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Student Number



Barker
College

2024

TRIAL HIGHER SCHOOL
CERTIFICATE EXAMINATION

Biology

ANSWER SHEET

Staff Involved:

- TKB - Mr Binet
- KIP - Mrs Prior
- ALP - Ms Pope

AM TUESDAY 20TH AUGUST

100 copies

Section I - Multiple Choice

Write your Student Number at the top of this page

Choose the best response and fill in the response oval completely

Start
Here

➔ 1	A ○	B ○	C ○	D ○	11	A ○	B ○	C ○	D ○
2	A ○	B ○	C ○	D ○	12	A ○	B ○	C ○	D ○
3	A ○	B ○	C ○	D ○	13	A ○	B ○	C ○	D ○
4	A ○	B ○	C ○	D ○	14	A ○	B ○	C ○	D ○
5	A ○	B ○	C ○	D ○	15	A ○	B ○	C ○	D ○
6	A ○	B ○	C ○	D ○	16	A ○	B ○	C ○	D ○
7	A ○	B ○	C ○	D ○	17	A ○	B ○	C ○	D ○
8	A ○	B ○	C ○	D ○	18	A ○	B ○	C ○	D ○
9	A ○	B ○	C ○	D ○	19	A ○	B ○	C ○	D ○
10	A ○	B ○	C ○	D ○	20	A ○	B ○	C ○	D ○

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General

Instructions:

- Write your student number on all answer pages
- Reading time - 5 minutes
- Working time - 3 hours
- Write using black pen
- Draw diagrams using pencil
- For questions in Section II, show all relevant working in questions involving calculations
- NESA approved calculators may be used

Total marks:

100

Section I - 20 marks (pages 3 - 13)

- Attempt Questions 1 - 20
- Allow about 35 minutes for this section

Section II - 80 marks (pages 15 - 39)

- Attempt Questions 21 - 33
- Allow about 2 hours and 25 minutes for this section

Section I

20 marks

Attempt Questions 1 – 20

Allow about 35 minutes for this part

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

Select the alternative A, B, C or D that best answers the question.

Fill in the response oval completely.

Sample $2 + 4 =$ A 2 B 6 C 8 D 9
 A ○ B ○ C ○ D ○

If you think you have made a mistake, put a cross through the incorrect answer and fill in the new answer.

A ● B ~~●~~ C ○ D ○

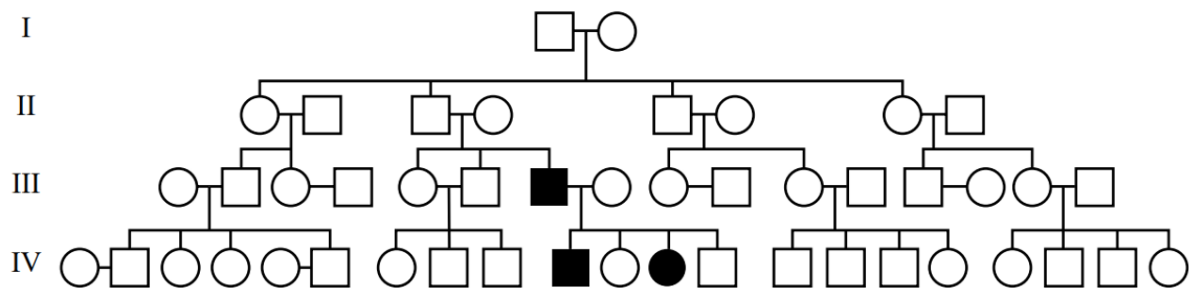
If you change your mind and have crossed out what you consider to be the correct answer, then indicate this by writing the word *correct* and drawing an arrow as follows.

A ● B ~~●~~ C ○ D ○

Correct
↓

1. Both plants and animal use a variety of mechanisms in the defence against pathogens. Which of the following is common to the defence systems of plants and animals?
 - A. antibodies
 - B. programmed cell death
 - C. cell-mediated immunity
 - D. interferon

2. The pedigree shows the inheritance of a rare autosomal dominant trait in a family called hereditary retinoblastoma. Prior to generation III, there was no occurrence of the condition in the family.



The appearance of hereditary retinoblastoma can be explained by

- A. mutation.
- B. selective breeding.
- C. invitro fertilisation.
- D. the misuse of antibiotics.

