kidney cells to undergo apoptosis.

Question 19

As part of the Australian vaccination program, babies are provided with an immunisation against measles.

The immunity that is developed as a result of being vaccinated is best described as

- A. naturally acquired active immunity.
- B. artificially acquired active immunity.
- C. naturally acquired passive immunity.
- D. artificially acquired passive immunity.

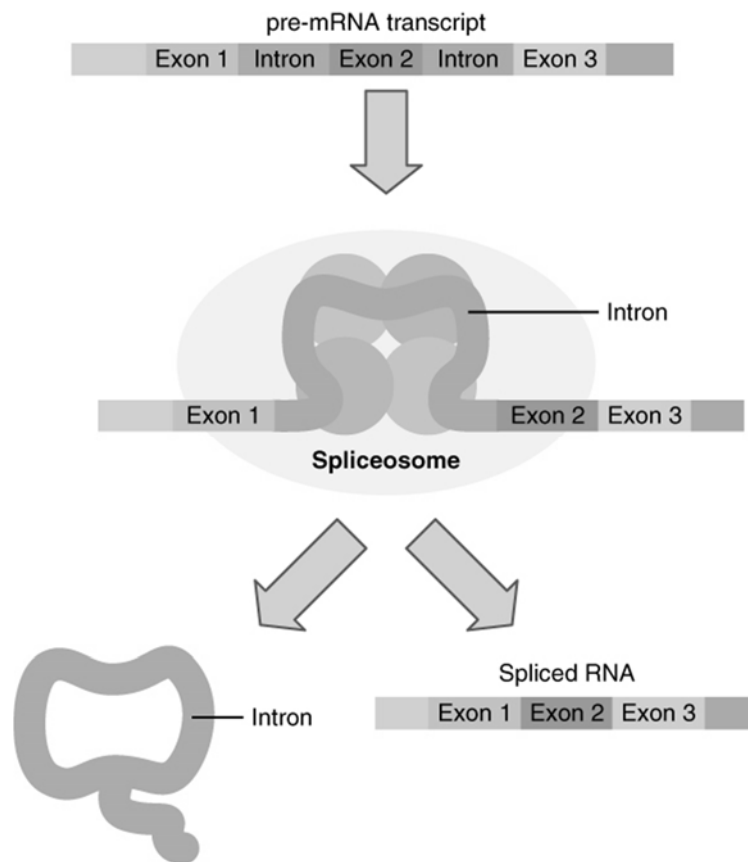
Question 20

Pathogenic agents, such as viruses, differ from cellular pathogens because

- A. pathogenic agents are only composed of proteins.
- B. pathogenic agents contain less DNA than cellular pathogens.
- C. pathogenic agents are unable to replicate outside a host cell.
- D. pathogenic agents are unable to exchange DNA with a host cell.

Question 21

The diagram below shows a process that occurs during the post-transcriptional modification of the pre-mRNA transcript.



Which of the following statements is correct?

- A. The spliced RNA will now leave the nucleus and be read by a ribosome.
- B. The spliceosome is made up of DNA that will be broken down and reused.
- C. A methylated cap needs to be added to the spliced RNA in front of the first exon.
- D. All post-transcriptional modification processes protect mRNA from degradation by the actions of nucleases.

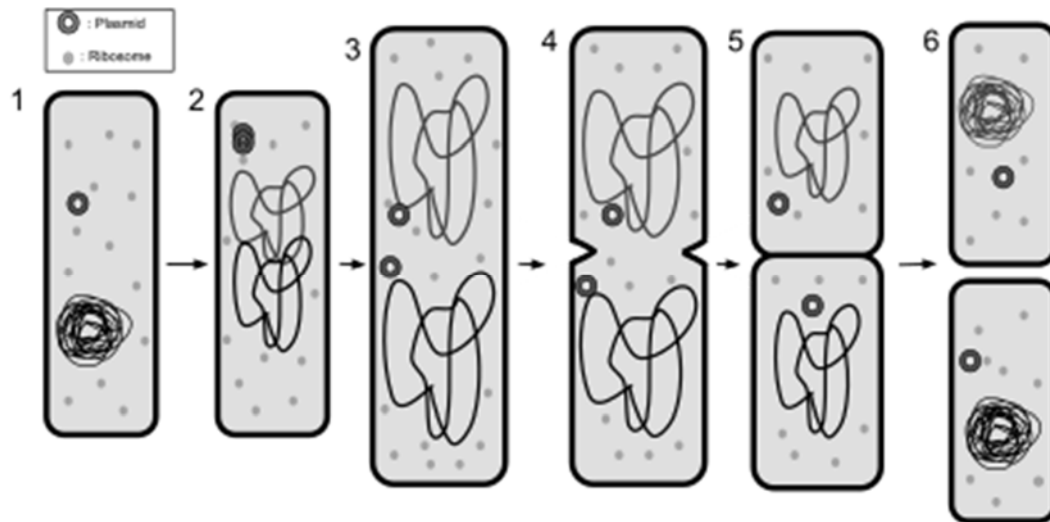
Question 22

A correct comparison between prokaryotic chromosomes and eukaryotic chromosomes is that they both

- A. contain introns and exons.
- B. are located in a membrane.
- C. are packaged into structures by the action of proteins.
- D. form homologous pairs as a result of processes that occur during replication.

