

Trial Examination 2019

VCE Biology Units 3&4

Written Examination

Question and Answer Booklet

Reading time: 15 minutes
Writing time: 2 hours 30 minutes

Student's Name: _____

Teacher's Name: _____

Structure of booklet

<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	80
			Total 120

Students are permitted to bring into the examination room: pens, pencils, highlighters, erasers, sharpeners and rulers.

Students are NOT permitted to bring into the examination room: blank sheets of paper and/or correction fluid/tape.

No calculator is allowed in this examination.

Materials supplied

Question and answer booklet of 36 pages

Answer sheet for multiple-choice questions

Instructions

Write your **name** and your **teacher's name** in the space provided above on this page, and on the answer sheet for multiple-choice questions.

Unless otherwise indicated, the diagrams in this booklet 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 booklet.

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

Students are advised that this is a trial examination only and cannot in any way guarantee the content or the format of the 2019 VCE Biology Units 3&4 Written Examination.

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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.

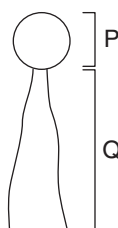
Marks will **not** be deducted for incorrect answers.

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

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

Question 1

The diagram below represents an important biological biomacromolecule. Regions P and Q are referring to parts of the biomacromolecule.



It is reasonable to conclude that

- A. region P is hydrophobic because it is in direct contact with water.
- B. region P, as a component of the plasma membrane, is in contact with either the extracellular or intracellular environments.
- C. region Q is at the end of the hydrophilic phosphate tails, which face away from water.
- D. both regions P and Q are lipophilic as the biomolecule is a type of lipid.

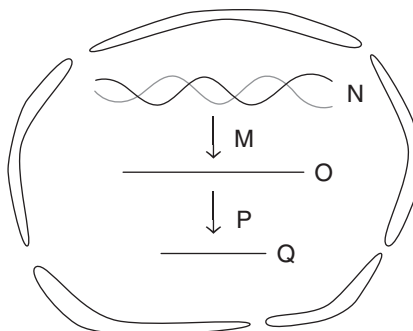
Question 2

Which one of the following is often referred to as the ‘central dogma of biology’?

- A. DNA $\xrightarrow{\text{translation}}$ RNA $\xrightarrow{\text{transcription}}$ protein
- B. RNA $\xrightarrow{\text{translation}}$ DNA $\xrightarrow{\text{transcription}}$ protein
- C. DNA $\xrightarrow{\text{transcription}}$ RNA $\xrightarrow{\text{translation}}$ protein
- D. protein $\xrightarrow{\text{transcription}}$ DNA $\xrightarrow{\text{translation}}$ RNA

Question 3

The diagram below illustrates the processes M and P and the structures N, O and Q occurring inside the nucleus of a cell.



It is appropriate to say that

- A. structure N represents a chromosome.
- B. process M represents gene expression.
- C. process P splices out introns and joins exons.
- D. structures O and Q have the same nucleotide sequence.

Question 4

The mitochondrial matrix can be isolated and analysed for its chemical composition.

The biomolecules that would be expected to be present would be

- A. mRNA, rRNA, tRNA and DNA.
- B. DNA, glucose, rRNA and water.
- C. tDNA, water, oxygen and enzymes.
- D. NADPH, ADP, mRNA and carbon dioxide.

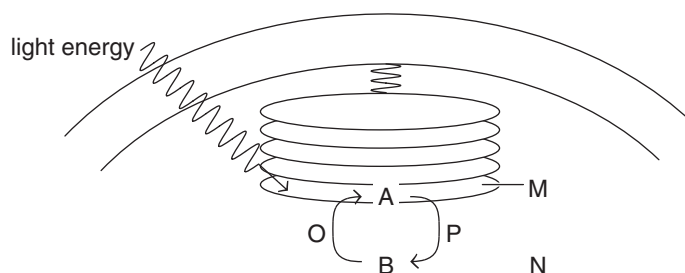
Question 5

Enzymes

- A. are only functional at the quaternary level.
- B. are only able to produce one product.
- C. are used up in the chemical reaction they catalyse.
- D. have an active site that substrates are complementary to.

Use the following information to answer Questions 6–8.

The following diagram shows a number of reactions, regions and factors. Reactions A and B are important biochemical reactions within the chloroplast. Areas M and N are regions within the chloroplast. Factors O and P are cycled between the two biochemical reactions.



Question 6

Which one of the following combinations of reaction, factors and area is correct?

	Reaction A	Factors P	Area N
A.	glycolysis	ADP, Pi and NAD	cytosol
B.	light-dependent	ATP and NADPH	stroma
C.	electron transport	NADPH and NADP	cristae
D.	light-dependent	ADP, Pi and NADPH	lumen of the grana

Question 7

The products of reaction B are

- A. carbon dioxide and water.
- B. glucose and water.
- C. pyruvic acid and lactic acid.
- D. oxygen and water.

Question 8

Area N can be isolated, enabling reaction B to be investigated.

Which one of the following statements would be appropriate with respect to the reaction?

- A. It would stop if light energy was not provided.
- B. It would only proceed if factors O and light energy were provided.
- C. It would only proceed if reaction A, light energy and factors O were provided.
- D. It could proceed in the dark if factors P were provided.

Use the following information to answer Questions 9–11.

Rennin is a proteolytic enzyme that has the role of coagulating milk in the stomach of some animals. Humans have isolated this enzyme and use it in the production of cheese. An experiment was conducted to investigate the effect of pH changes on the functioning of rennin. The steps are listed below.

1. 5×10 ml buffer solutions were set up at pH 3, 5, 7, 9 and 11.
2. 10 ml of full cream milk was added to each.
3. All solutions were incubated for 10 minutes at 37°C .
4. 2 ml of a rennin solution was added to each solution.
5. The time it took for each solution to coagulate was measured.
6. The experiment was concluded if coagulation was not recorded by 10 min and a +10 result was recorded.
7. The above steps were repeated five times.

Results for the experiment are listed in the table below.

pH	Time taken for the milk to coagulate (seconds)				
	Trial 1	Trial 2	Trial 3	Trial 4	Trial 5
3	27	29	25	32	17
5	68	72	60	85	74
7	155	201	155	184	172
9	234	302	324	208	413
11	+10 min	+10 min	+10 min	+10 min	+10 min

Question 9

Which one of the following would be a suitable hypothesis for this experiment?