3. Select the row below which correctly contrasts the characteristics of internal and external fertilisation.

	<i>Internal Fertilisation</i>	<i>External Fertilisation</i>
A.	Many eggs produced Significant parental care of young	Few eggs produced Little parental care of young
B.	Many eggs produced Little parental care of young	Few eggs produced Significant parental care of young
C.	Few eggs produced Little parental care of young	Many eggs produced Significant parental care of young
D.	Few eggs produced Significant parental care of young	Many eggs produced Little parental care of young

4. Which of the following statements about proteins is correct?

- A. A protein with a quaternary structure will be an enzyme.
- B. Proteins are not involved in the human immune response.
- C. Proteins are chains or polymers known as a polypeptide.
- D. Proteins are chains of amino acids held together with hydrogen bonds.

5. Which row of the table correctly compares the processes of meiosis and mitosis?

	<i>Meiosis</i>	<i>Mitosis</i>
A.	produces diploid cells	produces haploid cells
B.	occurs in germ cells	occurs in somatic cells
C.	no genetic variation occurs	genetic variation increases
D.	the number of chromosomes doubles	the number of chromosomes remains the same

6. Viruses can be detected in sewage. Human faecal matter is the main source of pathogenic viruses in sewage. Infected individuals shed viral particles in their faeces.

An advantage of testing sewage for viral particles to control possible virus outbreaks is:

- A. Infected individuals can be prevented from shedding the virus.
 - B. Infection in a community can be rapidly identified.
 - C. Infected individuals can be located quickly.
 - D. Sewage can be treated for the virus.
7. A girl is carrying a piece of wood. A small piece breaks off and becomes embedded in her finger. The next day, she notices an inflammatory response occurring in her finger.

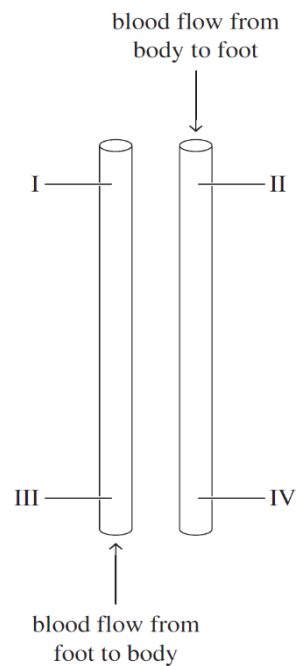
In the region around the small pieces of wood embedded in her finger:

- A. mast cells would release antibodies.
 - B. the skin tissue would become pale and cold.
 - C. the capillaries would become more permeable.
 - D. red blood cells would leave the blood vessels and engulf foreign material.
8. Researchers are exploring the ethical implications of using CRISPR-Cas9 for gene editing in humans.

Which scenario best illustrates a potential ethical dilemma associated with this technology?

- A. Using CRISPR-Cas9 to correct a genetic mutation responsible for a hereditary disease in an unborn foetus.
- B. Employing PCR to amplify DNA samples for forensic analysis in criminal investigations.
- C. Implementing gene therapy to treat a genetic disorder by introducing a functional gene into somatic cells.
- D. Utilising Next-Generation Sequencing to sequence the genome of an endangered species for conservation purposes.

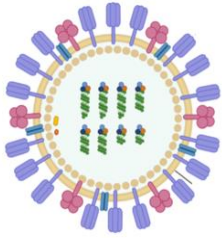
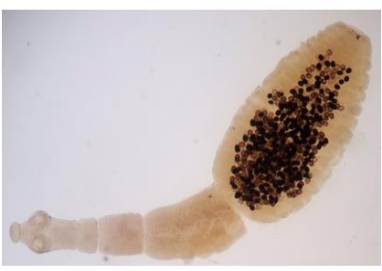
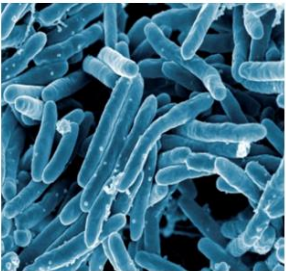
9. The diagram shows the blood vessels in the leg of a bird that wades in cold water.



In which area is the blood temperature the highest?

