

Student Number



Pymble Ladies' College

2021 HIGHER SCHOOL CERTIFICATE
TRIAL EXAMINATION

BIOLOGY

General Instructions

- Reading time – 5 minutes
- Working time – 3 hours
- Write using black pen
- Draw diagrams using pencil
- Board-approved calculators may be used

Total marks – 100

This paper has two parts, Part A and Part B

Part A – 20 marks

- Attempt Questions 1–20
- Allow about 35 minutes for this part

Part B – 80 marks

- Attempt Questions 21–35
- Allow about 2 hours and 25 minutes for this part

Part A – 20 marks

Attempt Questions 1–20

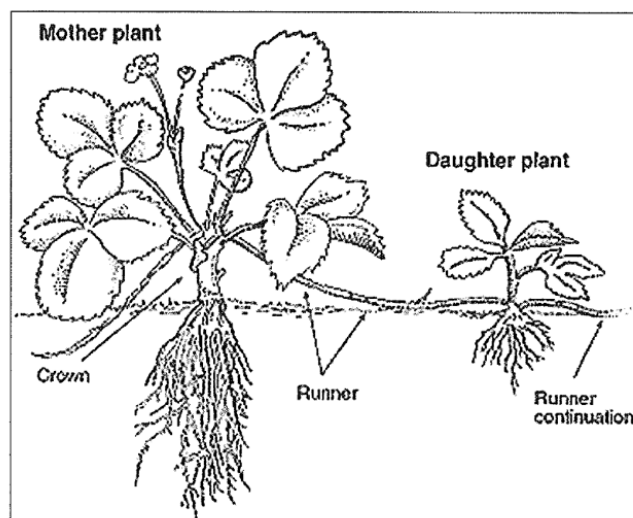
Allow about 35 minutes for this part

Use the separate multiple-choice answer sheet for Questions 1–20.

1. In 1856, the Austrian monk Gregor Mendel began his now famous research using pea plants, which led to a proposed model for inheritance. His success was based on precise experimentation and careful observations.

Which of the following techniques ensured the data he obtained was reliable?

- (A) He bred hundreds of plants and tabulated each outcome.
 - (B) He ensured all plants self-pollinated by covering them with plastic bags.
 - (C) He ensured pure breeding lines by previously breeding each variety for 2 years.
 - (D) He kept plants isolated in a greenhouse to prevent accidental cross-pollination.
2. Observe the image of a method of reproduction.



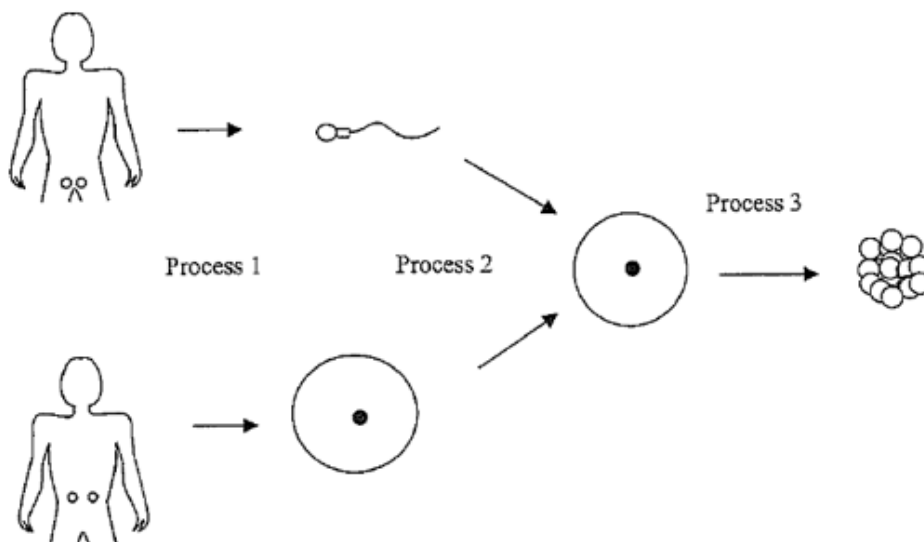
When is this method of reproduction most useful?

- (A) The environment is stable and numbers can be increased very quickly.
- (B) The environment is constantly changing and numbers need to be increased.
- (C) The environment is stable and new plants with significant variation can be produced.
- (D) The environment is changing moderately fast and numbers need to increase to keep up with this change.

3. A segment of DNA is 'switched on' to produce a polypeptide. This polypeptide is then manipulated into the desired protein. The protein is then taken and changed to function as an enzyme to control the production of other cellular molecules.

Identify the process described.

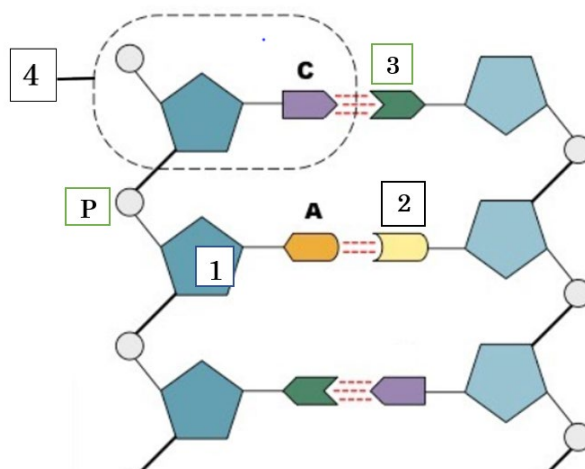
- (A) meiosis.
(B) gene expression.
(C) gene replication.
(D) gamete formation.
4. The diagram below represents three processes that occur during reproduction.



Which processes contribute to variation between individuals?

- (A) Process 1 only.
(B) Processes 1 and 2.
(C) Processes 1 and 3.
(D) All three processes.

5. A student drew the following incomplete diagram of DNA. Choose the option that could be used to correctly complete labels 1, 2, 3 and 4.



	1	2	3	4
(A)	sugar	thymine	guanine	nucleotide
(B)	sugar	uracil	guanine	nucleotide
(C)	sugar	nucleotide	guanine	thymine
(D)	phosphate	sugar	base	thymine

6. The table compares some features of two marsupial mammals, the Long-tailed planigale and the Tammar wallaby.

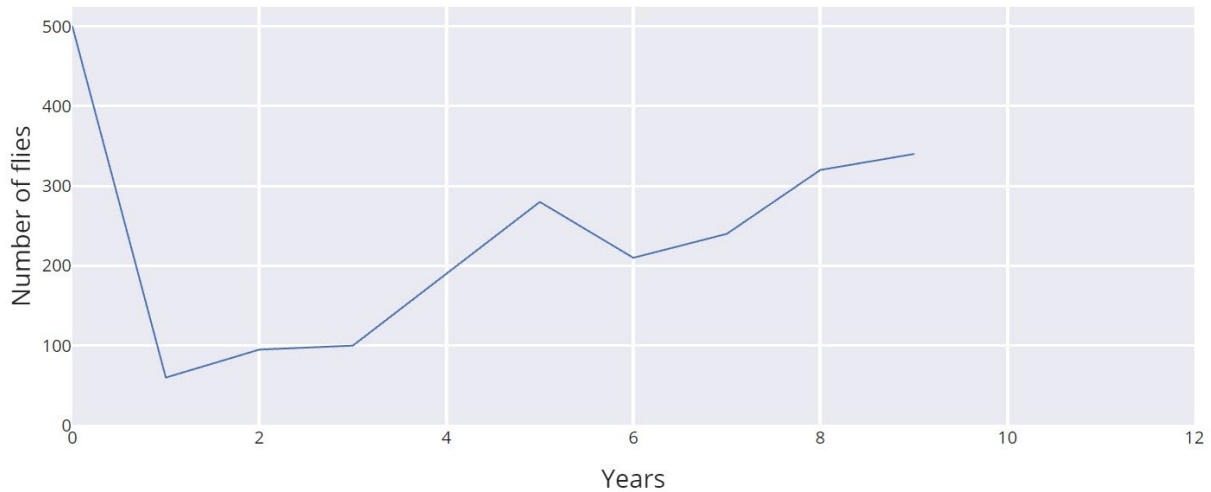
	Long-tailed planigale, <i>Planigale ingrami</i>	Tammar wallaby, <i>Macropus eugenii</i>
Distribution	Northern Australia	South-west Australia
Mass (gram)	4.0	4800
Body heat produced (Joules/gram/hour)	29.9	5.8
Surface area/mass (cm ² /gram)	2.7	0.3

Predict which animal will have the greater difficulty maintaining body temperature when the ambient temperature is 10°C.

- (A) Tammar wallaby because it has a larger body to keep warm.
 (B) Tammar wallaby because it produces less body heat per gram.
 (C) Planigale because it normally lives in tropical northern Australia.
 (D) Planigale because it has a greater surface area per unit body mass.