- As the pH increases, the time taken for the milk to coagulate will decrease.
- As the pH increases, the rate of reaction will decrease.
- As the milk takes more time to coagulate, the pH decreases.
- As the pH deviates from a pH of 7, the time taken for the milk to coagulate will increase.

Question 10

An appropriate comment about the experimental data would be that

- the data became more precise with increasing numbers of trials.
- the data is invalid because coagulation time is difficult to measure.
- an average for each pH would be an appropriate way to process the data.
- the accuracy would be high because the repeatability was also high.

Question 11

Which one of the following would be a suitable explanation for the obtained results?

- Low pH is the optimal environment for cheese production.
- At a high pH, the active site of rennin has not denatured.
- As stomachs are acidic, the rennin enzyme is denatured in that environment.
- The most suitable environment for cheese production would be 37°C and pH 7.

Question 12

The following table shows a list of different signalling molecules, as well as an example of each.

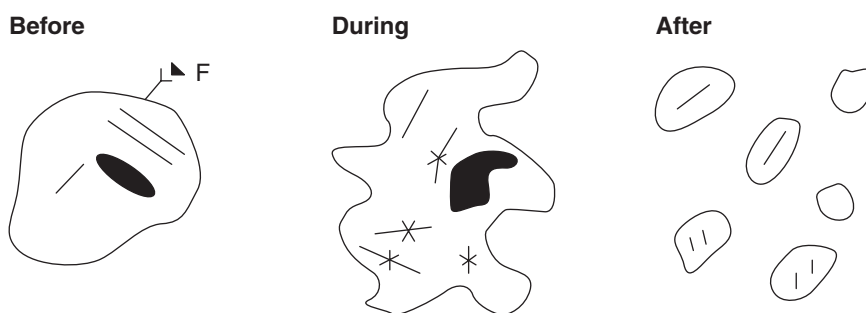
Molecule	Example
plant hormone	gibberellic acid
animal hormone	oestrogen
neurotransmitter	serotonin
cytokine	interleukin 10
pheromone	androstenone

In terms of action, it would be appropriate to say that

- A. both oestrogen and androstenone are intra-specific airborne signalling molecules.
- B. interleukin 10 is a signalling molecule between leucocytes.
- C. gibberellic acid binds to postsynaptic receptors to stimulate a response.
- D. serotonin only travels in the bloodstream to target tissue with complementary receptors.

Question 13

The diagram below shows the before, during and after effects of apoptosis.

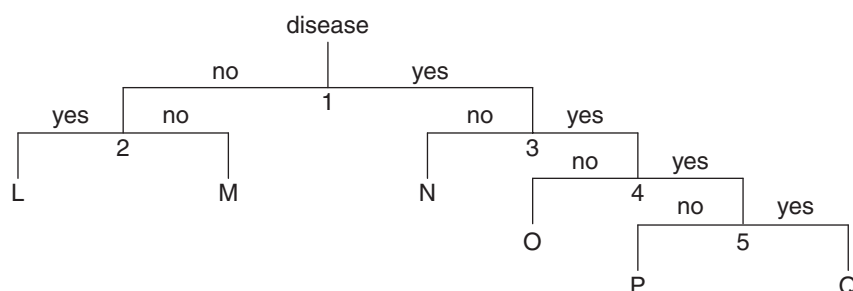


It would be accurate to say that

- A. F is an intrinsic signalling molecule.
- B. the crosses (×) in the 'during' phase of apoptosis could be caspase.
- C. the 'after' diagram includes blobs.
- D. the process depicted would promote cancerous growth.

Question 14

An emerging disease was being classified by carrying out a variety of techniques that served to eliminate a particular type of pathogenic organism/agent. As shown in the following diagram, steps 1 to 5 were applied to the disease and the result of the test was recorded as either a 'yes' or a 'no'. L to Q represent particular groups of disease-causing pathogens.



Which of the following scenarios is correct? (An NA meant the test was 'Not Applied'.)

	Step 1	Step 2	Step 3	Step 4	Step 5
Organism	Is the pathogen cellular?	Does the pathogen contain nucleic acid?	Is the pathogen eukaryotic?	Does the pathogen possess a cell wall?	Is the pathogen unicellular?
A. prion	no	yes	NA	NA	NA
B. virus	no	no	NA	NA	NA
C. fungi (yeast)	yes	NA	yes	yes	yes
D. bacteria	yes	NA	yes	no	NA

Question 15

It is appropriate to state that

- A. allergens are antigenic to allergy sufferers.
- B. non-self antigens are displayed on the surface of all cells within a multicellular individual.
- C. allergens have a similar shape to self-antigens in non-allergy sufferers.
- D. self-antigens are always on the surface of transplanted cells.

Question 16

Neutrophils and macrophages are part of the cellular innate immune response.

When they encounter a pathogen they both have the capacity to produce cytokines that

- A. stimulate the humoral response.
- B. can lead to a localised inflammatory response.
- C. would lead to vasoconstriction near the site of infection.
- D. stimulate a fever regardless of the type of pathogen.

Question 17

Cows only produce milk after they have given birth to a calf. To keep milk production in cows high, the calves are removed from the mothers and hand-reared so that the milk from the cow can be used for commercial purposes. However, if the calves are left with their mother for two weeks before being hand-reared, they are more likely to thrive.

This is due to the milk

- A. artificially providing short-term immunity to the calf.
- B. providing a natural form of active immunity for the calf.
- C. providing an active form of passive immunity for the calf.
- D. naturally providing a form of passive immunity for the calf.

Question 18

One person infected with measles can infect up to eighteen non-infected people, which makes it about four times more contagious than influenza; however, the mortality rate in 2018 was very low. Vaccination programs over many years have provided ways of reducing the rapid spread of the disease. In 2018 there were virtually zero cases of measles in the developed world.

Based on this information, it would be reasonable to state that

- A. vaccination programs have reduced the chance of measles reproducing.
- B. isolating individuals with measles is the best way to reduce the spread of this disease in the population.
- C. vaccination programs could now be stopped because the developed world has herd immunity against measles.
- D. the mortality rate is low in 2018 due to the virus mutating from the more virulent version present in the 1950s.