- A. I
 - B. II
 - C. III
 - D. IV
10. During the process of gene cloning in bacteria, a plasmid is often used. Which of the following best describes the role of a plasmid in this process?
- A. It provides the necessary enzymes for DNA replication.
 - B. It serves as a marker to identify successful cloning events.
 - C. It increases the mutation rate to produce genetic variability.
 - D. It acts as a vector to introduce new genetic material into the bacterial cell.

11. The pathogens responsible for four named diseases are illustrated. Note that images are not to scale.

	
Influenza	Giardiasis
	
Hydatid disease	Tuberculosis

(Images available under Creative Commons License: CC-BY-SA-4.0)

A newly synthesised general antibiotic would most likely be effective against:

- A. Influenza
 - B. Giardiasis
 - C. Hydatid disease
 - D. Tuberculosis
12. Errors that occur during meiosis can cause chromosomal mutations. One category of chromosomal mutation is aneuploidy, which refers to cells having an abnormal number of chromosomes.

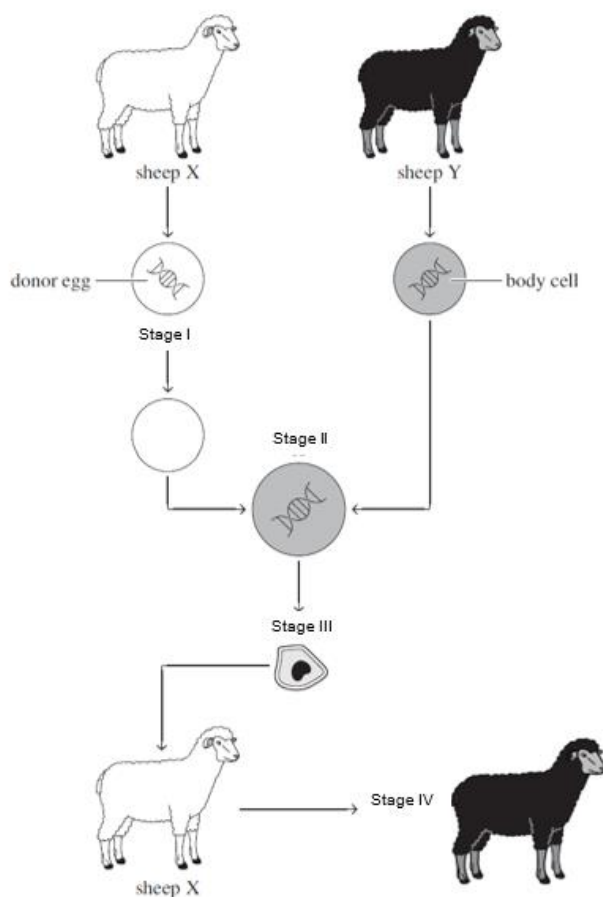
Which of the following is a likely cause of aneuploidy?

- A. Chromosome duplication during the first division in meiosis (Metaphase I).
- B. Non-disjunction of chromosomes during the first separation of chromosomes (Anaphase I).
- C. Chromosome inversion during the chromosome condensing stage of meiosis (Prophase I).
- D. A failure of cytokinesis at the end of the first cell division in meiosis (Meiosis I).

13. What is the initial impact of growing transgenic crops on biodiversity?

- A. Decreases biodiversity
- B. Maintains biodiversity
- C. Decreases biodiversity locally, but increases it globally
- D. Increases biodiversity