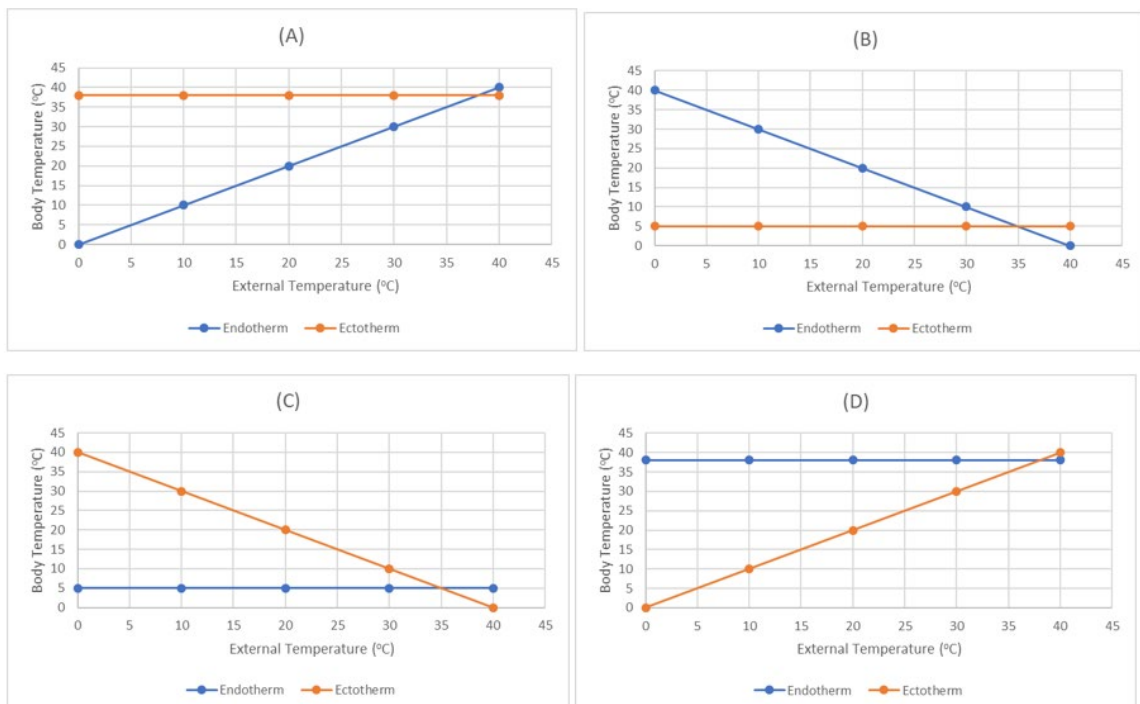
7. The information in the graph below shows the change in numbers of a fruit fly population. The population that was sprayed with a particular insecticide in the first year of investigation and again five years later.

CHANGE IN NUMBER OF FLIES OVER TIME

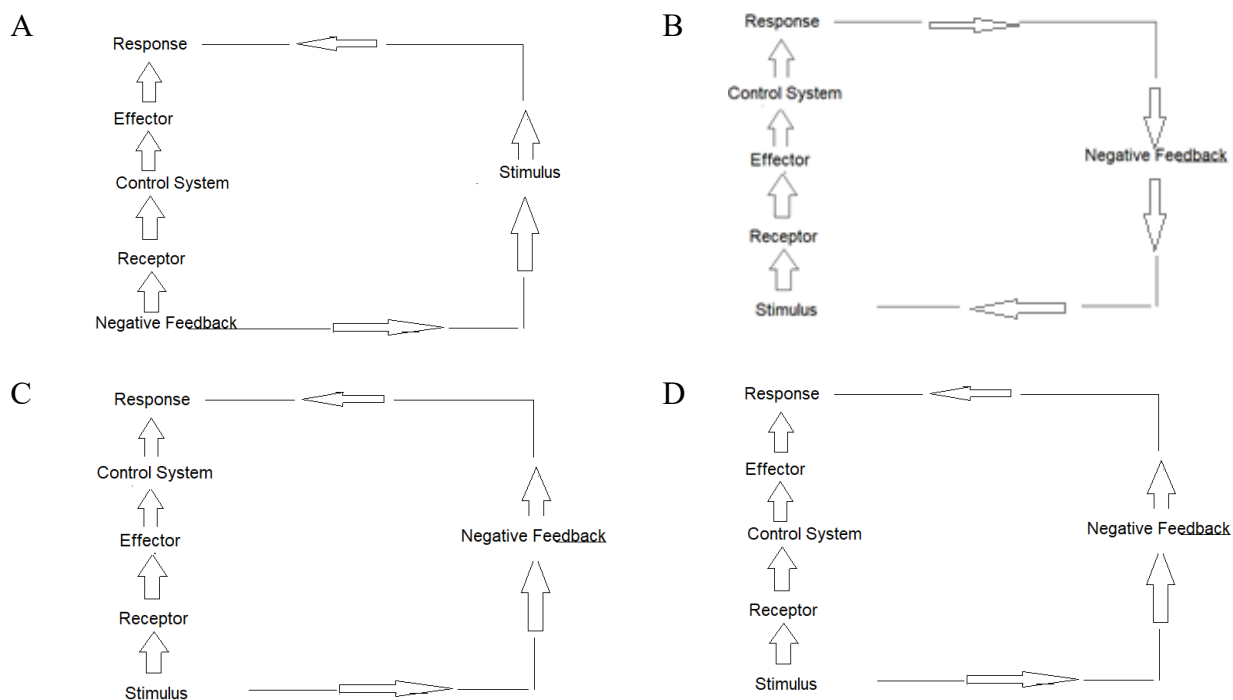


What is the reason for the small drop in numbers after the second spraying is:

- (A) There are less flies breeding.
 (B) The flies become immune to the insecticide.
 (C) The insecticide was more concentrated at the first spraying.
 (D) There is a higher percentage of resistant flies in the population.
8. Which of the following graphs best shows the relationship between external temperature and body temperature for an endotherm and an ectotherm?



9. Which of the following correctly represents a feedback mechanism?



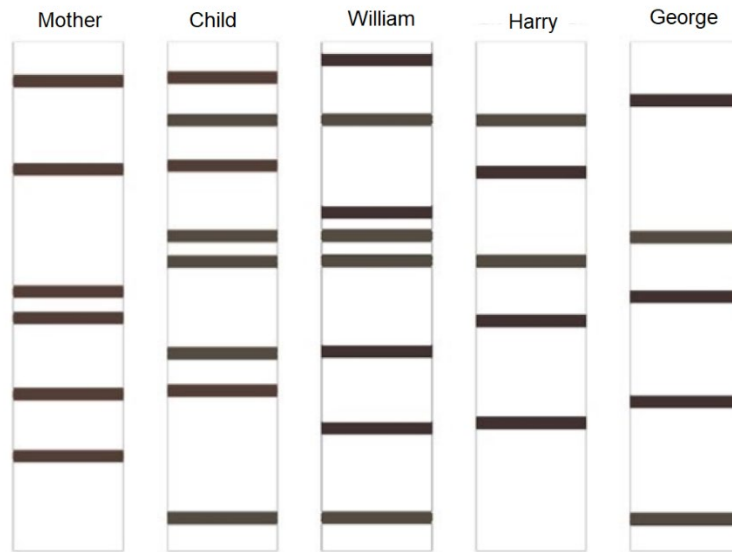
10. The table shows the death rate per 100 000 people aged 45-64 from various diseases.

Causes of deaths	Death rate per 100 000 for cigarette smokers and non-smokers			
	Non-smokers		Smokers	
	Male	Female	Male	Female
Lung Cancer	10	5	90	20
Other cancers	150	200	180	180
Cardiovascular disease	450	140	800	250
Total deaths	610	345	1070	450

From the data available in the table, which of the following would be a reasonable conclusion?

- (A) Smoking causes lung cancer.
- (B) More males smoke than females.
- (C) Smoking protects females from cancer.
- (D) Cigarette smoking is a risk factor for lung cancer.

11. DNA profiling can be used to test for paternity. Three men (Harry, William and George) were tested to determine the paternity of a child and the following banding patterns were produced.



Which individual could you conclude is the most likely to be the father from these data?

- (A) Harry.
 - (B) George.
 - (C) William.
 - (D) None of the three men, as none of their profiles exactly matches that of the child.
12. Which of the following can introduce new alleles into a population's gene pool?
- (A) Mutation and gene flow.
 - (B) Genetic drift and gene flow.
 - (C) Mutation and natural selection.
 - (D) Genetic drift and natural selection.
13. For centuries, genetically identical plants have been produced by taking multiple cuttings from one plant and growing them into another plant.

Which term describes this process?

- (A) Gene cloning.
- (B) Artificial pollination.
- (C) Whole organism cloning.
- (D) Genetically modified plants.

14. Advances in DNA technology have made it possible to carry out genetic screening for particular genetic diseases. Many people may decide not to have children based on the result of their genetic screening. What impact will this have on human evolution?
- (A) Alter the frequency of an allele and will, therefore, have an impact on future human evolution.
 - (B) Have no impact on future human evolution since the genes or DNA are not altered in the testing.
 - (C) Increase genetic variation in the human population and will, therefore, have an impact on future human evolution.
 - (D) Result in complete loss of an allele from a population and will, therefore, have an impact on future human evolution.
15. The table below provides the genetic diversity index for four populations of the platypus.

Population	Genetic diversity index
I	0.419
II	0.606
III	0.032
IV	0.431

(Note: The lower the index, the less variation in the population).

- Based on the information in the table, which of the platypus populations is at the greatest risk of extinction due to genetic factors?
- (A) Population I.
 - (B) Population II.
 - (C) Population III.
 - (D) Population IV.
16. Which term describes a molecule capable of triggering an immune response?
- (A) Antigen.
 - (B) Pathogen.
 - (C) Antibody.
 - (D) Antibiotic.

17. Students wanted to compare the number of bacteria in bottled and tap water. They placed a 1mL sample of tap water on an agar plate and spread the water evenly over the agar. They then repeated the same procedure on another agar plate with the bottled water. Both plates were incubated at 30°C for 48 hours.