Question 23

The image below shows an overview of a process that occurs in prokaryotic cells.



Which of the following statements correctly describes the cellular process shown in the diagram?

- A. The process has to be mitosis.
- B. The process has to be binary fission.
- C. The process could be mitosis or binary fission.
- D. The diagram shows a range of processes that occur during the cell cycle.

Question 24

A diploid cell should contain

- A. one complete set of chromosomes.
- B. a homologous pair of each chromosome.
- C. two identical copies of each chromosome.
- D. genomic DNA arranged into discrete chromosomes.

Question 25

A mutation caused a single codon to be removed from the central section of an mRNA molecule.

Which of the following is most likely to occur?

- A. The process of translation will be prevented from occurring.
- B. A premature stop codon will always be formed just after the mutation point.
- C. The codons to be read will be unaffected after the mutation point.
- D. The primary structure of the protein will be extensively altered after the mutation point.

Question 26

Which of the following options is earliest to occur during gene expression?

- A. mRNA is read by a ribosome.
- B. Replication of the specific gene occurs.
- C. The leading strand of DNA is read by DNA polymerase.
- D. tRNA transfers an amino acid from the cytosol to the ribosome.

Question 27

Sickle cell anaemia is caused by a single mutation in the beta-haemoglobin gene. The original DNA sequence is CTGGAG and the altered DNA sequence is CTGGGG.

Which of the following correctly describes this mutation?

- A. deletion
- B. frameshift
- C. duplication
- D. substitution

Question 28

The table below shows the recognition sequences for a range of restriction enzymes (also known as endonucleases) as well as providing information.

Enzyme	Recognition sequence	Structure of cut DNA
EcoRI	5' GAATTC 3' CTTAAG	5' G AATTC 3' CTTAA G
BamHI	5' GGATCC 3' CCTAGG	5' G GATCC 3' CCTAG G
HindIII	5' AAGCTT 3' TTCGAA	5' A AGCTT 3' TTCGA A
Sau3A	5' GATC 3' CTAG	5' GA TC 3' 3' CT AG 5'
Pov11	5' CAGCTG 3' GTCGAC	5' CAG CTG 3' 3' GTC GAC 5'
Alu1	5' AGCT 3' TCGA	5' AG CT 3' 3' TC GA 5'

The following double-stranded sequence of DNA contains flanking regions as well as a desired gene. The desired gene is shown in bold.

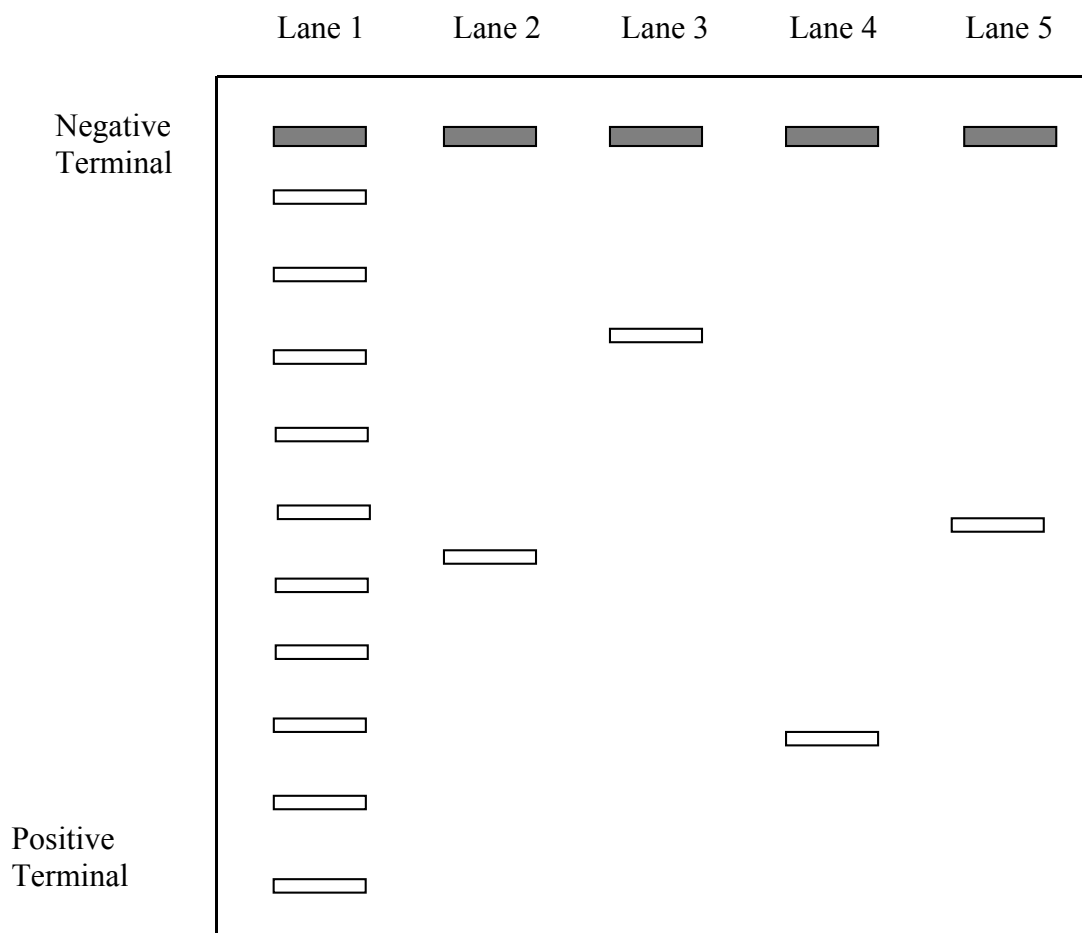
5' AGCTCGAATTC **GGACTTCAGCATCATC** CAGCTGGAATTC 3'
3' TCGAGCTTAAG **CCTGAACTCGTAGTAC** GTCGACCTTAAG 5'