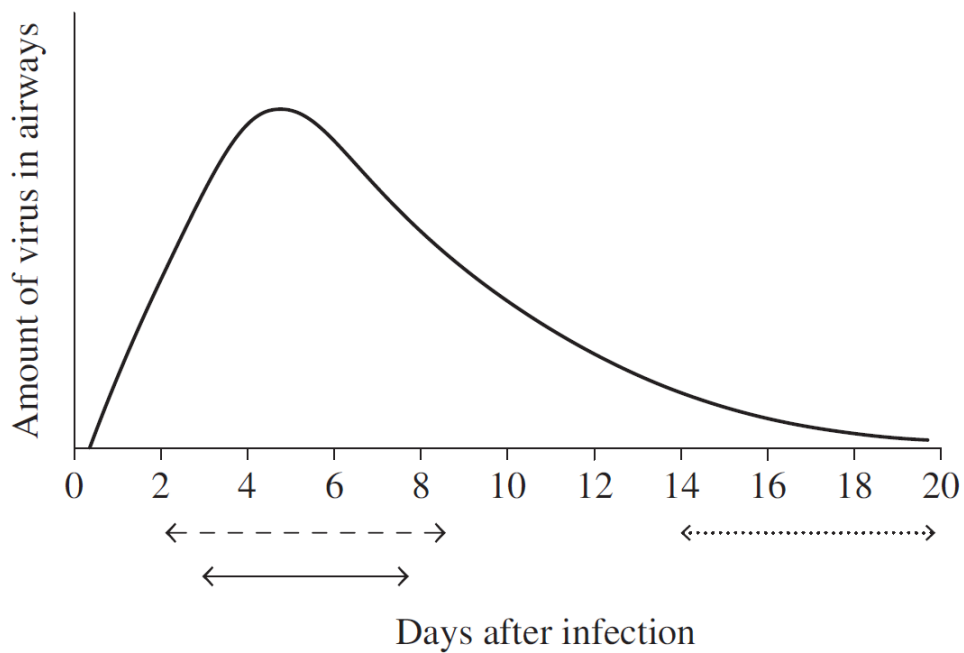
14. A simplified diagram of whole organism cloning is shown.



Which row of the table correctly identifies stages I-IV?

	<i>Stage I</i>	<i>Stage II</i>	<i>Stage III</i>	<i>Stage IV</i>
A.	Removal of DNA	Fusion of cells	Embryo forms	Clone of sheep Y
B.	Addition of DNA	Removal of DNA	Transfer to uterus	Clone of sheep X
C.	Mutation of DNA	Fusion of cells	Embryo forms	Clone of sheep Y
D.	Removal of DNA	Mutation of DNA	Embryo forms	Clone of sheep X

15. The graph shows data about a common virus gathered from a survey of more than 1000 affected individuals.



KEY

← ——— → symptoms visible

← - - - → infectious

← → recovery

Which of the following conclusions is the most likely to be drawn from the graph?

- A. The virus can be treated with an antibiotic.
- B. The individual will be most infectious around day 5.
- C. Individuals can not shed the virus after day 9.
- D. Affected individuals are only infectious while they are showing symptoms.

16. A group of scientists conducted a study to investigate whether changes in air temperature had any effect on the core body temperature of a particular animal. They measured the air temperature and the animal's core body temperature every six hours for two days. The table shows the results of these measurements.

<i>Time (hours)</i>	<i>Air temperature (°C)</i>	<i>Core body temperature (°C)</i>
0	15.1	36.9
6	17.3	37.1
12	19.4	37.3
18	22.4	37.4
24	16.3	37.2
30	17.9	37.2
36	20.0	37.4
42	23.7	37.5
48	17.1	37.3

It can be stated that the animal is:

- A. poorly adapted to its environment.
 - B. not an endotherm because its core body temperature is approximately 37°C.
 - C. an endotherm because it maintains its core body temperature.
 - D. an endotherm because its core body temperature varies considerably with the air temperature.
17. Several breeds of domestic dog exhibit a condition called merle, in which the coat has patches of coloured fur on a paler background of the same pigment. The mutant merle allele (M) causes the dilution of the fur pigment over the normal allele (m). The image on the right shows a heterozygote (Mm) red merle dog, with patches of brown on a background of lighter-coloured fur.