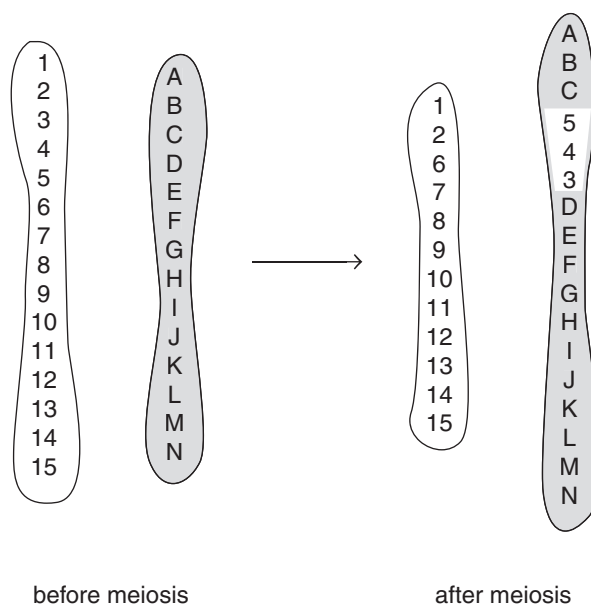
Question 19

An example of an immune deficiency disease is

- A. multiple sclerosis.
- B. cancer.
- C. HIV.
- D. hypersensitivity to pollen.

Question 20

The diagram below represents an event that occurred during meiosis.

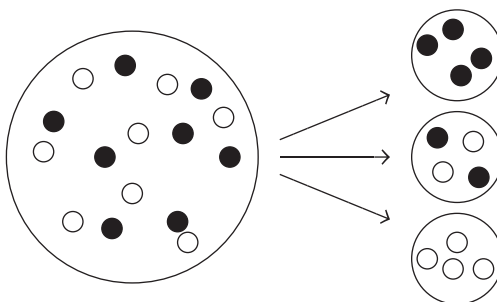


The type of mutation depicted is

- A. a point mutation.
- B. aneuploidy.
- C. a block inversion mutation.
- D. a block addition mutation.

Question 21

The diagram below represents a random event occurring in an original population, where it was divided into three smaller groups in different geographical areas. The colour of the individuals represents their phenotype.



The example depicted here shows

- A. a form of genetic drift called the founder effect.
- B. gene flow between populations of a particular species.
- C. how selection pressures can alter the gene pool.
- D. a form of genetic drift called natural selection.

Question 22

Cichlid fish in African lakes show a large variation in structural morphology, particularly the jaw size. Lake Victoria is very large with a range of different environmental niches for cichlid fish to exploit, and it was historically connected with many other lake systems in Africa. There are currently over 2000 species of cichlid fish in African lakes that have evolved in the last 15 000 years. Two very different species are compared in the table below.

	<i>Pseudotropheus crabro</i>	<i>Boulengerochromis microlepis</i>
habitat	coastal rocks	open water
diet	small eggs and debris	small worms and freshwater prawns
size	up to 20 cm in length	up to 1 m in length
jaw	relatively small	relatively large

In the process of speciation leading to cichlid fish variants such as those compared above, an ancestral group will undergo natural selection.

This would involve

- A. the ancestral group having a faster mutation rate in the BMP4 master regulatory gene, which would lead to more variation in the original cichlids.
- B. the larger cichlid fish in the ancestral group only breeding with each other and the smaller cichlid fish in the ancestral group only breeding with each other.
- C. cichlid fish in a coastal environment having an increased mutation rate in the BMP4 gene, leading to it being active for a shorter time during embryological development and giving them smaller jaws.
- D. a selective advantage for the cichlid fish who had a mutation in the BMP4 gene that made it active for longer during their embryological development in an open water environment.

Question 23

Which one of the following correctly orders the first appearances in the fossil record for the stated groups of organisms?

- A. multicellular organisms, flowering plants, animals on land, mammals
- B. multicellular organisms, animals on land, flowering plants, mammals
- C. multicellular organisms, animals on land, mammals, flowering plants
- D. flowering plants, multicellular organisms, animals on land, mammals

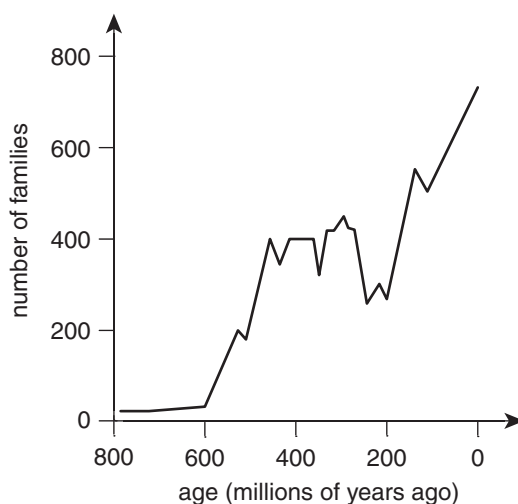
Question 24

Absolute dating of fossils includes

- A. counting the number of isotopes that are present in a fossil and determining the half-life from this.
- B. determining the stratigraphic layer the fossil is located in compared to other stratigraphic layers.
- C. determining the actual age of the sedimentary layer a fossil is located in.
- D. using a known half-life of an isotope and calculating the amount of the isotope remaining in the sample being dated to determine the age it existed.

Question 25

The following graph illustrates the changes in biodiversity (number of families) during the Phanerozoic eon.



It is appropriate to conclude that

- A. the largest increase in biodiversity was between 200 million years ago and now.
- B. there were four extinction events that occurred in the Phanerozoic eon.
- C. 300 families existed 400 million years ago.
- D. the biodiversity present 500 million years ago was greater than the biodiversity present 200 million years ago.

Question 26

The hedgehog (*Atelerix albiventris*) is a spine-covered, ant-eating mammal that evolved from a mole-like mammal that did not eat ants. The echidna (*Tachyglossus aculeatus*) is a spine-covered, egg-laying, ant-eating mammal that evolved from an animal similar to a platypus, which also did not eat ants.