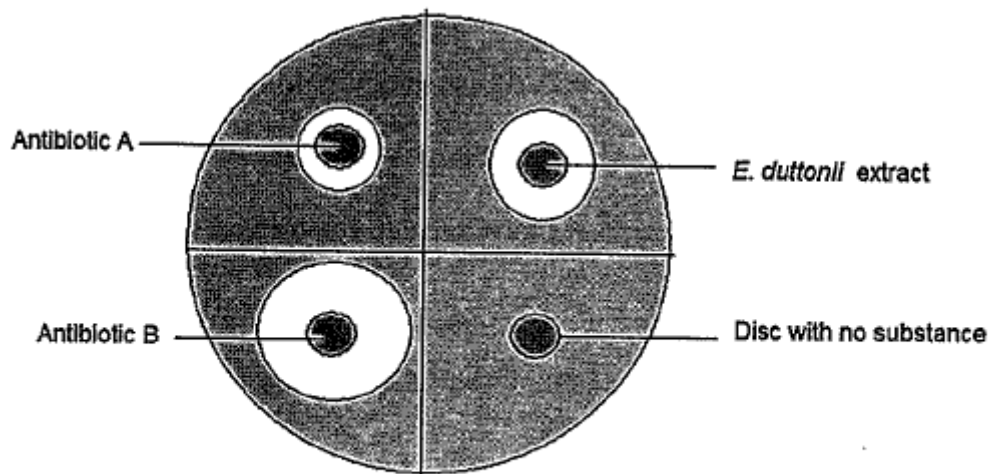
In this experiment, what is the dependent variable?

- (A) Type of water (bottled or tap).
 - (B) Amount of water on each plate.
 - (C) Incubation temperature for each plate.
 - (D) Number of bacterial colonies on each plate after 48 hours.
18. 'Herd immunity' describes a population where a vast majority of people are immunised. Why is herd immunity an effective way to control the spread of infection?
- (A) Diseases that originated in cows cannot spread.
 - (B) Even those who are not immunised will be protected from the pathogen.
 - (C) Everyone has already had the disease.
 - (D) There are less potential carriers in the population.
19. When using showers at a public swimming pool or gym it is advisable to wear footwear to reduce the chance of developing tinea (also called Athlete's foot). This is a condition caused by a fungus which can be passed on from one person to another. When a person with tinea walks barefoot, they leave behind some of the fungal cells. Other people can then pick up these as they walk on the floor.

What type of disease is tinea?

- (A) Non-infectious disease.
- (B) Disease that is infectious and is transmitted by a vector.
- (C) Disease that is infectious and is transmitted by direct contact.
- (D) Disease that is infectious and is transmitted by indirect contact.

20. *Eremophila duttonii* (*E.duttoni*) also known as Harlequin fuchsia bush is a plant used in traditional Australian Aboriginal medicine. A scientist used a spreader to cover agar plates evenly with 0.5mL of *E. coli* broth and placed disks soaked in various substances as shown in the diagram on each quarter of the agar plate. The experiment was repeated multiple times and produced consistent results. Results of the investigation are shown in the diagram below.



- Bacteria have grown where the plate is shaded (grey area)
- No bacteria have grown in areas that are not shaded (clear white area)

What can be concluded about *E.duttoni* extract from this experiment?

- (A) Ineffective treatment for bacterial infections.
- (B) An effective treatment for all bacterial infections.
- (C) More effective at inhibiting the growth of *E.coli* than Antibiotic A.
- (D) More effective at inhibiting the growth of *E.coli* than Antibiotic B.

Student Number

Part B – 80 marks

Attempt Questions 21–35

Allow about 2 hours and 25 minutes for this part.

At School Instructions

Write your Student Number at the top of this page.

Answer the questions in the spaces provided. These spaces provide guidance for the expected length of response.

Extra writing space is provided at the back of this booklet. If you use this space, clearly indicate which question you are answering

Online Instructions

Write your Student Number at the top of **each** piece of writing paper you use.

At the top of the page **clearly** write the question number and part (eg Q31 or Q31b). **Do not** rewrite the question.

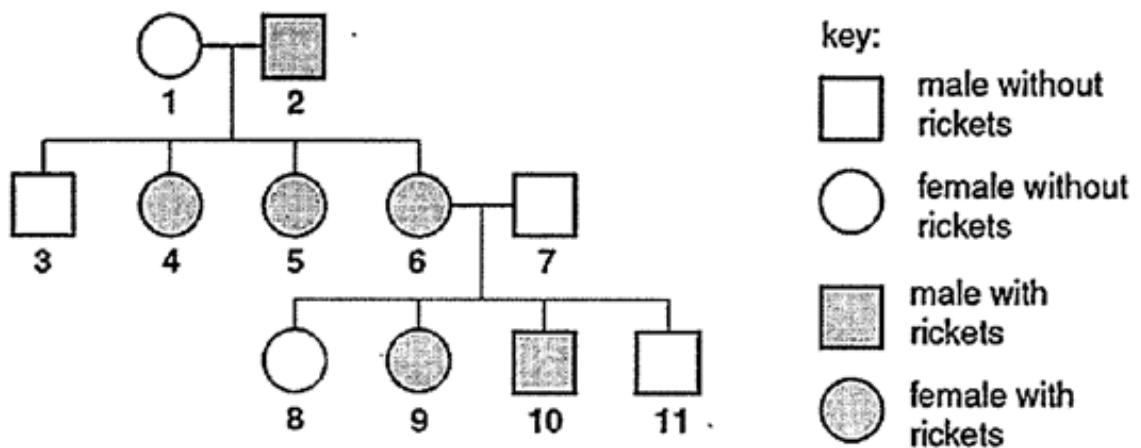
Set out your answers carefully leaving space between each question.

The lined spaces in this question booklet are a guide to the expected length of your answer.

Question 21 (4 marks)

Rickets is a bone disorder that affects infants and young children. It involves the softening and weakening of bones. It is usually caused by a lack of vitamin D, calcium ions or phosphate ions. A rare form of rickets that cannot be treated with vitamin D supplement therapy is caused by a mutant allele on the X chromosome.

The figure below shows a pedigree chart for a family that has a history of this condition.



- a) State the genotypes of individuals 3 and 9.

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- b) Explain why all daughters of individuals 1 and 2 have the disease.

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Question 22 (7 marks)

The chart below shows which amino acids are coded for by different combinations of mRNA nucleotides.

		Second letter				
		U	C	A	G	
First letter	U	UUU } Phe UUC } UUA } Leu UUG }	UCU } UCC } Ser UCA } UCG }	UAU } Tyr UAC } UAA Stop UAG Stop	UGU } Cys UGC } UGA Stop UGG Trp	U C A G
	C	CUU } CUC } Leu CUA } CUG }	CCU } CCC } Pro CCA } CCG }	CAU } His CAC } CAA } Gln CAG }	CGU } CGC } Arg CGA } CGG }	U C A G
	A	AUU } AUC } Ile AUA } AUG Met	ACU } ACC } Thr ACA } ACG }	AAU } Asn AAC } AAA } Lys AAG }	AGU } Ser AGC } AGA } Arg AGG }	U C A G
	G	GUU } GUC } Val GUA } GUG }	GCU } GCC } Ala GCA } GCG }	GAU } Asp GAC } GAA } Glu GAG }	GGU } GGC } Gly GGA } GGG }	U C A G

Leiden factor V thrombophilia is a genetic disease which causes an increase in blood clotting. The disease is caused by a mutated version of the gene associated with factor V, one of the body's clotting factors.

mRNA sequence for normal factor V is as follows:

UCC CUG GAC AGG **CGA** GGA AUA CAG GUA UUU

-mRNA sequence with a point mutation causing thrombophilia is as follows:

UCC CUG GAC AGG **CAA** GGA AUA CAG GUA UUU

- a) Using the data in the table, identify the change in amino acid resulting from the mutation in Leiden factor V thrombophilia.

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Question 22 continued on next page

b) The following DNA sequence produces a polypeptide with the amino acid sequence Phe-Tyr-Ala. Draw a flowchart to show ONE other type of point mutation (different from the point mutation that causes thrombophilia above). Use this DNA sequence to show the effect that this mutation would have on the polypeptide produced.

AAA ATA CGT

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c) Describe the effects of a named genetic disease caused by a chromosomal mutation. 2

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Question 23 (6 marks)

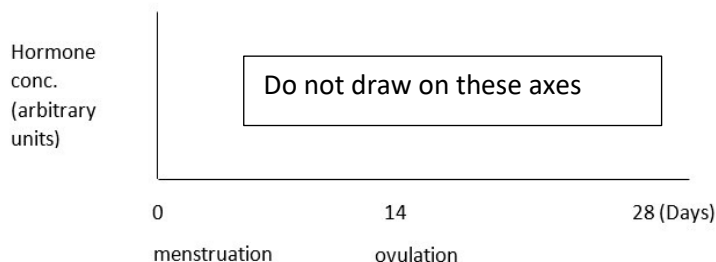
The human menstrual cycle is under the control of four hormones. Two, FSH and LH, are made by the pituitary gland, and the other two, oestrogen and progesterone, are made within the ovaries. The information box below describes how they act.

Hormonal Control of the Menstrual Cycle

1. **FSH** stimulates the 'ripening' of an egg. As the follicle develops it produces **oestrogen** which, amongst other things, 'switches off' **FSH** production to make sure that only one egg 'ripens' at once.
2. **LH** levels remain low throughout the cycle, except for a sudden surge which triggers ovulation - the release of the egg, on about the 14th day.
3. The follicle which released the egg then produces **progesterone**, which targets the lining of the uterus, making it receptive to a fertilised egg should fertilisation occur.
4. After about 22 days of the cycle, if fertilisation has not occurred, **progesterone** and **oestrogen** levels drop. Once they get below a certain level menstruation is triggered on around the 28th day of the cycle.

- a) Redraw the axis in the picture below, in the space provided at the bottom of the page. Then, use the information provided above to graphically represent the changing levels of all four hormones.

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Question 23 continued on next page

b) Describe a negative feedback relationship between two of the hormones. 3

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c) Why is this negative feedback needed? 1

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Question 24 (5 marks)

Homeostasis can be said to consist of two stages: 5

- Detecting changes from the stable state.
- Counteracting changes from the stable state

Justify this statement with reference to a named example.