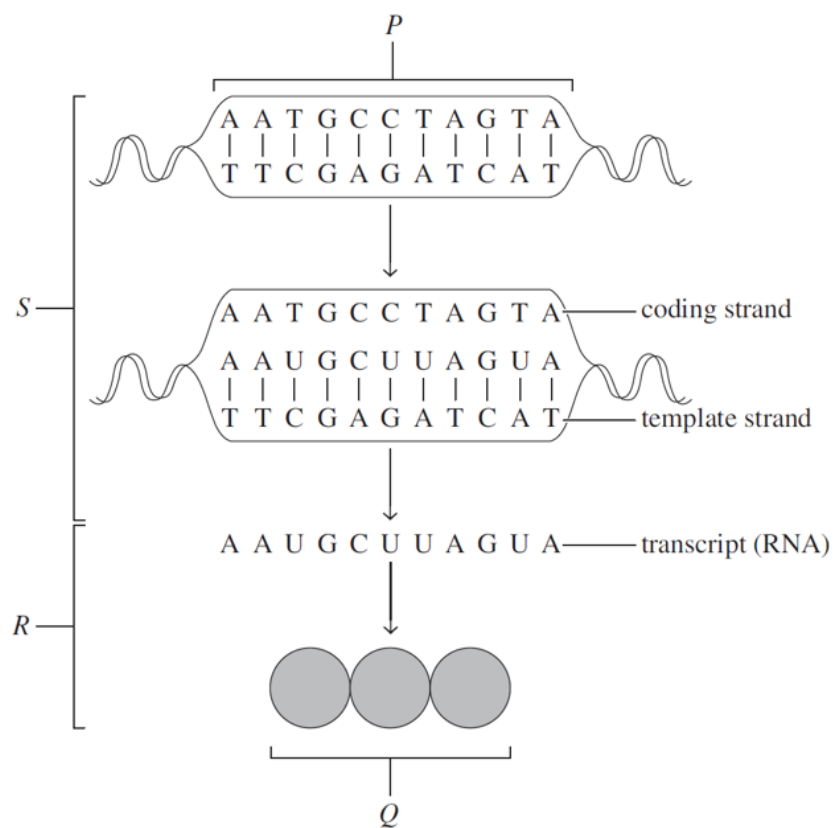
This type of inheritance is:

- A. incomplete dominance
- B. codominance
- C. sex linkage
- D. simple Mendelian



(Image available under
Creative Commons
License: CC-BY-SA-2.0)

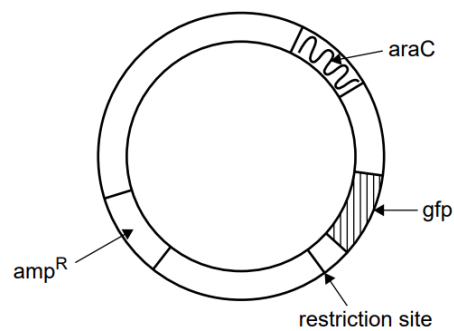
18. The diagram shows a simplified version of a process involving nucleic acids.



Which row of the table correctly identifies the components of this process?

	P	Q	R	S
A.	DNA	polypeptide	translation	transcription
B.	DNA	polypeptide	transcription	translation
C.	polypeptide	RNA	translation	transcription
D.	DNA	RNA	transcription	translation

19. An example of a plasmid used in cloning is shown.



The plasmid contains a restriction site and the following three genes:

- amp^R – provides resistance to the antibacterial ampicillin
- gfp – encodes the green fluorescent protein (gfp), which fluoresces under UV light
- araC – encodes a protein required to promote the expression of gfp when arabinose is present

The results of the experiment are shown in the table.

Plate	W untransformed bacteria only	X untransformed bacteria only	Y transformed bacteria	Z transformed bacteria
Diagram of plate				
Added to plate	nutrient agar only	nutrient agar and ampicillin	nutrient agar, ampicillin and arabinose	nutrient agar and ampicillin
Description of result	lawn of bacteria	no growth	bacterial colonies present	bacterial colonies present

Which plate would contain bacteria that fluoresce under UV light?

- Plate W
- Plate X
- Plate Y
- Plate Z

20. An analysis of the quantity of nuclear DNA in different cells of a domestic dog was carried out, with the following results. (1 Gb = 1 billion base pairs)

<i>Cell</i>	<i>I</i>	<i>II</i>	<i>III</i>
No. base pairs	2.5 Gb	5 Gb	15 Gb

Which of the following gives a possible identification or location for each cell type?

	<i>Cell I</i>	<i>Cell II</i>	<i>Cell III</i>
A.	white blood cell	testis	liver cell
B.	ovary	red blood cell	liver tumour
C.	red blood cell	ovary	liver cell
D.	testis	muscle cell	liver tumour

End of Section I

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Student Number



Biology

Section II Answer Booklet

80 marks

Attempt Questions 21 - 33

Allow about 2 hours and 25 minutes for this part

Instructions:

- Write your student number at the top of every answer page.
 - Answer the questions in the spaces provided. These spaces provide guidance for the expected length of response.
 - Show all relevant working in questions involving calculations.
 - Extra writing space is provided at the back of this booklet. If you use this space, clearly indicate which question you are answering.
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Question 21 (4 marks)

Describe how ONE physiological and ONE behavioural adaptation assist in body temperature regulation in endotherms.