The appearance of these two species is due to

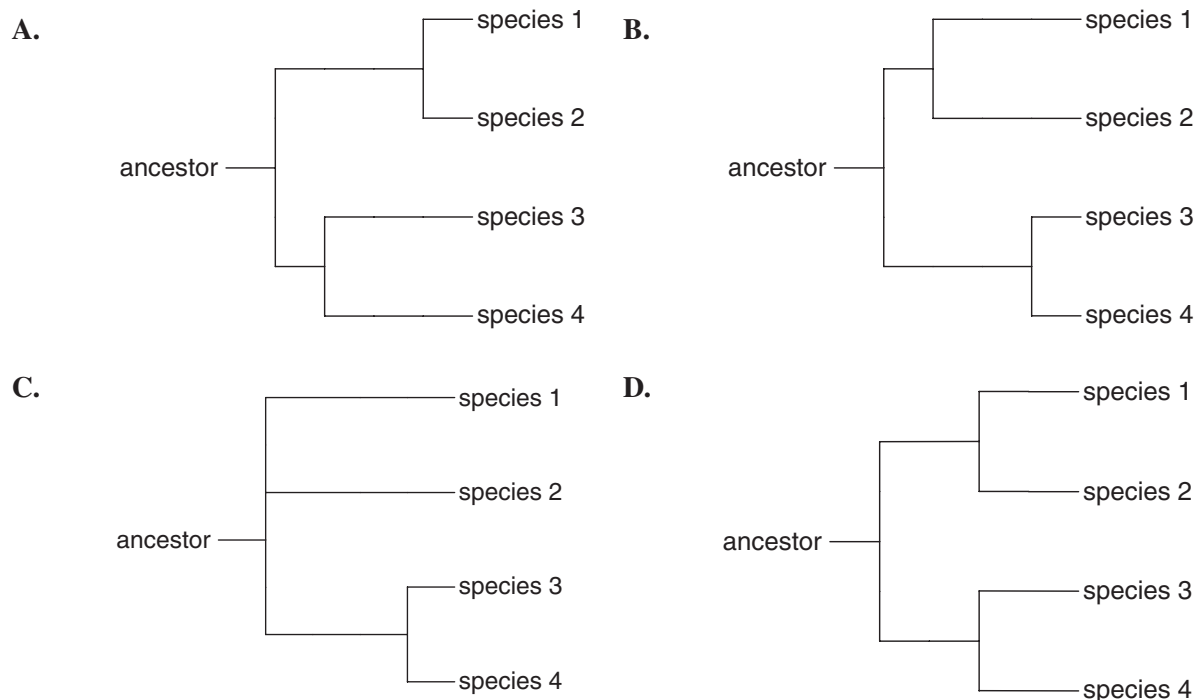
- A. artificial selection.
- B. convergent evolution.
- C. divergent evolution.
- D. cultural evolution.

Question 27

A section of DNA was analysed between four currently living species to determine their relatedness. This was compared to the ancestral DNA from the same loci.

Organism	DNA sequence
ancestor	AGG GCT CGT ACG TAC ATG GCG TAC CTA GCT AGC TAC GAT GCA
species 1	AGC GCT CGT ACG TAC ATG GCG AAC CTA GCT AGC TAC CAT GCA
species 2	AGC GCT CGT ACG TAC ATG GCG TAC CTA GCT AGC TAC GAT GCA
species 3	AGG GCT CGT ACG TAC ATC CGG TAC CTA GCT AGC TAC GAT GCT
species 4	AGG GCT CGT ACG TAC ATG GCG TAG GTA GCT AGC TTT GAT GCA

Which one of the following is the most suitable phylogenetic tree to depict the evolution of these species?

**Question 28**

Which one of the following hominins first appeared in the fossil record?

- A. *Pan troglodytes* (chimpanzee)
- B. *Australopithecus afarensis*
- C. *Homo erectus*
- D. *Homo sapiens*

Question 29

mtDNA studies are a useful tool to determine human migration patterns and, as a result, Africa appears to be the region where humans originated.

It would be reasonable to assume based on mtDNA mutation rates that

- A. African populations would show more variation in their mtDNA compared to any populations out of Africa.
- B. populations in South America would show more mtDNA variation compared to African populations.
- C. only females from different populations can be compared because mitochondria are inherited down the female line.
- D. Indigenous Australian and Torres Strait Islander peoples, being the oldest indigenous group out of Africa, show more mtDNA differences compared to African populations.

Question 30

The earliest evidence of cultural evolution in the line leading to modern humans is

- A. the ritualistic burial of the deceased.
- B. the harnessing of fire to cook food.
- C. the construction of stone tools to cut through the hides of animals.
- D. cave paintings as a method of communication.

Question 31

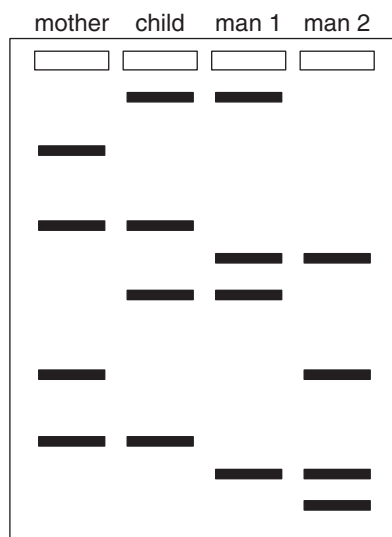
A biotechnologist has various tools to use when manipulating DNA.

Which row from the following table correctly matches the tool with the element involved in the manipulation of DNA?

	Ligase	Endonuclease	Plasmid	Polymerase
A.	cutting	pasting	vector	replicating
B.	pasting	cutting	vector	replicating
C.	replicating	cutting	pasting	vector
D.	pasting	vector	replicating	cutting

Use the following information to answer Questions 32 and 33.

A paternity case was solved using genetic profiling. Gene loci from the mother, child and two men were investigated to determine which of the two men was the father of the child. The diagram below shows the results of the gel electrophoresis procedure.



Question 32

The smallest gene locus analysed on the gel is from

- A. the mother.
- B. the child.
- C. man 1.
- D. man 2.

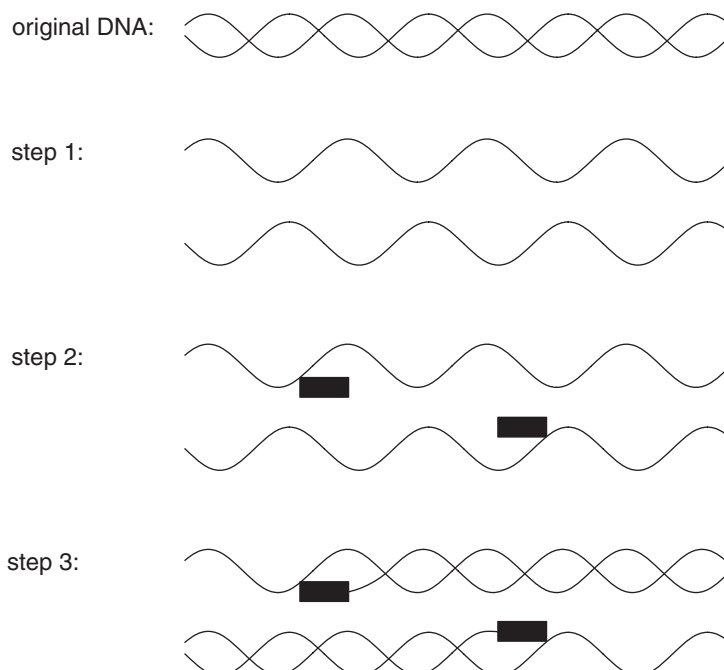
Question 33

A suitable conclusion that could be made would be that

- A. man 1 is the father because two of his gene loci are similar to two of the child's gene loci.
- B. neither man can be the father, because all gene loci bands between one of them and the child would need to match for them to be the father.
- C. man 2 is the father because none of his loci bands match those of the mother.
- D. no conclusion can be made, because even though band patterns may match, the nucleotide sequences may be different for each band.