Which restriction enzyme would be the best choice to use to cut out the gene from the overall sequence?

- A. Alu1
- B. Pov11
- C. EcoRI
- D. BamHI

Question 29

The diagram below represents an electrophoresis gel. The wells are shown in grey. Lane 1 contains a DNA ladder and the other four lanes contain samples to be identified.



The DNA ladder contains 10 DNA fragments ranging in size from 1 kb to 10 kb. The fragments are spaced every 1 kb. The original plasmid is 5.3 kb long and the desired gene is 2.9 kb long.

Which of the lanes contains the fragment of DNA that represents a recombinant plasmid?

- A. Lane 2
- B. Lane 3
- C. Lane 4
- D. Lane 5

Question 30

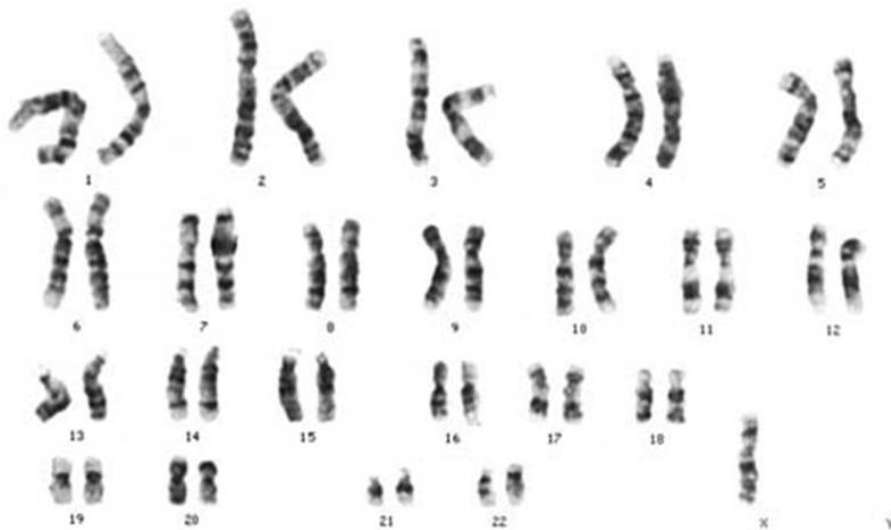
A woman with type A blood has a partner with type B blood. They have two children, one of whom has type A blood and the other has type B blood.

Which of the following conclusions are most valid?

- A. Both of the parents have to be heterozygous.
- B. Both of the offspring have to be homozygous.
- C. This couple could have children with three different phenotypes.
- D. The children are adopted because all of the parents' offspring should have type AB blood.

Question 31

The following image shows the karyotype obtained from a sample of amniotic fluid surrounding a foetus.



From observing this karyotype, it could be concluded that the cells of this individual are

- A. diploid.
- B. euploid.
- C. polyploid.
- D. aneuploid.

Use the following information to answer questions 32 and 33.

Colour blindness in humans is an X-linked recessive condition. A woman with normal vision has a father who is colour blind and is married to a man who has normal vision.

Question 32

How many different phenotypes are possible in their offspring?

- A. one
- B. two
- C. three
- D. four

Question 33

The woman is concerned that some of her children will also be colour blind.

Which of the following statements is correct?

- A. Her sons will have a 25 per cent chance of being colour blind.
- B. Her sons will have a 50 per cent chance of being colour blind.
- C. Her daughters will have a 50 per cent chance of being colour blind.
- D. All of her children have a 25 per cent chance of being colour blind, regardless of their gender.

Question 34

An Afrikaner is an Afrikaans-speaking native of South Africa who is of European, especially Dutch, descent. Variegate porphyria is an autosomal dominant trait that is common in this population, with approximately 1 out of every 200 members of the Afrikaner population being affected. In comparison, in the United States, variegate porphyria affects 1 in 25 000 people. All Afrikaners affected by this condition have been found to be the descendants of a single Dutch couple who immigrated to South Africa in the 1680s.

Which of the following conclusions is most valid?