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Question 22 (3 marks)

Draw a table that compares the forms in which DNA exists in eukaryotes and prokaryotes. Provide TWO features for each type of organism.

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Student Number

Question 23 (2 marks)

The extract is from the website of a plant nursery that specialises in edible and medicinal native plants.

We specialise in edible and medicinal native plants that have been used by countless generations of First Nations peoples. We offer the general public a chance to share in the culture of 'bush tucker'. We certify that all of our plants are disease-free.	
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It is important to recognise and protect the cultural and intellectual property of Aboriginal people. Discuss a potential issue with the information given in the nursery's website.

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Question 24 (4 marks)

Several farmers noticed a disease affecting their apple crops.

The fruit developed slowly and began to rot on the tree before ripening. The farmers approached academics at the local agricultural college for help in determining what was causing the problem.

The academics thought this would be a good assignment to set their post-graduate students.



(Image available under
Creative Commons License:
CC-BY-SA-4.0)

Outline the steps the students should use to determine the cause of the disease.

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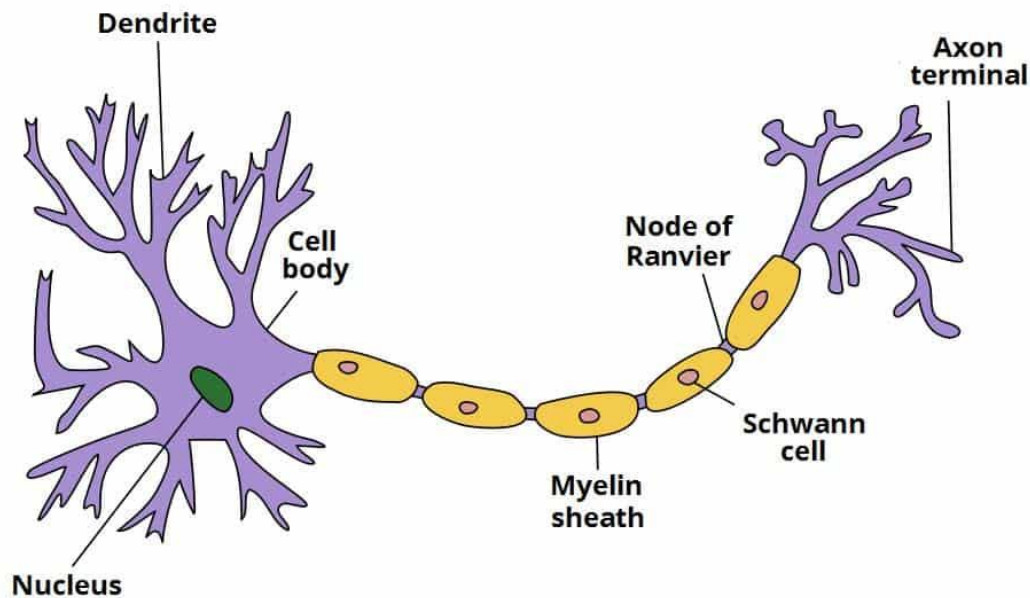
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Student Number

TURN OVER FOR QUESTION 25

Question 25 (14 marks)

The image shows a typical neurone.



Source: <https://teachmeanatomy.info/the-basics/ultrastructure/nerves/>

To ensure consistent action potential conduction, neurones require a myelin sheath with an even axon diameter. The data in the table show the relationship between the thickness of the myelin sheath and the time it takes for nerve conduction to occur. The thickness of the myelin sheath is measured by the number of wraps.

Impact of myelin sheath diameter on conduction velocity in neurons

<i>Number of wraps in myelin sheath</i>	<i>Conduction velocity (ms^{-1})</i>
1	0.6
2	1.2
3	1.5
4	1.6
5	1.8

Question 25 continues on page 21

Question 25 (continued)

- (b) Multiple sclerosis is an inflammatory condition that attacks the myelin sheath, or the cells that produce the myelin sheath. This can ultimately result in a loss of myelin.

With reference to the graph in part a), explain how multiple sclerosis will impact the function of a neuron.

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- (c) Research is underway to determine effective gene therapy techniques that can be used to target genetic factors that cause multiple sclerosis (MS).

With regards to the stimulus provided on MS, evaluate the benefits of using genetic technology in medicinal applications in humans.

In your answer, include reference to one technology that could be used, advantages, as well as social AND economic factors that need to be taken into consideration.