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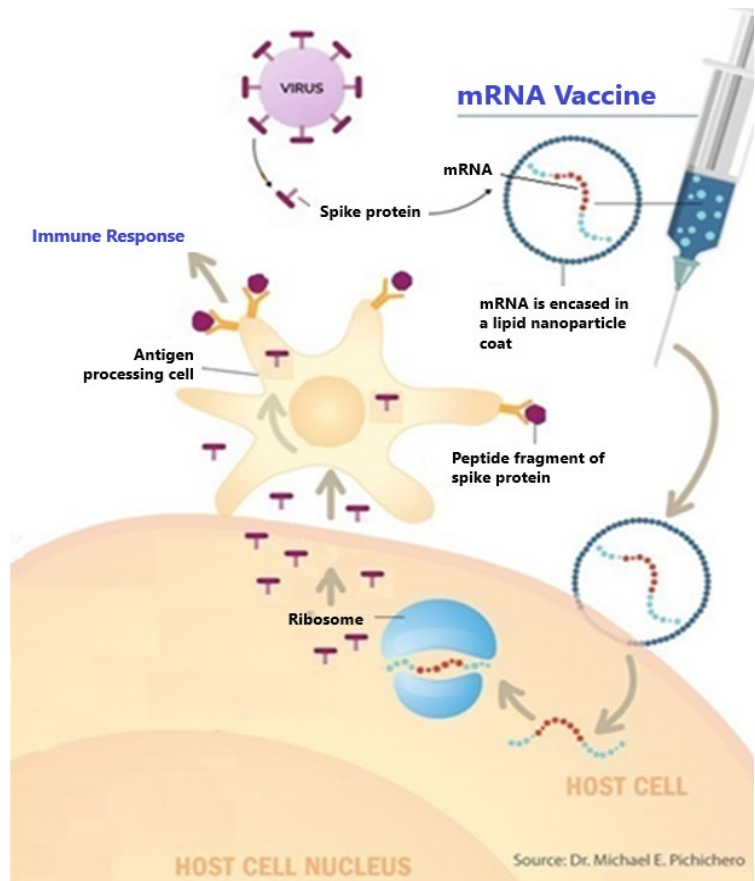
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Question 25 (6 marks)

Researchers have been studying and working with mRNA vaccines for decades. Interest has grown in these vaccines because they can be developed in a laboratory using readily available materials, making vaccine development faster than traditional methods. The first mRNA vaccine to be used widely is one for COVID-19.

The diagram outlines the mechanisms involved in the production and activity of the COVID-19 mRNA vaccine.



- a) Use the information provided in the diagram to describe how this vaccine produces the molecule that stimulates the immune response.

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Question 25 continued on next page

- b) Explain how immunity against COVID-19 develops as a result of receiving the vaccine. 3

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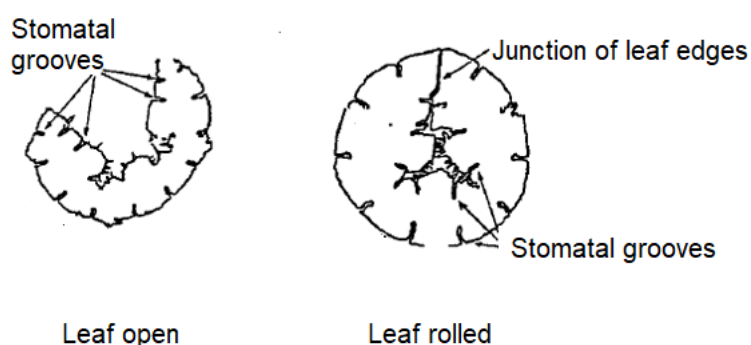
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Question 26 (4 marks)

The appearance of a cross section of porcupine grass appears different with a change in environmental conditions.



- (a) Explain which diagram, A or B, represents porcupine grass under dry conditions by referring to one of the adaptations shown. 2

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Question 26 continued on next page

- (b) The following table shows the number of stomates in the upper and lower epidermis of leaves belonging to several species of plants.

Plant species	Average number of stomates per cm ²	
	Upper epidermis	Lower epidermis
A	4000	28100
B	1300	0
C	70	290

Identify the plant that is most likely to live in an arid environment and use the information to outline the process by which this plant is able to reduce water loss. 2

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Question 27 (6 marks)

Escherichia coli is a bacterium that reproduces once every 20 minutes at 35°C. A scientist set up an investigation of these bacterial cells. The independent variable was temperature and the following conditions were set up.

Tube	Conditions of incubation
1	Eight hours at 35°C
2	Eight hours at 10°C
3	Two hours at 35°C, four hours at 4°C then two hours at 35°C

(a) Write an aim for this investigation.

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(b) Identify the dependent variable.

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(c) Identify FOUR controlled variables in this investigation.

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Question 27 continued on next page

- (d) Describe how the scientist could increase the reliability of these results from this experiment.

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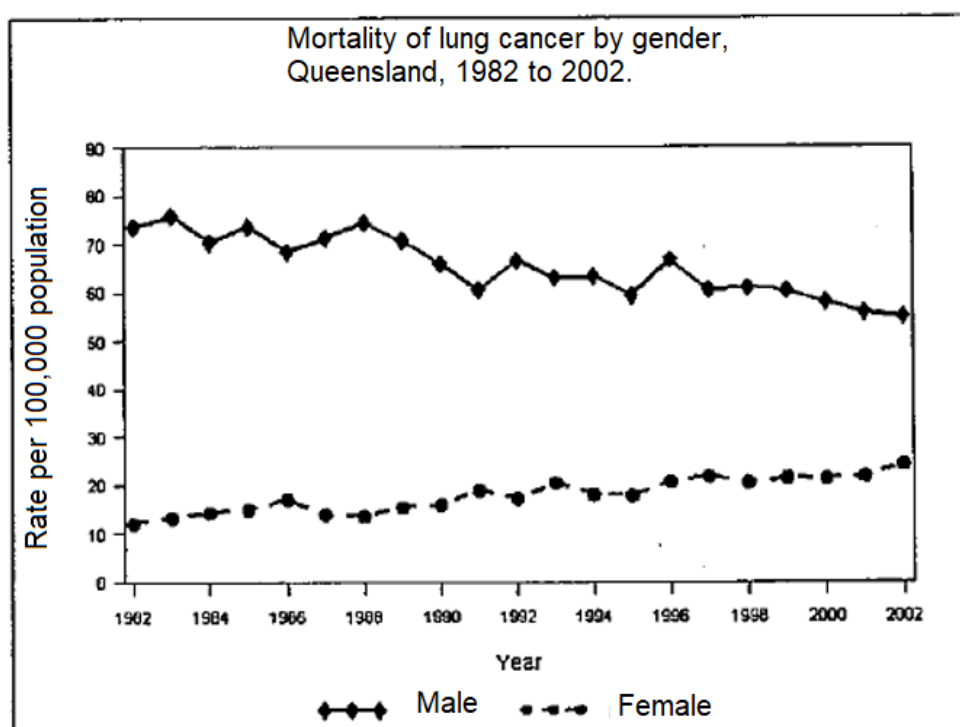
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Question 28 (5 marks)

Refer to the graph below to answer question 28.



- (a) The study above compares the rates of lung cancer per 100,000 population. Suggest a reason for using a large population sample.

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Question 28 continued on next page

(b) Identify TWO trends apparent in the above graph.

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(c) Outline a possible reason for EACH of the trends identified in part (b)

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Question 29 (7 marks)

Artificial insemination is one of the processes used in agriculture to control certain characteristics in populations of farmed animals. Using specific examples, assess the use of biotechnologies in agriculture and their potential impact on biodiversity.

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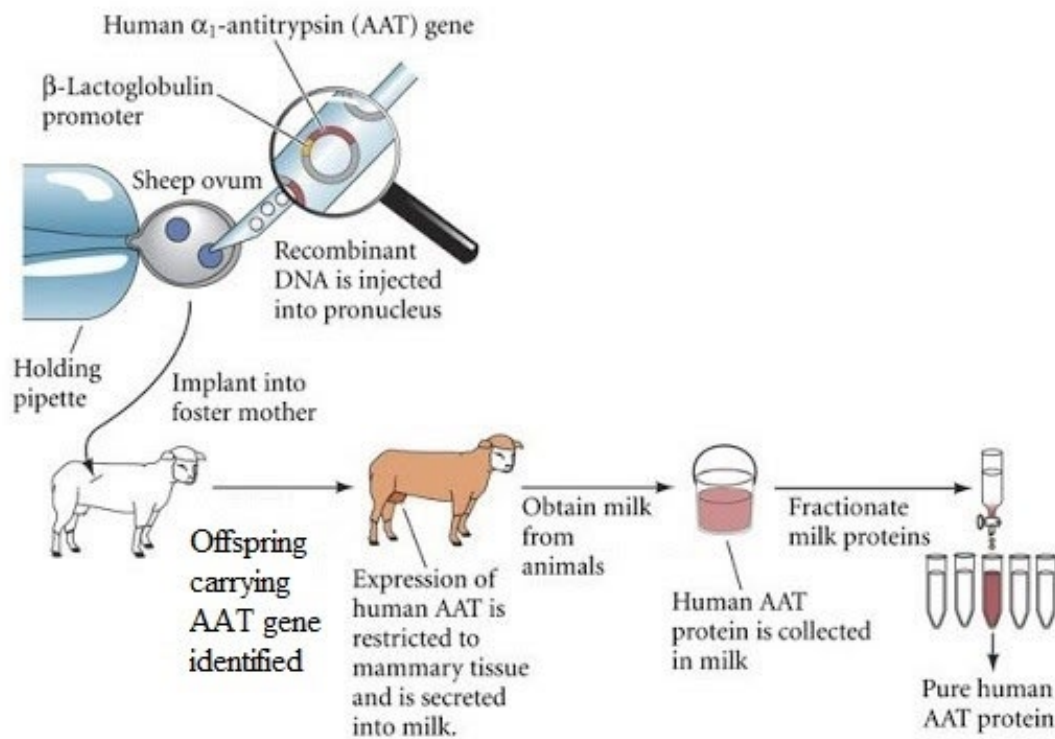
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Question 30 (5 marks)

Alpha-1-antitrypsin (α 1-antitrypsin) deficiency is a genetic disease which causes serious lung or liver disease in humans. Sheep can be genetically engineered to produce the protein, α 1-antitrypsin (AAT), in the milk produced by their mammary glands. The diagram shows the steps involved in this process.