- A. The information provided describes an example of the founder effect.
- B. There must be a selective advantage for Afrikaners who have inherited variegate porphyria.
- C. Having variegate porphyria increases the fertility of those affected, causing them to have larger numbers of offspring.
- D. There must be an environmental factor affecting the Afrikaner population that is not affecting the United States population.

Question 35

In 1995, several iguanas (*Iguana iguana*) survived a hurricane on a raft of uprooted trees and were transported from mainland North America to the Caribbean island of Anguilla. These few individuals were the first iguanas to reach the island.

Why would biologists be curious to track the health, adaptations and population size of the iguanas on Anguilla?

- A. This event could be the initial stage of speciation.
- B. The iguanas have been forced through a genetic bottleneck.
- C. They have the opportunity to observe a literal example of genetic drift.
- D. The iguanas aren't in their normal environment and will probably die out.

Question 36

The image below compares a representative of three different species, each of which is capable of flight. Species 1 is a pterosaur (an extinct flying dinosaur), Species 2 is a bat (a mammal) and Species 3 is an albatross (a type of bird).



The skeletons of these organisms show a similarity of structure indicating that members of each of these species had wings and were capable of flight.

This information is used to support the statement that these organisms are the products of

- A. speciation.
- B. natural selection.
- C. divergent evolution.
- D. convergent evolution.

Question 37

The image below shows a fossil of a species of dinosaur called *Archeopteryx*. This organism has several characteristics in common with birds, such as having a wishbone and a reversed perching toe. However, it also had sharp teeth and a bony tail, which are characteristics of dinosaurs.



Which of the following statements is correct?

- A. This is an indicator fossil because it indicates that some species of dinosaur had feathers.
- B. This is a transitional fossil because it has features in common with ancestral and descendant species.
- C. This is a hybrid fossil because it shows evidence that dinosaurs and birds were able to have hybrid offspring.
- D. This is an evidentiary fossil because it provides scientists with information that can be used to support the theory of evolution.

Question 38

Mitochondrial DNA is commonly used to establish the extent of relatedness between different organisms. It is referred to as a molecular clock.

Mitochondrial DNA can be used for this purpose because

- A. it mutates at a slower rate than genomic DNA.
- B. recombination does not occur in mitochondrial DNA.
- C. all members of a family will have identical mitochondrial DNA.
- D. mitochondrial DNA produces proteins that facilitate aerobic respiration, a process that is essential in all living organisms.

Question 39

Cystic fibrosis is an autosomal recessive genetic condition. The most common symptom of cystic fibrosis is the production of a thick, sticky mucus that clogs an affected individual's airways. Because this is a monogenic trait, clinical trials have been conducted to determine the effectiveness of gene therapy. A viral vector containing the corrected gene is inhaled directly into the lungs.

If an affected individual undergoes gene therapy

- A. it will prevent them from having offspring who have cystic fibrosis.
- B. the cells that take up the viral vector will undergo apoptosis as soon as the foreign DNA is inserted.
- C. success will be limited because the virus cannot be programmed to insert the gene at a particular location.
- D. a viral vector will remove the defective allele from the genome and replace it with a correctly functioning allele.

Question 40

There are two main theories regarding evolution, one of which is the Out of Africa theory.

Which of the following pieces of information can be used to support this theory?

- A. All of the oldest fossils of the hominin species are found in Africa.
- B. All modern and ancestral human species have the same mitochondrial DNA.
- C. Modern *Homo sapiens* colonised all other areas of the world at the same time.
- D. Successive waves of modern humans left Africa at different times but continued to interbreed with each other.

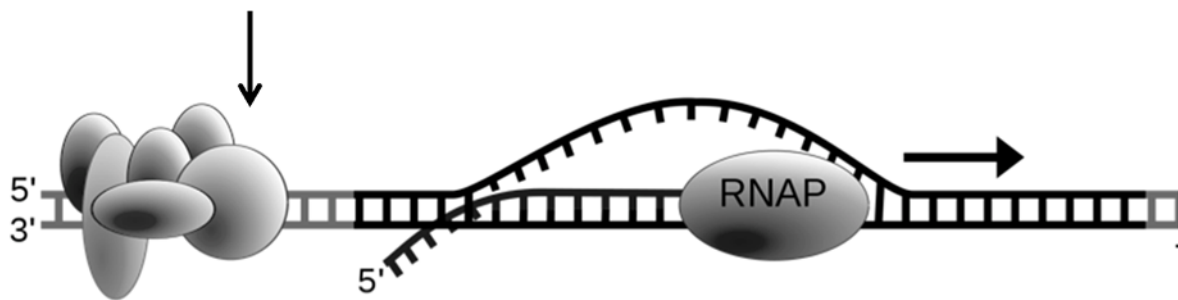
END OF SECTION A
TURN OVER

SECTION B – Short-answer questions**Instructions for Section B**

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

Question 1 (5 marks)

Escherichia coli is a species of bacteria that uses lactose as a food source. These bacteria are able to produce polypeptide enzymes that break down lactose into smaller chemicals that they are able to digest. The diagram below shows RNA polymerase (identified as RNAP in the diagram) reading a template strand of DNA. The substance indicated by the arrow is RNA primase, which provides a binding site for RNA polymerase.