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Question 25 continues on page 23

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Student Number

Question 25 (continued)

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End of Question 25

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Student Number

Question 26 (4 marks)

The image shows a selection of breakfast foods that are high in sugar.

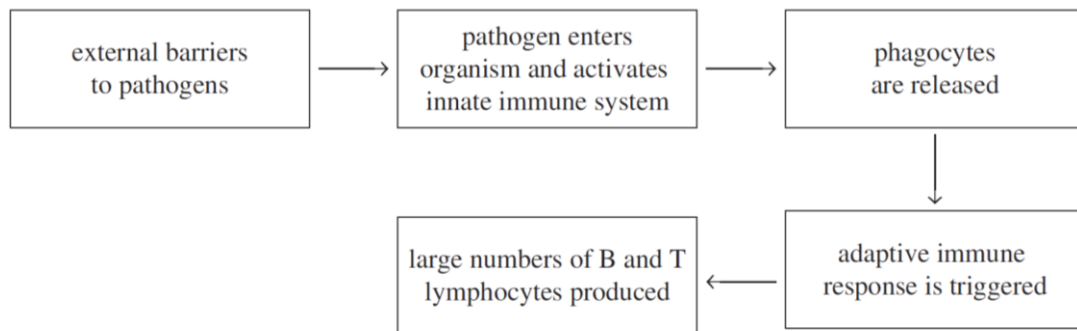
BAKER'S DELIGHT APPLE & CINNAMON SCROLL  7TSP PER SERVING 6g PER 100g	MUFFIN BREAK BANANA BERRY MUFFIN  9TSP PER SERVING 5.5g PER 100g	UNCLE TOBY'S YOGURT & HONEYCOMB BAR  2.5TSP PER SERVING 7.5g PER 100g	KELLOGG'S K-TIME TWISTS  3TSP PER SERVING 8.5g PER 100g	SANITARIUM UP & GO BREAKFAST STRAWBERRY  4.5TSP PER SERVING 2g PER 100g
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Source: https://www.sugarbyhalf.com/how_much_sugar_is_too_much

Construct a feedback loop to show how the human body responds after eating a cinnamon scroll. **4**

Question 27 (7 marks)

The diagram shows part of the human immune system's response to a pathogen.



Explain how the innate and adaptive immune systems respond to pathogens in the human body. In your answer, refer to the stages shown in the diagram.

7

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Student Number

Question 28 (6 marks)

The information given relates to the disease Dengue Fever.

The dengue fever virus can be spread by two species of mosquito: the Dengue mosquito (*Aedes aegypti*) and the Asian Tiger mosquito (*Aedes albopictus*). Both species are active during the day.

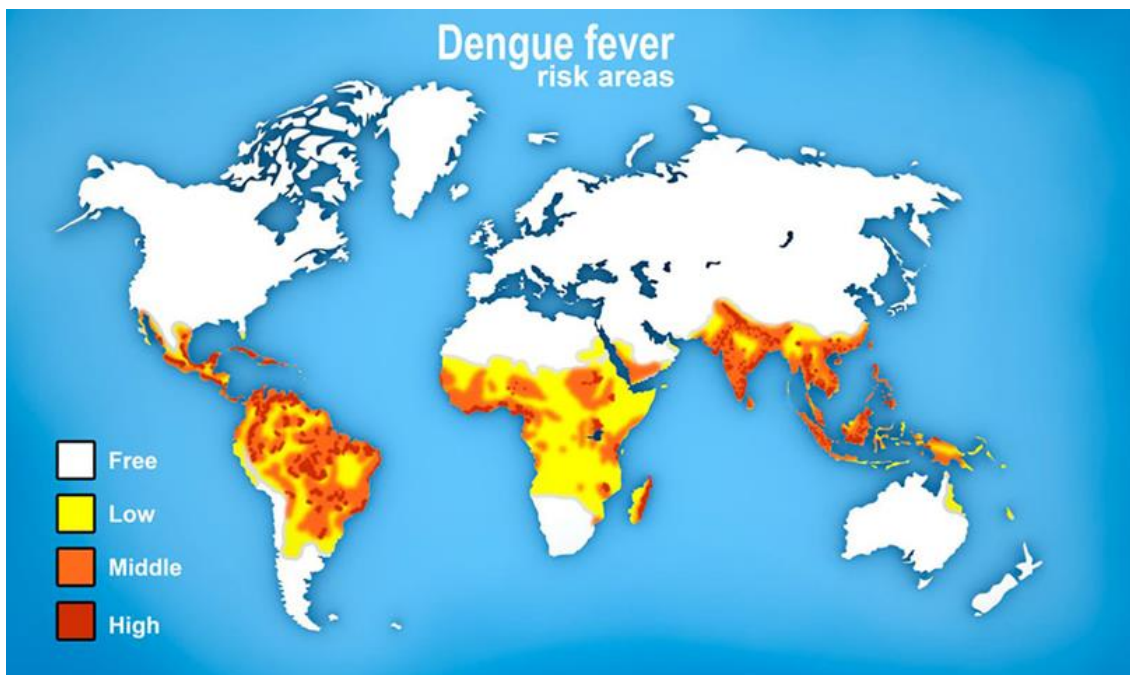
Dengue affects infants, children and adults.