- a) Identify the type of organism produced using this technology.

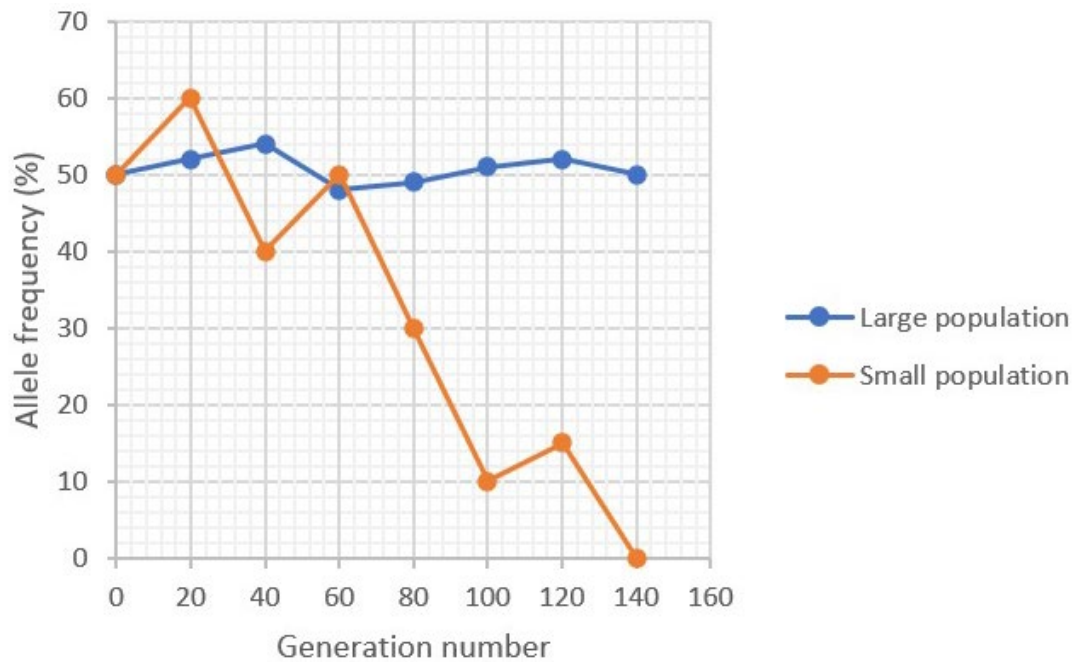
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- b) Using the example in the diagram, discuss ethical and social considerations of producing products using this technology.

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Question 31 (4 marks)

The frequency for an allele in a large breeding population of a mammal on the mainland of a continent is at 50%. Twenty individuals from this population have suddenly become isolated on an island. The graph below predicts the expected allele frequency for both the mainland and island populations over the next 140 generations.



a) Define the term 'allele frequency'.

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b) Justify the difference between the two populations shown on the graph.

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Question 32 (4 marks)

Sickle cell anaemia is a genetic disease that is caused by a single point mutation in the gene that helps make haemoglobin (codon GAG is mutated to GUG). Sickle cell anaemia is an example of a single nucleotide polymorphism (SNP).

The data table below shows the prevalence of malaria and the frequency of the sickle cell allele in several African countries.

Country	Prevalence of malaria (per 1,000 population)	Frequency of sickle cell allele (%)
Algeria	2	0.8
Democratic Republic of the Congo	45	14.5
Egypt	1	1.5
Ethiopia	10	2.6
Kenya	25	5.3
Sierra Leone	50	16.4

- a) In which region of DNA do SNPs more commonly occur?

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- b) What trend is shown in this data?

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- c) Using this data and your understanding of evolution, describe a possible reason for the change in frequency of the sickle cell allele in different African countries.

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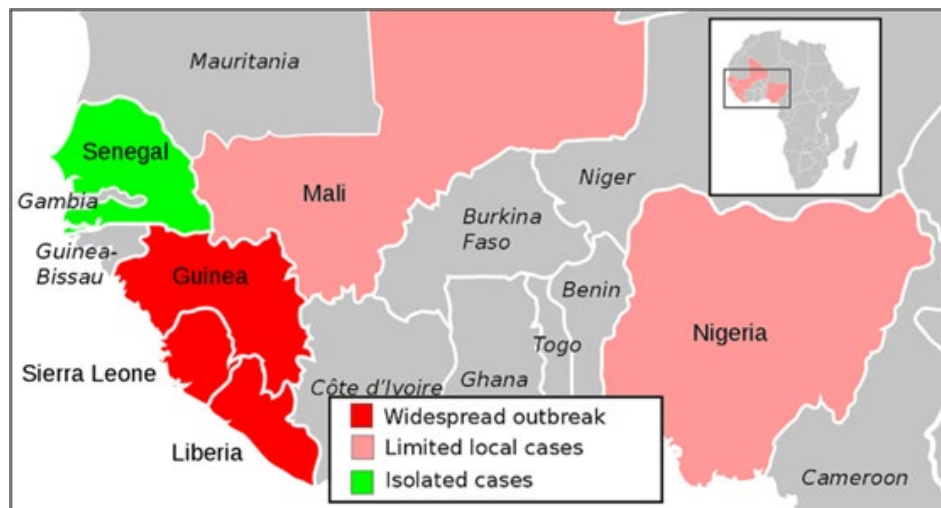
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Question 33 (4 marks)

Ebola is a highly contagious virus which can cause rapid death. It is transmitted through human to human contact/exchange of bodily fluids.

The diagram shows the spread of the Ebola epidemic in West Africa in 2014.



- a) Identify a possible procedure that could be employed by countries surrounding Guinea to prevent the spread of Ebola. 1

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- b) Compare the effectiveness of quarantine programs in Senegal and Guinea during this epidemic using the information from the map to support your answer. 3

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Question 34 (5 marks)

As part of your Biology course, you had to design and conduct a practical investigation relating to the microbial testing of water and food samples.

- a) State a hypothesis that you tested. 1

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- b) Describe the safe work practices employed during your investigation. 2

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- c) The following results were obtained in this investigation. Record the results in the table provided. 2

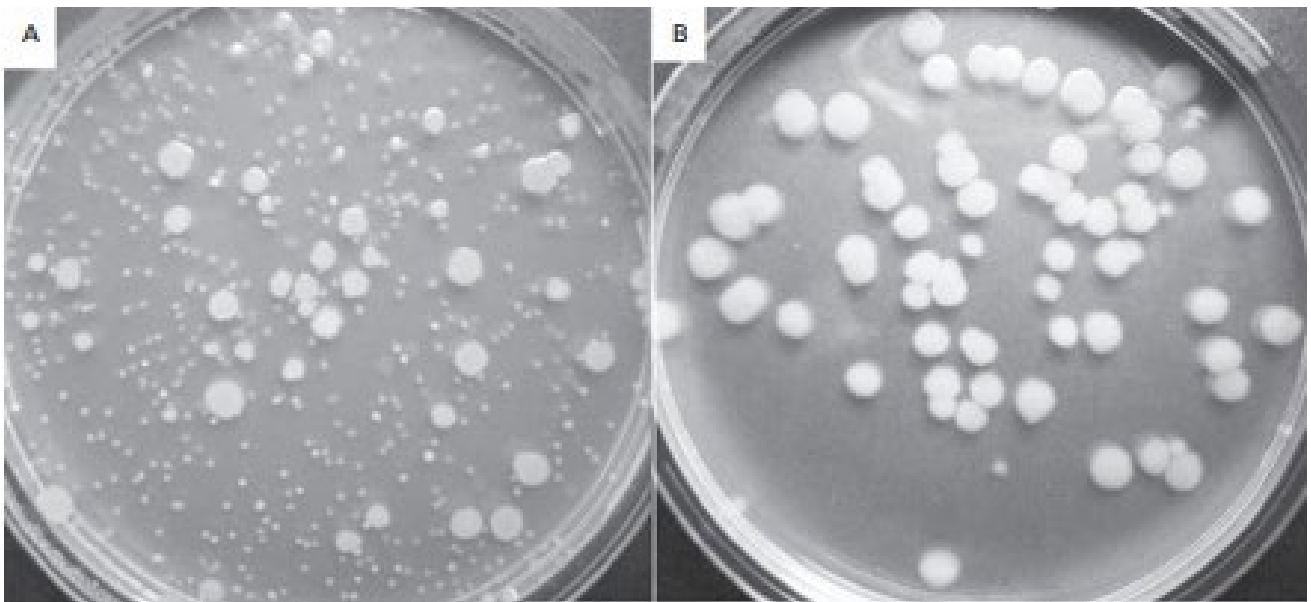
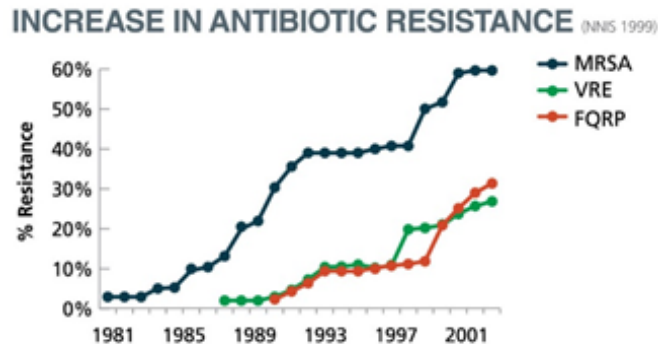


Plate name	Total count of bacterial colonies			
	Count 1	Count 2	Count 3	Average
A				
B				

The graphs below show information about the effectiveness of antibiotics as a treatment strategy of infectious diseases.