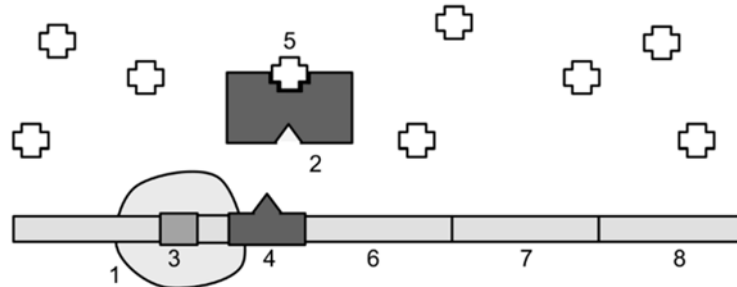


- a. Identify the molecule that will be released when RNA polymerase has finished reading the template strand of DNA.

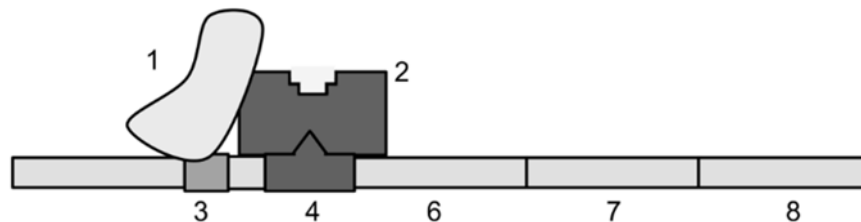
1 mark

E. coli bacteria do not need to always produce the enzymes that allow them to metabolise lactose. The lac operon system is responsible for controlling when these enzymes are produced. This is called gene regulation. The following diagrams show how enzyme production is affected by the presence or absence of lactose.

In this situation, the enzymes needed to metabolise lactose will be produced.



In this situation, the enzymes needed to metabolise lactose will not be produced.



- b.** Explain how *E. coli* bacteria benefit by having the ability to regulate the production of enzymes that allow them to metabolise lactose.

1 mark

- c.** Identify the structures labelled 2 and 4.

1 mark

- d.** Explain why the enzymes responsible for the metabolism of lactose will not be produced when structures 2 and 4 are arranged as shown in the second diagram.

1 mark

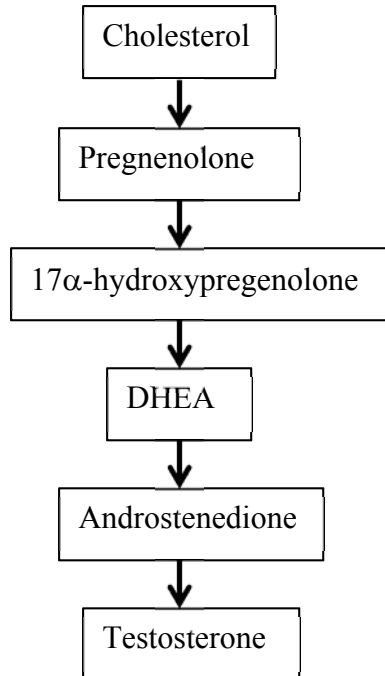
- e.** Regulation systems, such as the lac operon, rely on the ability of certain proteins to change shape.

Explain why it is essential that these proteins have this ability.

1 mark

Question 2 (5 marks)

The following diagram shows the relationship between a sequence of chemicals that are involved in the production of testosterone. The product of each reaction is the input for the next reaction. Large amounts of testosterone are secreted by male foetuses approximately eight weeks after fertilisation. Similar large amounts of testosterone will not be produced again until puberty occurs.



- a. What is the term used to describe this sequence of events?

1 mark

Testosterone can be converted into a substance called dihydrotestosterone in a reaction catalysed by the enzyme 5- α -reductase. Most individuals who have a Y chromosome begin to produce this enzyme approximately eight weeks after fertilisation. The development of male structural characteristics depends upon the production of dihydrotestosterone. There is a village in the Dominican Republic where 2 per cent of the population are born as females but become male with the onset of puberty.

- b.** Explain why these individuals who are genetically male are born appearing to be female, and why these individuals then develop male characteristics at puberty.

2 marks

A child was born who appeared to be phenotypically female. Some cellular material was extracted from the child and used to produce the karyotype shown below.

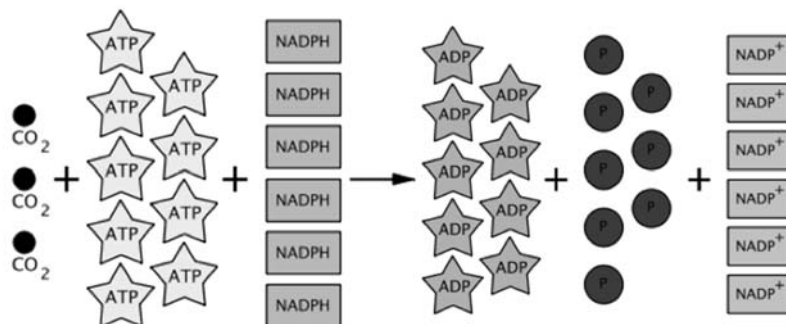


- c.** What conclusion can be drawn about this child? Use the information to provide a reason to support your answer.