Use the following information to answer Questions 34–37.

A sample of mtDNA was compared between three species of hominins: *H. sapiens*, *H. neanderthalensis* and *H. denisovan*. Initially a specific section of the DNA was extracted and amplified through the process of polymerase chain reaction (PCR). A diagram of the PCR process is illustrated below.



The samples were then compared through DNA hybridisation to determine the relatedness of each sample compared to the others. The results of the hybridisation are tabulated below. Similarity was measured based on the melting temperature of the hybridised strands compared to the original strands. A negative result demonstrates a lower hybridisation compared to the original.

	Melting temperature of the hybridised strand compared to the original strand (°C)		
	<i>H. sapiens</i>	<i>H. neanderthalensis</i>	<i>H. denisovan</i>
<i>H. sapiens</i>	0	−6.2	−3.1
<i>H. neanderthalensis</i>	−6	0	−4.1
<i>H. denisovan</i>	−2.9	−4.3	0

Question 34

Which row of the following table shows the correct name and temperatures that steps 1, 2 and 3 are carried out at?

	Step 1	Step 2	Step 3
A.	annealing (60°C)	extension (72°C)	melting (92°C)
B.	melting (92°C)	annealing (60°C)	extension (72°C)
C.	extension (92°C)	annealing (72°C)	melting (60°C)
D.	annealing (72°C)	melting (60°C)	extension (92°C)

Question 35

If the PCR started with 10 strands of DNA, at the conclusion of 4 cycles the number of strands of DNA produced would be

- A. 40
- B. 80
- C. 160
- D. 400

Question 36

Based on the results, it would be reasonable to conclude that

- A. *H. neanderthalensis* and *H. sapiens* had a more recent ancestor than *H. neanderthalensis* and *H. denisovan* as the melting temperature of their hybridised strands was greater.
- B. *H. denisovan* and *H. sapiens* had a more recent common ancestor because the melting temperature of the hybridised strands is the most similar compared to the original melting temperatures.
- C. *H. neanderthalensis* was the ancestor to *H. denisovan*, which in turn was the ancestor to *H. sapiens*, because the melting temperature of their hybridised strands was getting closer to the original melting temperatures.
- D. the three species measured are all hominins, and as a result would be expected to have melting temperatures of the hybridised strands relatively close to each other.

Question 37

The best explanation of the variation in the results would be that

- A. the bonds joining the nucleotides are the same along the length of each strand.
- B. multiple tests would have been conducted and the results presented are calculated as an average.
- C. mtDNA degrades over time, so it is more difficult to compare the mtDNA from extinct organisms and more variation would be expected to occur with them.
- D. the source of the mtDNA was different for each hominin tested and so the data generated cannot be compared.

Question 38

World Antibiotic Awareness Week aims to increase global awareness of antibiotic resistance and encourage best practices among the general public, health workers and policy makers to avoid the further emergence and spread of antibiotic resistance.

Appropriate best practices would include

- A. charging more money for each prescription to ensure the general public will not unnecessarily purchase antibiotics.
- B. health workers prescribing antibiotics only if the patient displays the symptoms of a viral disease.
- C. policy makers insisting that stronger antibiotics are used more regularly to treat disease.
- D. the general public ensuring that they fully complete any prescription allocated to them by health workers.

Question 39

Some diseases can spread rapidly and have a high level of mortality, while some spread more slowly and have a low level of mortality. All diseases that gain attention on the world stage need to be dealt with in a consistent and professional way to ensure that panic does not occur.

There would be concern of a pandemic if a pathogen had a

- A. rapid 1-day incubation period with virtually 100% mortality.
- B. slow 10-day incubation period with a very low (<1%) mortality.
- C. rapid 1-day incubation period with a very low (<1%) mortality.
- D. slow 10-day incubation period with a very high (>50%) mortality.

Question 40

The concept of rational drug design is growing in public awareness. The disease chronic myeloid leukaemia has been treated with Gleevec. Enfuvirtide has been used for the treatment of HIV. These drugs are manufactured molecules that usually have a shape complementary to the functional part of a factor that enables the disease to spread.

The drug called Relenza was designed to

- A. bind to neuraminidase on the influenza virus to prevent the virus from exiting lung cells.
- B. be an alternate treatment for cancer.
- C. bind to haemagglutinin on the influenza virus to prevent the virus from entering lung cells.
- D. be taken orally as a substitute for the influenza vaccine (Fluvax).

END OF SECTION A

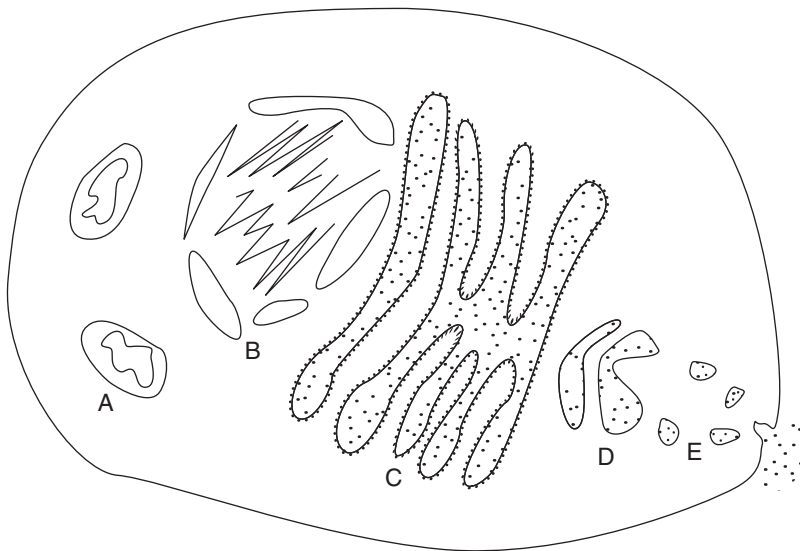
SECTION B**Instructions for Section B**

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

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

Question 1 (5 marks)

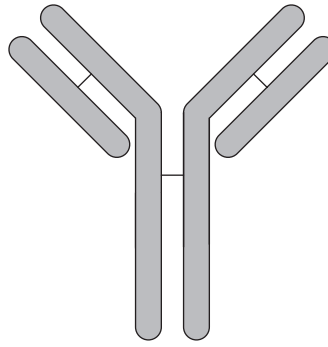
The following diagram shows an activated plasma B cell. Components A to E represent structures that are important to the functioning of the cell.