8

[illegible]

This image shows a full page of white paper with horizontal dotted lines. The lines are evenly spaced and run across the width of the page, providing a guide for handwriting practice. There are no margins, text, or other markings on the page.

This image shows a full page of white paper with horizontal dashed lines, typical of primary school writing paper. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.

Yr 12 Biology 2021 Task 4 – Trial Marking Guidelines with Markers Comments

Part A – Multiple Choice

Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Q14	Q15	Q16	Q17	Q18	Q19	Q20
A	A	B	B	A	B	D	D	All	D	C	A	C	A	C	A	D	B or D	D	C

Part B

	Marking Guidelines		Sample Answer	Markers Comments									
21a	Uses correct symbols for both alleles by identifying the dominant and the recessive Correctly states the genotypes of the two individuals	1	3 – X ^r Y 9 - X ^R X ^r	Well answered. Correct notation is important R – with rickets r – without rickets									
21b	Correctly identifies the type of inheritance Correctly identifies the genotype of the father and the mother Link the genotype to the daughters’ OR use a punnet square and include a statement of ratio Correctly identifies the type of inheritance Correctly identifies the genotype of the father and the mother Provides some relevant information	3 2 1	Rickets is a genetic disease that is caused by a dominant allele carried on the X chromosome. Since Individual 1 is an affected male then his genotype would be X ^R Y and therefore the only allele he would pass on to his daughters is X ^R . Since the affected allele is dominant all the daughters will have the disease since only one mutant allele on the X chromosome causes the disease. Individual 1 (mother) - X ^r X ^r Individual 2 (father) - X ^R Y <table><tr><td></td><td>X^R</td><td>Y</td></tr><tr><td>X^r</td><td>X^R X^r</td><td>X^r Y</td></tr><tr><td>X^r</td><td>X^R X^r</td><td>X^r Y</td></tr></table>		X ^R	Y	X ^r	X ^R X ^r	X ^r Y	X ^r	X ^R X ^r	X ^r Y	Most of the students have worked out that was sex-linked but not the dominant part. Type of inheritance – must state ‘dominant AND sex-linked’ OR ‘dominant AND on the X chromosome’ Correct notation is needed for punnet square. This has been taken into account if mark is lost in part a) Some students have confused the difference between heterozygous (Rr) and homozygous (RR or rr)
	X ^R	Y											
X ^r	X ^R X ^r	X ^r Y											
X ^r	X ^R X ^r	X ^r Y											

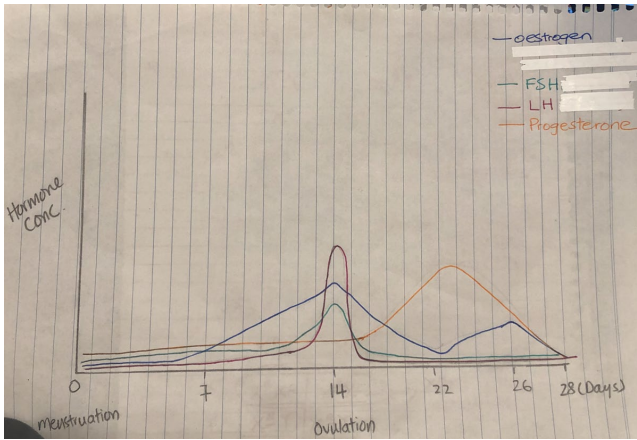
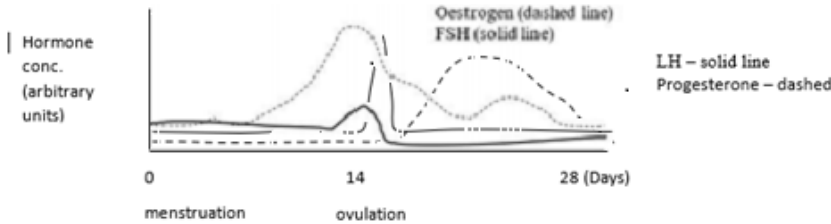
22a	<table><tr><td>Correctly identifies the change in amino acid</td><td>1</td></tr></table>	Correctly identifies the change in amino acid	1	Amino acid would change from Arg to Gln.	Well answered. Be clear and state the change fromto						
Correctly identifies the change in amino acid	1										
22b	<table><tr><td>Draws a flowchart showing a different point mutation including: - mutation in the DNA - mRNA - amino acid sequence - flow chart</td><td>4</td></tr><tr><td>Draws a flowchart showing three of the above</td><td>3</td></tr><tr><td>Draws a flowchart showing two of the above</td><td>2</td></tr><tr><td>Some relevant information</td><td>1</td></tr></table>	Draws a flowchart showing a different point mutation including: - mutation in the DNA - mRNA - amino acid sequence - flow chart	4	Draws a flowchart showing three of the above	3	Draws a flowchart showing two of the above	2	Some relevant information	1	Original DNA AAA ATA CGT → AAA ATT ACG T Mutated DNA – base insertion Amino acid sequence Phe-Stop ← UUU UAA UGC A mRNA	Accepted answers: - Base substitution (as long as it is not from G to A in the new DNA sequence) - Deletion - Insertion It is a flow chart, so it is important that you have identified the correct steps. Students lost marks mainly in having the mutation on mRNA where it should have been on DNA. Students also lost marks in skipping steps in the flow chart.
Draws a flowchart showing a different point mutation including: - mutation in the DNA - mRNA - amino acid sequence - flow chart	4										
Draws a flowchart showing three of the above	3										
Draws a flowchart showing two of the above	2										
Some relevant information	1										

Accepted answers:

- Base substitution (as long as it is not from G to A in the new DNA sequence)
- Deletion
- Insertion

It is a flow chart, so it is important that you have identified the correct steps.

Students lost marks mainly in having the mutation on mRNA where it should have been on DNA. Students also lost marks in skipping steps in the flow chart.

22c	<table><tr><td>Describe the effects of a named genetic disease caused by a chromosomal mutation</td><td>2</td></tr><tr><td>Give details of a chromosomal mutation OR names a disease caused by a chromosomal mutation</td><td>1</td></tr></table>	Describe the effects of a named genetic disease caused by a chromosomal mutation	2	Give details of a chromosomal mutation OR names a disease caused by a chromosomal mutation	1	A genetic disease caused by a chromosomal mutation is Down's syndrome. The effects of Down's syndrome may include short stature, intellectual disability and some characteristic facial features. This disorder arises as a result of a change in chromosome number. The individual has an extra copy of chromosome 21 caused by a random error in cell division.	Well answered. Majority of the answers gave Down Syndrome as the example. Other chromosomal mutations include: - Turner's syndrome - Klinefelter's syndrome - Cri du chat syndrome - 22q11.2 duplication
Describe the effects of a named genetic disease caused by a chromosomal mutation	2						
Give details of a chromosomal mutation OR names a disease caused by a chromosomal mutation	1						
23a	<table><tr><td>FSH level stays low with a spike around day 14 LH level stays low with a spike around day 14 Progesterone level stays low till day 14, rises, then decreases Oestrogen level stays low begins to rise from about day 7 with a peak at day 14, then decreases with another small increase at around day 26, then decreases</td><td>2</td></tr><tr><td>2 of the above</td><td>1</td></tr></table>	FSH level stays low with a spike around day 14 LH level stays low with a spike around day 14 Progesterone level stays low till day 14, rises, then decreases Oestrogen level stays low begins to rise from about day 7 with a peak at day 14, then decreases with another small increase at around day 26, then decreases	2	2 of the above	1	 	Majority of the students got 2 out of the 4 graphs correct (progesterone and LH) Make sure you read the information in the stimulus carefully regarding when the spikes are.
FSH level stays low with a spike around day 14 LH level stays low with a spike around day 14 Progesterone level stays low till day 14, rises, then decreases Oestrogen level stays low begins to rise from about day 7 with a peak at day 14, then decreases with another small increase at around day 26, then decreases	2						
2 of the above	1						

23b	Describe a negative feedback loop with two hormones in the question	3	After ovulation, LH stimulates the corpus luteum to produce progesterone which causes the hypothalamus to produce less GnRH. This causes less LH to be produced (or progesterone causes the anterior pituitary gland to produce less LH). This causes the corpus luteum to deteriorate which leads to an end to the menstrual cycle. <i>Could substitute FSH for LH and oestrogen for progesterone.</i>	Most students identified the relationship between two hormones in the question. Some lack descriptions.
	Identifies a negative feedback loop with two hormones in the question	2		
	Provides some relevant information OR relationship between two hormones	1		
23c	States an end to the menstrual cycle or menstruation brought on	1	To end the menstrual cycle (or to bring on menstruation).	Not well answered. A lot of students wrote about regulation of hormones and ensuring only one egg being released.
24	Uses a correct example of change from specific stable state, including: - Identifying receptors involved in detection - Describing negative feedback pathway - Identifying organs/glands involved in response - Describing body changes that effect the return to stable state	5	Maintaining an internal body temperature of 37°C is necessary so that the human body can operate as efficiently as possible. The role of homeostasis is to maintain this temperature level as close to optimum as possible. It relies on the body to detect changes to the stable state and counteract them. To do this it uses a negative feedback mechanism. Temperature receptors (thermoreceptors) detect changes in skin and blood temperature for example an increase in temperature. The hypothalamus then relays this information via nerve impulses and initiates a response by sending a message to effector tissues including blood vessels which dilate to release heat and sweat glands for evaporative cooling. The temperature is then returned to its stable state. This is demonstrated below in the diagram.	C – correct example of change from specific stable state R – receptors involved in detection identified N – negative feedback pathway described E – organs/glands involved in response identified B – body responses that effect the change described. Do not repeat what is already written in the question. Always start with a new statement eg, define homeostasis. ‘Justify’ does not need a judgment – just support for the statement or concept.
	Uses a correct example of change from specific stable state, including 3 of the above components	4		
	Uses a correct example of change from specific stable state, including 2 of the above components	3		
	Correct example with one component OR includes at least 2 components without specific link to a correct example	2		
	Provides some relevant information	1		