2 marks

Question 3 (5 marks)

The diagram below is a representation of one of the stages in a cellular process that only occurs in plants.



- a. What is the original source of energy used in the first stage of this process?

1 mark

- b. Identify the specific stage of the reaction that is shown occurring in the diagram.

1 mark

- c. Explain the importance of the role played by NADPH in the stage shown in the diagram.

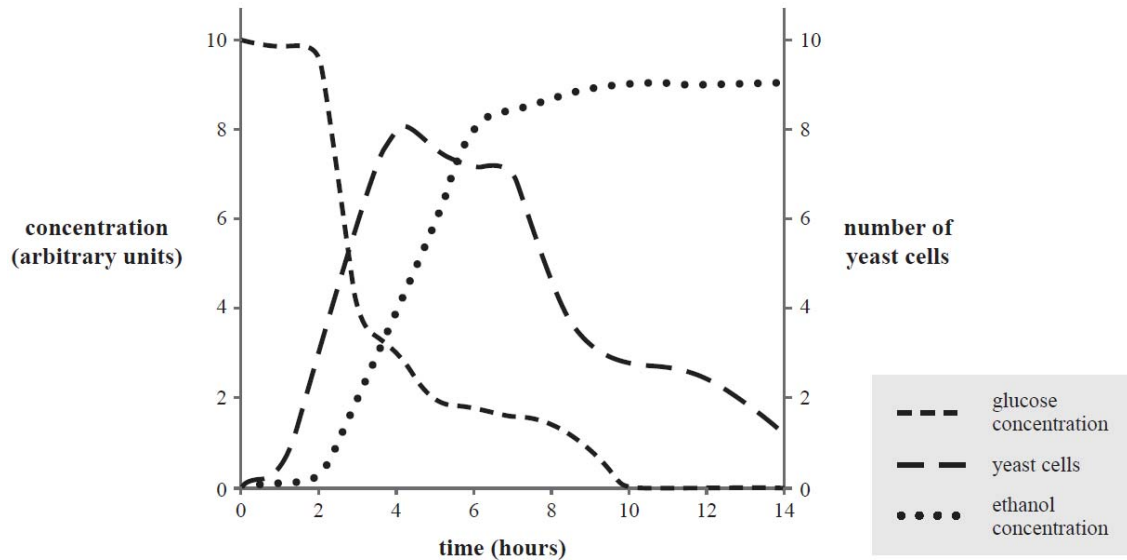
1 mark

- d.** Identify the area of the organelle where the stage of the reaction shown in the diagram is occurring. Use the information supplied to provide a reason to support your answer.

2 marks

Question 4 (6 marks)

A solution containing glucose was prepared and then treated to remove oxygen. Yeast cells were then placed into the solution, and the container holding the yeast cells and the solution was sealed. The graph below shows how the concentrations of glucose and ethanol molecules changed over a period of 14 hours. It also shows how the number of yeast cells inside the sealed container changed over the same period of time.



- a. What process are the yeast cells carrying out?

1 mark

- b. Explain the link between the glucose and ethanol concentrations after the ten-hour point was passed.

2 marks

- c. Explain why the number of yeast cells increases and then decreases.

1 mark

A second group of yeast cells were grown at the same time, with the only difference being that the second group of cells were consistently supplied with oxygen. The results were recorded and graphed in the same way as the results from the first group of yeast cells.

- d. Identify **one** way in which the second graph would be expected to differ from the first. Provide a reason to support your answer.

2 marks

Question 5 (5 marks)

Insulin is a peptide hormone that is produced by β -cells of the islets of Langerhans. The secretion of insulin increases in response to high blood glucose concentrations. Insulin is a signalling molecule that affects a range of cells. In response to insulin, fat and muscle cells take up glucose. Liver cells also take up glucose and convert glucose to glycogen.

- a.** Using insulin as an example, identify and discuss the three stages that occur in the stimulus-response model associated with cellular communication and response.

3 marks

- b.** Provide a reason why liver cells and muscle cells respond in different ways to insulin.

1 mark

- c.** Explain how glucose enters liver and fat cells.

1 mark

Question 6 (8 marks)

Most cytotoxic T cells express T cell receptors that can recognise a specific antigen. Antigens inside a cell combine with class I major histocompatibility complex molecules and are brought to the surface of the cell where they can be recognised by the cytotoxic T cell.

- a.** What is an antigen?

1 mark

- b.** A cell is displaying an antigenic fragment relating to antigen X. Describe what will occur if a cytotoxic T cell has a T cell receptor that is specific for that antigen.

1 mark

- c.** Exposure to an antigen also leads to the production of antibodies. Describe the series of events that occurs between the time when an individual is exposed to an antigen to the time when the individual produces antibodies.