- a. Which structure(s) (A–E) would be involved in a condensation reaction between amino acids? Include the name of the structure(s) in your answer. 1 mark

- b. List the structures (A–E) depicted in the diagram (in order) from manufacture to secretion of the product. 1 mark

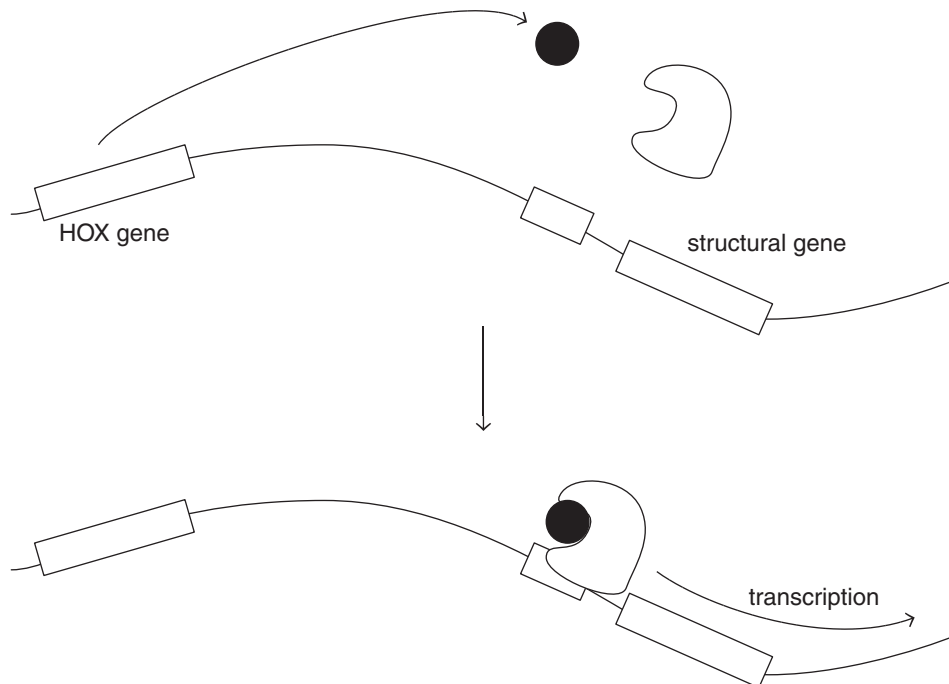
- c.** The diagram below shows the secretory product.



- i.** Name the secretory product of the cell. 1 mark
-
- ii.** Label the antigen-binding site(s) on the diagram above. 1 mark
- iii.** Show how the four polypeptide chains remain intact by labelling the diagram above. 1 mark

Question 2 (6 marks)

HOX genes are important regulatory genes that control body form and are highly conserved across most species. An example of how a HOX gene may work is illustrated in the diagram below.



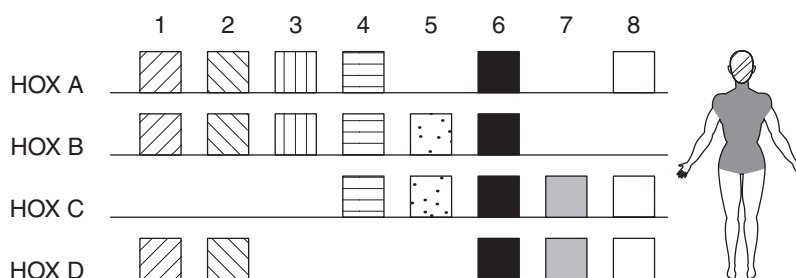
- a. i. In this case, describe the function of the transcription factor. 1 mark

- ii. Why would HOX genes be 'highly conserved' across species? 1 mark

HOX genes have been categorised into four main types (A, B, C and D), each one controlling the expression of many structural genes in different stages of embryonic development in most animals (genes 1–8).

The diagram below illustrates the action of these HOX genes in the development of body structures (arms, head, legs, body) in a human. The shading of the human gives a guide as to which HOX genes are active in the development of that body part. Once the body plan HOX genes are activated, the structural genes 1–8 may or may not be activated. A box with any type of shading represents this. If there is no box, the gene is repressed.

An example of this action would be if, for the development of the torso, one of the HOX genes activated in\ the HOX D. The structural gene HOX D will activate structural genes 1, 2, 6, 7 and 8, and repress genes 3, 4 and 5.



- b. i.** State the HOX gene(s) that are active in the development of arms and legs. 1 mark

- ii.** State the structural gene(s) that are the most repressed when the head is developing. 1 mark

- c.** Explain why the effect of the HOX A gene is different to the effect of the HOX B gene. 2 marks

Question 3 (5 marks)

Reverse transcriptase is an enzyme capable of converting RNA into DNA. Influenza is an RNA virus that utilises this enzyme as part of its reproductive cycle. A small section of the viral genome is shown below.

GAG UUG CCA GUG AAA UUC GAC

- a. State the resultant strand produced if the RNA strand above is in the presence of reverse transcriptase.

1 mark

- b. What is the purpose of the reverse transcriptase with respect to the viral reproductive cycle?

2 marks

- c. A list of anticodons and amino acids is tabulated below.

tRNA anticodons	Amino acid coded for
CUC, CUU, CAC	glu
AAU, AAC, AAA	leu
GGG, GGC, GGA, GGU, GAG, GAC	pro
CUG, CUA, CCA, GUG	asp
AAG, AAA	phe
UUU, UUG, UUC	lys

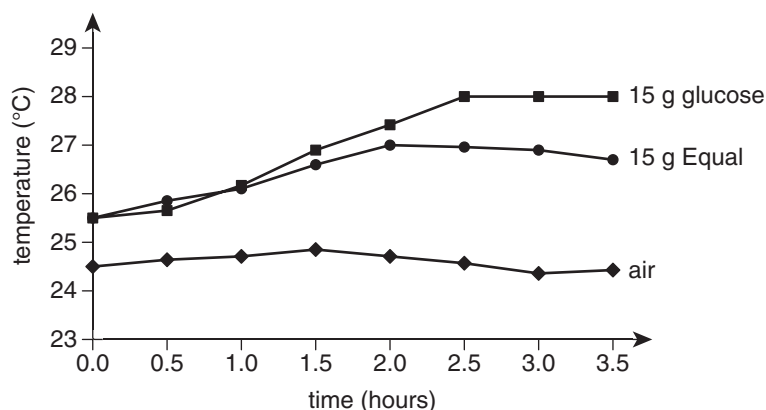
The representative section of the genome illustrated above is a portion of the neuraminidase gene.