		Copyright © 2008 Pearson Education, Inc.	An annotated diagram was an acceptable way to answer the question. Most students showed a good understanding of homeostasis. Marks were most commonly lost for not including sufficient specific detail on the example chosen – receptors and effectors had to be identified, a feedback pathway outlined and counteracting responses described.						
25a	<table><tr><td>Describes all key steps in the process: • mRNA code for antigenic spike protein is injected in vaccine • viral mRNA taken up by body cells • mRNA translated by ribosomes producing spike proteins • spike proteins (antigen) leave cells (to be detected by macrophages) </td><td>3</td></tr><tr><td>Outlines all key steps OR describes some key steps in the process</td><td>2</td></tr><tr><td>Provides some relevant information</td><td>1</td></tr></table>	Describes all key steps in the process: • mRNA code for antigenic spike protein is injected in vaccine • viral mRNA taken up by body cells • mRNA translated by ribosomes producing spike proteins • spike proteins (antigen) leave cells (to be detected by macrophages)	3	Outlines all key steps OR describes some key steps in the process	2	Provides some relevant information	1	The mRNA code for the spike protein (antigenic molecule) on the COVID virus is injected into the body in the vaccine. The viral mRNA is taken up by cells where the mRNA code is translated in the ribosomes producing many copies of the viral spike protein. The spike protein moves out of cells (where it is detected by macrophages / phagocytes / antigen presenting cells stimulating the immune response).	It is vital that each part of the question be answered individually. Always read all parts of the question to ensure that the correct information is included in each part. Describing how antigenic molecule is produced stops at production of spike proteins which leave the cell. Detection by macrophages is the start of how immunity develops (part b).
Describes all key steps in the process: • mRNA code for antigenic spike protein is injected in vaccine • viral mRNA taken up by body cells • mRNA translated by ribosomes producing spike proteins • spike proteins (antigen) leave cells (to be detected by macrophages)	3								
Outlines all key steps OR describes some key steps in the process	2								
Provides some relevant information	1								

			Common errors included: • misunderstanding that the spike protein was ‘inserted’ into mRNA. The mRNA has the code for the protein. • Omission of translation of mRNA at ribosomes to produce spike proteins • Not specifying that the spike protein is the viral antigen • Stating that a vaccine is a dead or weakened pathogen – in mRNA vaccines this is not the case						
25b	<table><tr><td>Explains that antigen (COVID spike protein) is detected by macrophages, causing the body to make specific antibodies and T-cells AND memory B and T-cells which provide future immunity</td><td>3</td></tr><tr><td>Describes production of memory B and T cells in response to antigen being detected by macrophages to provide immunity OR both memory cells and antibodies / T cells produced without link to macrophage detection</td><td>2</td></tr><tr><td>Provides some relevant information</td><td>1</td></tr></table>	Explains that antigen (COVID spike protein) is detected by macrophages, causing the body to make specific antibodies and T-cells AND memory B and T-cells which provide future immunity	3	Describes production of memory B and T cells in response to antigen being detected by macrophages to provide immunity OR both memory cells and antibodies / T cells produced without link to macrophage detection	2	Provides some relevant information	1	The antigenic spike proteins expressed by body cells are recognised by macrophages. The macrophages present the antigen on their surface to stimulate an immune response which produces specific antibodies (humoral response) and cytotoxic T-cells (cell mediated response) to destroy the spike protein. Specific memory B-cells and T-cells are produced and remain in the body providing immunity against COVID-19 in future infections.	The information that the antigenic spike protein is detected by macrophages is vital for this question and cannot be carried forward from part a). Most students lost a mark for this reason. It is also necessary to include both T and B cell response and T and B memory cells.
Explains that antigen (COVID spike protein) is detected by macrophages, causing the body to make specific antibodies and T-cells AND memory B and T-cells which provide future immunity	3								
Describes production of memory B and T cells in response to antigen being detected by macrophages to provide immunity OR both memory cells and antibodies / T cells produced without link to macrophage detection	2								
Provides some relevant information	1								

26a	Correctly identifies rolled leaf, B or diagram on right Provides a reason that relates to dry environment	2	The rolled leaf diagram (B or diagram on the right) refers to the porcupine grass in under dry conditions as this adaptation is minimising water loss to the environment with the position of stomatal grooves it traps moist air, which increases the humidity and reduces the diffusion of water to dry environment.	Rolling influences the environment around the stomata, but cannot close the stomatal groove, guard cells do this.
	Correctly identifies rolled leaf, B or diagram on right	1		
26b	Correctly identifies plant C Using specific data provides a reason that relates to reduced stomates per cm ² with more on lower epidermis and water loss.	2	Plant species C as it has significantly less stomates than plant A (89 times less) and has approximately 81% of stomates on the lower epidermis. Fewer stomates and their presence mostly on the underside of the leaf reduce evaporation and transpiration thus reducing water loss.	Must make use of specific information from the table.
	Correctly identifies plant C	1		
27a	Correctly states an aim that relates temperature to bacterial growth	1	The aim is to see the effect of temperature on the growth of Escherichia Coli.	
27b	Correctly identifies bacterial growth/number	1	Number of Bacteria	Also accepted colony size. Did not accept reproduction rate as this is the speed/rate of reproducing over a certain time period. If this was the case, the tubes would have to be examined throughout the 8 hours.

27c	Correctly identifies four controlled variables	2	Type of bacteria Amount of growth medium – eg agar Type of growth medium – agar Inoculating techniques	Also accepted total time, size of tubes, amount of bacteria at the start, same incubator. Did not accept same person/scientist performing the experiment. Did not accept control group used as this is not a controlled variable.
	Correctly identifies 2 or 3 controlled variables	1		
27d	Correctly identifies repetition and achieving consistent results	2	The scientist should repeat these experiments multiple times to show that consistent results received. The more similar repeated measurements are, the more reliable the results.	Also accepted large sample size.
	Identifies repetition only	1		
28a	Correctly provides reason for large sample size	1	larger sample sizes give more reliable results and give a more close approximate to the population. Or Larger samples sizes aid in determining the average value-this average is the <i>mean</i> . The larger the sample size, the more precise the mean.	Did not accept ‘make it reliable or valid’. Needed to say ‘make the results more reliable’ or ‘makes it valid as more data is collected’.
H28b	Correctly identifies two trends in graph with data for both	2	The mortality rate in females demonstrates a slight increase from 1982 – 2002 with 11per 100000 increasing to approximately 22 per 100000 Males in the same time have demonstrated a decrease with numbers falling from 73 per 100000 to 55 per 100000.	Must include both types of data – years and numbers to get full marks.
	Identifies only one trend with data or two trends without data	1		
28c	Correctly provides reason for each trend	2	Male numbers may have decreased due to the increased education of smoking leading to lung cancer and smoking decreased in numbers. Or early detection of lung cancer and therefore treatment leading to a slight decrease in mortality rate for males. Female numbers may increase due to higher number of females smoking and this leading to increased lung cancer and death due to lung cancer or lung cancer may act differently in females leading to a higher mortality rate.	Needed to link reason with trend clearly ie smoking causes lung cancer.
	Identifies correctly only one reason for one trend	1		

29	Makes a judgement about the use of biotechnologies in agriculture. Demonstrates a thorough understanding of TWO biotechnologies used in agriculture, with named examples. Shows a clear relationship between the biotechnologies and the impact on biodiversity.	6-7	Biotechnologies are of great benefit to the agricultural industry as they are used to manipulate the reproduction of plants and animals for higher yields and better quality products. They will result in less biodiversity overall though, as humans are choosing which alleles remain in the population rather than the environment disrupting normal natural selection process. Genetic Engineering has allowed modified crops such as Bt cotton to be produced. Bt cotton has a gene from <i>Bacillus thuringiensis</i> (Bt) incorporated into its genome. The Bt gene allows the cotton to produce a toxin that kills caterpillars when they eat it. This reduces the need to spray crops with insecticide which can be harmful to human health and also reduces costs for the farmer. Biodiversity is affected though as the number of caterpillars is reduced which may reduce the food available for species that feed on them, thus affecting food chains and food webs potentially reducing the number of species that can survive. Bt cotton may also reduce the biodiversity of the caterpillar population as susceptible varieties are killed and only those that are resistant survive to reproduce. Artificial Insemination in agriculture involves collecting semen from desirable male animals such as bulls. Semen can be frozen, stored and transported to other locations and can be used to inseminate many females in order to produce multiple offspring with desirable traits. Fresian-Jersey cows are an example of AI. These hybrids have the desired characteristics of both parents and so produce large quantities of creamy milk. AI results in a loss of biodiversity as one male has many offspring. All the offspring will be genetically half siblings so will have reduced genetic variation.	The following elements were needed in your answer (they do not necessarily equate to one mark each – please refer to the marking guideline rubric) J – judgement statement B – biotechnology definition B1 – biotechnology example 1 description B1A – biotechnology example 1 assess B2 – biotechnology example 2 description B2A – biotechnology example 2 assess I – Impact of biotechnologies on biodiversity Also accepted Artificial Pollination and Cloning.
	Makes a judgement about the use of biotechnologies in agriculture. Demonstrates a sound understanding of TWO biotechnologies used in agriculture, with named examples. Shows a relationship between the biotechnologies and the impact on biodiversity. OR Demonstrates a thorough understanding of TWO biotechnologies used in agriculture, with named examples. Shows a relationship between the biotechnologies and the impact on biodiversity but lacks a convincing judgement statement.	4-5		
	Describes ONE biotechnology used in agriculture. OR Outlines TWO biotechnologies used in agriculture without a link to biodiversity.	2-3		
	Provides some relevant information.	1		