2 marks

The Immunise Australia Program implements the National Immunisation Program Schedule, which currently includes vaccines against 16 different diseases. These include measles, German measles, whooping cough, diphtheria and meningococcal disease.

- d.** A health professional stated, ‘The more people who are vaccinated, the fewer opportunities a disease has to spread.’

What concept is the health professional referring to? Explain why a disease is less likely to spread in a population where large numbers of people have been immunised.

2 marks

The National Immunisation Program Schedule includes booster injections for whooping cough at two months, four months, six months and four years.

- e.** Why do immunisation programs require children to have booster injections for a range of diseases? How does the provision of booster shots lead to long-term immunity?

2 marks

Question 7 (5 marks)

A child was observed to have a rash and shortly afterwards the child experienced respiratory problems. The child's doctor recommended a series of tests including the skin prick test, which is shown in the photograph below. This test involves piercing the skin with a sharp object and then exposing the individual to a range of substances.



- a. What term is used to describe the condition experienced by the child?

1 mark

- b. What term is used to describe the substances applied to the individual's skin?

1 mark

The degree of sensitivity is determined by the degree of response. A positive response to a substance is called a weal, which is a raised swollen area surrounding the point where the skin was pierced.

The scale used is as follows:

Weal size	Less than 4 mm	5 to 10 mm	10 to 15 mm	More than 15 mm
Interpretation	Negative	Mildly sensitive	Moderately sensitive	Very sensitive

The results for this child were:

Substance	Peanuts	Dog fur	Dust	Cat fur	Washing powder	Saline	Histamine
Size (mm)	0	0	0	2	16	0	10

- c. What advice should be given to the parents of this child? Use the information provided to support your answer.

2 marks

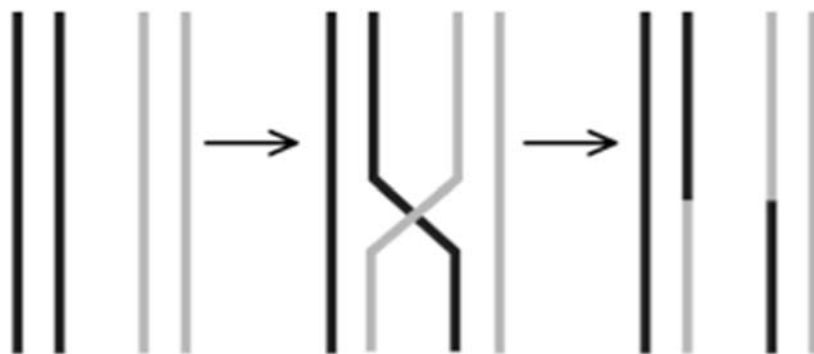
- d. The response to histamine would occur in all individuals and is not an indication of sensitivity.

Explain the purpose of exposing the child to histamine as a standard part of the skin prick test.

1 mark

Question 8 (6 marks)

The following shows a process that occurs between a homologous pair of chromosomes during meiosis.



- a. Identify the process and explain what occurs during this process.

2 marks

- b. What impact does this process have on gamete formation? Explain how a species benefits as result of this process occurring.

2 marks

Sometimes inversion will happen during this process. An example of this is shown in the diagram below.

Set 1: Before inversion

Set 2: After inversion

	A	B	C	D	E	F	G		
--	---	---	---	---	---	---	---	--	--

	d	c	b	a	E	F	G		
--	---	---	---	---	---	---	---	--	--

	a	b	c	d	e	f	g		
--	---	---	---	---	---	---	---	--	--

	A	B	C	D	e	f	g		
--	---	---	---	---	---	---	---	--	--

- c. What effect will inheriting either of the second set of chromosomes have on the phenotype of the individual who inherits them? Provide a reason to explain your answer.

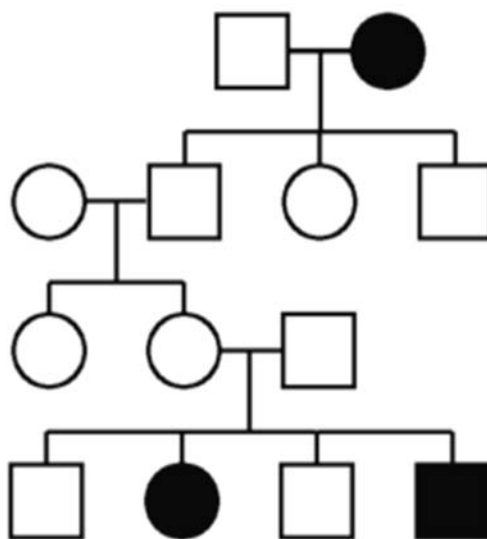
2 marks

Question 9 (9 marks)

Medium-chain acyl-CoA dehydrogenase deficiency (MCADD) is an inherited metabolic disorder that is characterised by the inability to break down medium-chain fatty acids. There are more than 60 known mutations that cause MCADD.

Symptoms of MCADD include lethargy, vomiting and seizures, which can lead to those affected going into a coma within two hours of symptoms presenting. It is estimated that 25 per cent of undiagnosed people will die the first time that they experience symptoms.