Use the anticodon table to determine the amino acid sequence of the small section of the neuraminidase gene.

2 marks

Question 4 (8 marks)

An experiment was set up to determine the effect of changing the type of carbohydrate on the rate of cellular respiration in yeast cells. Two 10% solutions of yeast were made up. One contained 20 g of glucose and the other contained 20 g of Equal (an artificial sweetener). Both were placed in separate thermoses and the temperature of each was measured at 30-minute intervals for a total of 6 hours. A third thermometer was placed next to the two thermoses that measured the air temperature for the duration of the experiment. The results of the experiment are set as a graph below.



- a. i.** State the purpose of measuring the air temperature as shown by the 'air' curve on the graph. 1 mark
- _____
- _____
- ii.** What is the dependant variable in this experiment? 1 mark
- _____
- _____
- iii.** At what time did the yeast cells with Equal reach a temperature of 26.5°C? 1 mark
- _____
- _____
- b.** Explain the results obtained relating to the effect of 20 g of glucose on yeast cellular respiration. 2 marks
- _____
- _____
- _____
- _____

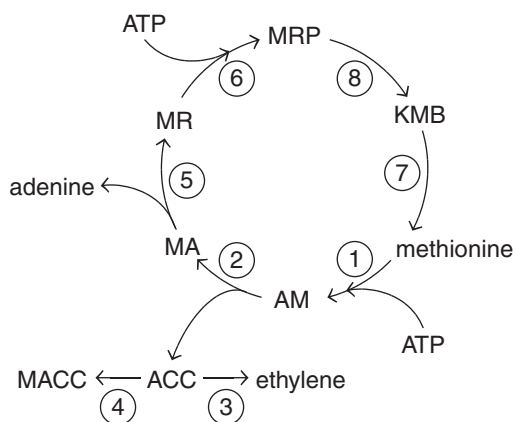
- c.** Equal is an artificial sweetener that is structurally different to glucose and is sometimes taken as a dietary supplement.

- i.** Use data from the graph to confirm that Equal could be used as a dietary supplement. 1 mark

- ii.** Give **two** reasons why these results would be an **inaccurate** indicator of the action of Equal. 2 marks

Question 5 (7 marks)

Ethylene (a non-protein signalling molecule) is an important plant hormone that is involved in a wide range of situations. It is synthesised via the methionine cycle, which is illustrated in the diagram below. Figures 1–8 represent enzymes involved in the cycle.



- a. i.** Use evidence from the diagram to explain whether the methionine cycle is an anabolic or catabolic cycle.

1 mark

- ii.** In the space below, draw the shortest biochemical pathway from methionine to ethylene, including all the requirements for the reactions illustrated in the diagram.

1 mark

Rising levels of carbon dioxide, particularly in ripening fruit, provide a stimulus for ethylene production. Once secreted into the environment, ethylene binds to cell-surface transmembrane receptors on target cells, such as in ripening fruit.

- b. i.** Discuss the chemical nature of ethylene. 1 mark

- ii.** Describe the process that would occur in the ripening fruit after ethylene binds to a receptor. 2 marks

- c.** A single strand of an artificially manufactured nucleic acid called asRNA is complementary to the mRNA that is used to make proteins important for the ripening process. This is known as anti-sense technology and could allow fruit to ripen more slowly, allowing fruit farmers the possibility of a greater profit margin.

Describe how anti-sense technology could reduce the amount of enzyme 2 in the diagram on page 25 and how this would lead to slower ripening of fruit. 2 marks

Question 6 (7 marks)

Plants and animals have a wide variety of defence mechanisms, both physical and chemical, that reduce the chance of pathogens entering the organism and causing an infection.

- a. Name a specific physical and chemical barrier an animal possesses that reduces the chance of a pathogen causing infection, and describe how it carries out this role. 4 marks

	Specific barrier	Description
Physical barrier		
Chemical barrier		

- b. Citronella oil is an extract from lemongrass that is a non-toxic insect deterrent. A typical lemongrass plant contains the following concentrations of chemicals:

- citronellal (32–45%)
- geraniol (11–13%)
- geranyl acetate (3–8%)
- limonene (1–4%)

Commercially produced citronella oil has different proportions of these chemicals. The proportions are determined by various factors such as cost, safety and availability. It was thought that increasing the proportion of geraniol increased the insecticide properties and increased the sensitivity on human skin. The range of geraniol in a typical lemongrass plant was the initial amount in citronella oil.

How would companies designing and making products such as citronella oil determine the ideal proportion of geraniol in the final product?

3 marks

Question 7 (10 marks)

Coeliac disease is caused by an immune reaction to the gluten protein found in wheat, rye and barley. The autoimmune disease is becoming increasingly prevalent and is estimated to currently affect 1 in 70 Australians and 1.4% of the global population. Normally when gluten-containing food is eaten, the indigestible part of gluten moves through the digestive tract to be excreted. In coeliac disease, gluten gets through a leaky intestinal wall and comes into contact with immune cells. This mounts an immune response against the gut cells as well as the secretion of inflammation molecules.

- a.** State **two** immune cells, other than a plasma B cell, that would be involved in the active immune response against gluten and state the specific role they play in the response. 4 marks

Cell	Type of immune cell	Specific role played
1		
2		

A gluten-free diet is a solution for a coeliac disease sufferer; however, traces of gluten are still present in foods even though they carry a label of 'gluten-free'. A new coeliac therapeutic vaccine is emerging (Nexvax 2) that aims to suppress the immune system's response against gluten. Therapeutic vaccines aim to reprogram the immune system to learn not to react by regular injections of small amounts of gluten into the body. The end result aims to be similar to how allergy shots work to desensitise the immune system to allergens. A successful clinical trial was undertaken in Australia in 2018 that involved 116 people divided into an experimental group and a placebo group.