30a	Identifies type of organism	1	The sheep is a transgenic organism	GMO not accepted.
30b	Identifies one relevant ethical and one relevant social consideration for this case and provides points for and/or against each Identifies one relevant ethical and one relevant social consideration for this case and provides points for and/or against one issue Identifies one relevant ethical or social consideration and provides points for and/or against OR identifies one relevant ethical and one relevant social consideration for this case Identifies one relevant ethical or social consideration for this case	4 3 2 1	The development of these transgenic sheep to produce milk that contains AAT protein provides social benefits by providing treatment for people who suffer the problems associated with AAT deficiency. This not only helps the individual and their family to contribute more readily to society by working but also reduces the burden on the health care system. However, concerns may be raised about unforeseen health risks to patients such as possible allergic reactions to the product. Ethical considerations include concerns for animal welfare if the sheep are not cared for humanely and whether using this type of technology is ‘playing God’. However, as this disease causes serious lung or liver disease, it could be seen as unethical to not to use this technology to provide medicine that prevents human suffering.	Marking code: E = ethical issue S = social issue F = argument For A = argument Against Must make use of the key words social and ethical. Issues must be directly linked to one consideration, not generalised. Answer must link to the stimulus provided.
31a	Defines the term	1	Allele frequency is the measure of how common an allele is in a population	It is not the number of alleles in a population. Question refers to a specific allele.
31b	Explains difference between populations in terms of genetic drift Shows some understanding of genetic drift and describes one of the population changes over time OR Describes the difference between the two populations Provides some relevant information	3 2 1	Genetic drift refers to the random changes in allele frequency that occur in all populations due to chance, rather than selective pressures. On the mainland, the large population buffers against random loss of alleles. This is reflected in the consistent line for the large population (i.e., the relative frequency of the allele remains stable). In the small breeding population, relative frequencies of the allele may fluctuate to such an extent that allele may become reduced or lost (frequency 0%) from the gene pool altogether, as suggested by the graph which shows the removal of the allele after 140 generations. Alternatively, the allele may become fixed in the population (100%).	Either define Genetic Drift or demonstrate your understanding of the effect of genetic drift on small populations. Must include the term <i>genetic drift</i> or <i>founder effect</i> .

32a	Identifies correct region	1	SNPs occur most commonly in non-coding regions of DNA	Also accepted <i>introns</i> Many students did not answer the question and referred to a region in Africa
32b	Identifies correct trend	1	The higher the prevalence of malaria, the higher the frequency of the sickle cell allele	Although not technical correct, the opposite trend was accepted
32c	Provides a reason that malaria acts a selection pressure for the sickle cell allele	2	Malaria is acting as a selection pressure for presence of the sickle cell allele. A possible reason is that the sickle cell allele may protect carriers against malaria, providing a survival advantage.	Not well answered. Need to <i>use data</i> and <i>understanding of evolution</i> to achieve 2 marks.
	Identifies that malaria is a selection pressure for sickle cell allele OR describes a plausible mechanism of evolution of the sickle cell allele in African countries but doesn't refer to Malaria	1		
33a	Identifies an appropriate method of preventing spread of Ebola	1	Countries surrounding Guinea could employ strict quarantine of all people trying to cross the border to prevent those infected from entering.	Well answered. Most students answered quarantine but vaccination and mask wearing were also accepted.
33b	Using the map, compares the isolated cases in Senegal with the widespread outbreak in Guinea as demonstrating a more effective quarantine program in Senegal.	3	There is a widespread outbreak across Guinea whereas in Senegal there are only isolated cases. This suggests that the quarantine program in Senegal is far more effective in controlling the epidemic than those used in Guinea.	Well answered.
	Uses data from the map to identify a difference between Senegal and guinea OR suggests a different strategy but doesn't link to map	2		
	Identifies a difference between Senegal and guinea	1		

34a	<table><tr><td>States an appropriate hypothesis that identifies the independent variable (food and water samples) and some sort of dependent variable</td><td>1</td></tr></table>	States an appropriate hypothesis that identifies the independent variable (food and water samples) and some sort of dependent variable	1	The food and water samples tested will grow a range of different types of microorganisms.	Some students wrote an aim instead of a hypothesis, be careful.																			
States an appropriate hypothesis that identifies the independent variable (food and water samples) and some sort of dependent variable	1																							
34b	<table><tr><td>Describes 2 or more safe practices used in microbiological investigations</td><td>2</td></tr></table>	Describes 2 or more safe practices used in microbiological investigations	2	There is the potential to grow harmful microorganisms. So once inoculated, agar plates are not reopened and are disposed of after appropriate autoclaving. To reduce the likelihood of growing human pathogens, plates are incubated at 40 degrees Celcius	Well answered																			
	Describes 2 or more safe practices used in microbiological investigations	2																						
<table><tr><td>Identifies safe practices employed during the investigation OR describes a safe practice employed during the investigation</td><td>1</td></tr></table>	Identifies safe practices employed during the investigation OR describes a safe practice employed during the investigation	1																						
Identifies safe practices employed during the investigation OR describes a safe practice employed during the investigation	1																							
34c	<table><tr><td>Takes 3 counts of the total number of bacterial colonies on plates A and B and records an average</td><td>2</td></tr></table>	Takes 3 counts of the total number of bacterial colonies on plates A and B and records an average	2	<table><tr><th rowspan="2">Plate name</th><th colspan="4">Total count of bacterial colonies</th></tr><tr><th>Count 1</th><th>Count 2</th><th>Count 3</th><th>Average</th></tr><tr><td>A</td><td>308</td><td>292</td><td>320</td><td>307</td></tr><tr><td>B</td><td>67</td><td>76</td><td>66</td><td>70</td></tr></table>	Plate name	Total count of bacterial colonies				Count 1	Count 2	Count 3	Average	A	308	292	320	307	B	67	76	66	70	Many students miscounted Plate A. There are 300 colonies, an average count of >250 was accepted. For plate B a range of 50-70 was accepted.
	Takes 3 counts of the total number of bacterial colonies on plates A and B and records an average	2																						
Plate name	Total count of bacterial colonies																							
	Count 1	Count 2	Count 3	Average																				
A	308	292	320	307																				
B	67	76	66	70																				
	<table><tr><td>Only counts the large colonies on plate A OR makes one other error in counting or calculating averages</td><td>1</td></tr></table>	Only counts the large colonies on plate A OR makes one other error in counting or calculating averages	1																					
Only counts the large colonies on plate A OR makes one other error in counting or calculating averages	1																							

35	Makes a judgement about the effectiveness of antibiotics. Demonstrates a thorough understanding of infectious diseases and the use antibiotics to treat infectious diseases caused by bacteria. Correctly interprets AND references information from BOTH graphs to support evaluation. Communicates logically and succinctly, with precise use of biological terms.	7-8	<i>When used correctly, antibiotics are very effective at treating bacterial infections diseases. However if antibiotics are overused or misused, bacteria can develop resistance to antibiotics which could ultimately render them ineffective against treating infectious diseases.</i> <i>Infectious diseases are diseases that have been caused by a pathogen. One type of pathogen is Bacteria. Bacterial infections can be treated with the use of antibiotics, which are chemicals destroy bacterial infections by preventing bacteria from replicating, preventing their cell wall forming or by disrupting protein synthesis.</i> <i>Graph 1 shows just how effective antibiotics have been in reducing deaths caused by infectious diseases. Before the introduction of antibiotics in the 1930s, deaths due to infection in the US dropped by 220 deaths per 100,000 (from 260 per 100,000 in 1935 to 60 per 100,000 in 1950 following the introduction of sulfa and penicillin). Deaths from infection continued to decline til 1980, but has risen slightly since then.</i> <i>Graph 2 explains why this has occurred. Since 1980, graph 2 shows the increase in antibiotic resistance. In 1981, MRSA was susceptible to antibiotics, but antibiotic resistance increased to 60% by 2001. A similar trend is observed for VRE and FQRP, both bacteria showing 20% and 25% resistance respectively in 2001.</i>	The following elements were needed in your answer (they do not necessarily equate to one mark each – please refer to the marking guideline rubric) J – judgement statement I – define infectious disease A – describe how antibiotics work S1a – Data from stimulus 1 S1b – Description of what stimulus 1 shows (reduction in deaths after introduction of antibiotics) S2a – Data from stimulus 2 S2b – Description of what stimulus 2 shows (rise in antibiotic resistance) C – clear and logical This was generally well answered, the most common error was forgetting to define the biological terms in the question (infectious disease and antibiotics).
	Makes a judgement about the effectiveness of antibiotics. Demonstrates a thorough understanding of infectious diseases and the use antibiotics to treat infectious diseases caused by bacteria. Interprets or references information from BOTH graphs. OR Demonstrates a thorough understanding but lacks a convincing judgement statement.	5-6		
	Demonstrates a sound understanding of infectious diseases and the use of antibiotics to treat infectious diseases. Interprets OR references information from graphs.	3-4		
	Provides some relevant information about infectious diseases and antibiotics.	1-2		