The following pedigree chart shows the incidence of MCADD in a family over four generations.



- a. What is the mode of inheritance for this trait? Provide **two** reasons to support your answer.

3 marks

- b.** Write appropriate allele symbols for this trait.

1 mark

- c.** A couple, both of whom are unaffected, have a child who has MCADD. They then have a second child who is unaffected.

What is the probability that this child is homozygous? Use a Punnett square to help you to provide an explanation for your answer.

2 marks

- d.** The results from studies were used to estimate that between 1 in 40 and 1 in 80 people are carriers for the condition. The mutations that cause MCADD can be detected using genetic screening. It has been suggested that the entire population should be screened for the alleles that cause MCADD.

Discuss **two** reasons to support why a government health body would reject this suggestion.

2 marks

- e. In the United Kingdom, all older siblings of an affected child are offered the opportunity to undergo genetic screening for the MCADD mutation.

Explain the importance of these individuals undergoing genetic screening when the rest of the population is not screened.

1 mark

Question 10 (7 marks)

French Island is Victoria's largest coastal island and is located in Western Port Bay. Koalas were introduced to the island from mainland populations in the 1880s. As the population has remained free of the disease chlamydia, the koalas on French Island have been regularly translocated back to the mainland to interbreed with the mainland koalas since 1923.

- a. What term is used to describe interbreeding between two populations?

1 mark

In the 1920s, 18 koalas were translocated from French Island to Kangaroo Island, which is located off the coast of South Australia. All koalas currently living on Kangaroo Island are the descendants of these 18 koalas.

- b. What would be the extent of genetic variation of the modern population of koalas on Kangaroo Island? What concerns would be raised about their potential use for conservation efforts? Explain.

2 marks

- c. It is possible that the small Kangaroo Island population may be affected by genetic drift or even a population bottleneck.

Why are small populations more vulnerable to these events?

1 mark

- d.** Koalas in South Gippsland are now the most genetically diverse of southern koala populations and as such are crucial for long-term conservation.

Explain why conserving this population is important, with particular reference to selection pressures.

1 mark

Studies of hypervariable regions of mitochondrial DNA (mtDNA) samples from Victorian koalas found that genetic diversity in these populations was low. It was hypothesised that the low diversity was due to inbreeding, hunting and disease. To test this hypothesis, samples of mtDNA were obtained from preserved museum specimens from the late 1700s to the early 1920s.

- e.** In terms of genetic variation, what findings would this study have been expecting to find in the mtDNA from the museum specimens compared with the mtDNA of modern koalas?

1 mark

- f.** The scientists found that there was no significant difference in the extent of genetic variation between the mtDNA taken from the historic koalas compared with the mtDNA of the modern koala population.

Identify a valid conclusion that the scientists conducting the research may have reached.

1 mark

Question 11 (4 marks)

In 2013, the fossilised bones of 15 members of a previously unknown branch of the human family tree were discovered in a cave in South Africa. This species was named *Homo naledi*.

H. naledi stood about 1.5 metres tall and weighed approximately 45 kilograms. Their hands, wrists and feet were similar to those of modern humans, but their cranial capacity was much smaller. Their upper body was more similar to earlier humans than to modern humans. Their most unusual feature was extremely curved fingers, more curved than almost any ancestral species of human.

Experts stated that this find ‘highlighted the complexity of the human family tree and the need for further research to understand the history and ultimate origins of our species’.

- a. How does the discovery of new fossils affect our understanding of human evolution?

1 mark

Experts are uncertain how old the bones are, but say they were probably placed there after death, a discovery that shines light on ancient human rituals.

- b. It is believed that *H. naledi* was highly suited to climbing trees. Identify a feature of *H. naledi* fossils that could be used to support this conclusion.

1 mark

- c. The bones were of at least 15 individuals and there are thought to be many more. This evidence indicates that the bones were deliberately placed there.

What is the cultural significance of these findings?

1 mark

- d. A number of articles released in 2015 identify *H. naledi* as being ‘a new species of hominid’. Is this completely correct? Provide a reason to support your answer.

1 mark

Question 12 (5 marks)

The first successful attempt at cloning occurred in the 1950s, with two scientists Briggs and King cloning a species of frog *Rana pipiens*.

Cloning was accomplished by the following steps:

1. Eggs were obtained from two different frogs.
2. Scientists removed the nucleus from both eggs.
3. The genetic material from frog 1 was placed into the empty egg from frog 2.
4. The egg was then allowed to develop under normal conditions.

- a.** Explain why the donor cell had to be a somatic cell rather than a gamete.

1 mark

- b.** Which frog would the cloned frog have been genetically identical to? Provide a reason to support your answer.

1 mark

- c.** What type of cloning has occurred in this example?

1 mark

- d.** Briggs and King attempted to perform nuclear transfers with progressively older cells, and found that as the cells developed it became much more difficult to produce clones.

Why would this happen?

1 mark

- e. After their initial success, Briggs and King speculated that this type of cloning ‘may have other uses’.

Identify **one** currently existing or potential use for cloning.

1 mark

END OF QUESTION AND ANSWER BOOK