- b. i.** What was the purpose of a placebo group in this clinical trial? 1 mark

- ii.** When comparing the placebo group with the experimental group, what **three** controlled factors would need to be taken into account to ensure experimental validity? 2 marks

- c. Compare a therapeutic vaccine such as Nexvax 2 with a preventative vaccine that is administered annually, such as Fluvax, to individuals wanting to reduce the chance of contracting influenza.

3 marks

Question 8 (9 marks)

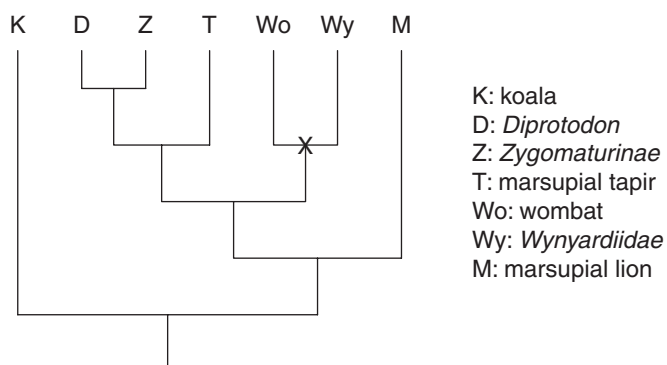
The giant wombat (*Diprotodon*) coexisted with Indigenous Australian peoples about 50 000 years ago. It was the largest of the herbivorous marsupials (up to 3.8 m in length) and existed in Australia from 1.6 million years ago until 46 000 years ago.

- a. Describe the fossil evidence needed to place the existence of *Diprotodon* within that time frame. 1 mark

- b. Lake Callabonna, a dry salt lake in South Australia, is the place where many *Diprotodon* fossils have been located. One particular find was absolutely dated with carbon dating to be 54 000 years old. The half-life of carbon-14 is about 6000 years.

Describe how carbon dating could be used to date this *Diprotodon* fossil to be 54 000 years old. 2 marks

The cladogram below illustrates the evolutionary relationship between several herbivorous marsupials.



- c. i. Explain whether it would be appropriate to say the *Diprotodon* is more closely related to koalas or to wombats. 1 mark
- ii. Describe the DNA hybridisation results expected to support the answer to **part c.i.** 2 marks
- d. Describe an event that may have occurred at point X on the diagram that would explain to the divergence of the two lineages displayed. 3 marks

Question 9 (7 marks)

According to the 'Out of Africa' hypothesis, ancestral humans left Africa 1.8 million years ago and divided into several different species during the Pleistocene epoch. Only one branch of this ancient family tree could give rise to the present-day human species. The origin of modern humans in Africa explains why today's African people are more genetically variable than other indigenous human populations.

According to the 'multiregional' evolution hypothesis, the first humans to leave Africa 1.8 million years ago never divided into different species. Instead, the original population separated geographically but exchanged genes with each other through recurrent gene flow. The greater genetic variation within Africa is thought to be a consequence of a larger original population size, greater ecological diversity and local selection.

Ancient DNA evidence from Neanderthals, early modern humans in Europe and a handful of ancient samples from Africa have changed our understanding substantially. Modern humans originated as a population within Africa, with substantial gene flow from other hominin populations of the Middle Pleistocene, and then moved out of Africa. Today's modern humans of Eurasia derive most of their ancestry from a bottlenecked population that existed before 70 000 years ago. The descendants of this bottlenecked population mixed with Neanderthals and with another archaic human population, the Denisovans. The modern human populations that ultimately arrived throughout Asia, Australia, the Americas and Europe would all carry a small fractions of DNA from these two groups.

- a.** Describe **one** difference raised in the passage above between the 'Out of Africa' hypothesis and the 'multiregional' hypothesis, using supporting evidence for both. 2 marks

- b.** How would 'recurrent gene flow' impact the gene pool of modern humans? 2 marks

- c.** A genetic bottleneck existed for the ancestors of modern humans that moved out of Africa 70 000 years ago.

How could this genetic bottleneck impact current genetic diversity? 2 marks

- d.** Some scientists describe the early evolutionary process that lead to modern humans as 'multiregional evolution within Africa'.

Use evidence from the passage on page 32 to support this view.

1 mark

Question 10 (8 marks)

Rhizobium larrymoorei is a bacterium capable of transferring DNA into plants. The bacteria usually cause cancer-like diseases, but certain harmless strains (such as strain LBA 4404) can be used that do not cause disease and still have the capacity to transfer genes. The gene to be transferred needs to be spliced into a plasmid (previously isolated from strain LBA 4404).

- a.** Define the term 'plasmid'. 1 mark

- b.** Outline the steps required to insert a gene into a plasmid. 3 marks

The recombinant plasmid is reintroduced back into *Rhizobium larrymoorei* and the genetically transformed bacteria are then selected, usually based on antibiotic-resistant genes also present within the plasmid.

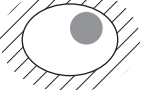
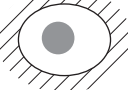
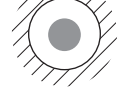
- c.** Describe how the method of bacterial selection outlined above is achieved. 2 marks

The next task is to transfer the gene in the plasmid into the genome of the plant cell and then to propagate many copies of the plant cell so that a line of genetically modified plants can be produced.

- d.** What factors would need to be taken into account to allow the plant to be described as transgenic as well as a genetically modified organism (GMO)? 2 marks

Question 11 (8 marks)

An experiment was conducted to test the effect of the antibiotic ampicillin on the growth of group B *Streptococci* bacteria. Small discs (circles) were soaked in different concentrations of ampicillin and each one was placed on an agar plate covered in a colony of *Streptococci*. The plates were incubated for 24 hours and then analysed for the regions of growth (shaded) or lack of growth (clear) to determine the effectiveness of the ampicillin.

Ampicillin (mg/L)	Trial			Size
	1	2	3	
0				0
1				5 mm
2				8 mm
3				11 mm
4				13 mm

bacterial growth circles of no growth ampicillin disc




- a. State the hypothesis being tested in this experiment. 1 mark

- b. Describe why a circle of no growth is present in trial 2 with 3 mg/L of ampicillin. 1 mark

- c. Give an appropriate title for the final column of the data table. 1 mark

- d.** Construct a graph of the data on the axes below.

2 marks



- e.** State the data set that shows the highest level of precision and explain why.

1 mark

- f.** Write a suitable conclusion for this experiment.

2 marks

END OF QUESTION AND ANSWER BOOKLET