People develop dengue fever after being bitten by a mosquito that is infected with the virus. The virus is not spread directly from person to person. The mosquito becomes infected when it bites a person who has dengue virus in their blood. The virus multiplies inside the mosquito and the mosquito will infect other people when it bites them.

People with dengue fever develop illness between 3 and 14 days (usually 4-7 days) after being bitten by an infectious mosquito. The fever typically lasts around 6 days.

The warning signs which occur 3-7 days after the first symptoms include: severe abdominal pain, rapid breathing, blood in vomit, persistent vomiting, bleeding gums, fatigue and restlessness.

There is no specific treatment for dengue fever. There is currently no vaccine to prevent initial dengue infection. Patients should seek medical advice, rest and drink plenty of fluids.



Question 28 continues on page 28

Question 28 (continued)

- (a) With reference to the map, explain how a change in climate could affect the spread of dengue fever.

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- (b) Outline TWO measures that can be taken by individuals and TWO measures that can be taken by public health authorities in Australia to limit the spread of dengue fever.

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End of Question 28

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Student Number

Question 29 (3 marks)

Haemophilia A is a recessive blood clotting disorder that arises from a defect in the gene which is carried on the X chromosome.

A couple is considering starting a family. However, the father suffers from Haemophilia A. The mother is healthy with no family history of the disease.

What is the probability that a potential grandson will have Haemophilia A if they have a daughter who partners with an affected man? Show all relevant working.

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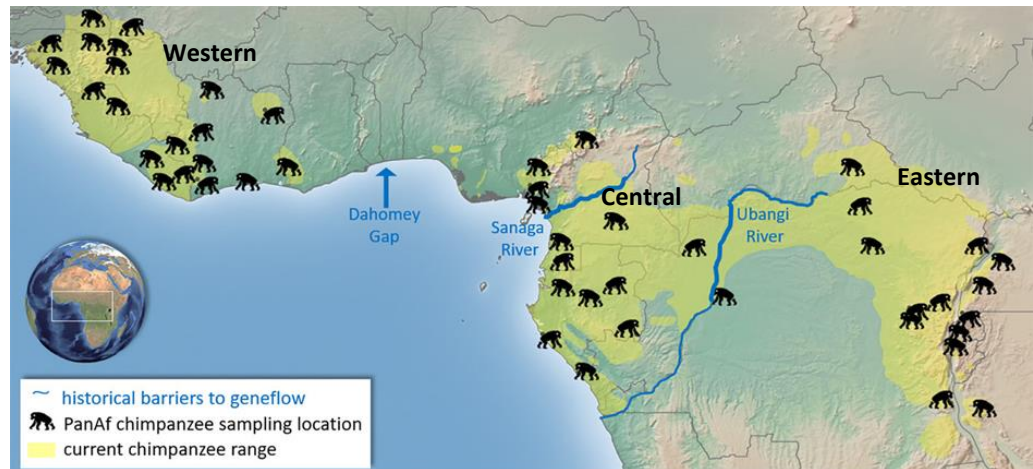
Student Number

Question 30 (10 marks)

Common chimpanzees in equatorial Africa have long been recognized as falling into three distinct populations or sub-species: western, central and eastern chimpanzees. These populations are genetically hugely diverse.

Dr Rory Bowden from the Department of Statistics at Oxford University, who led a study on the diversity in chimpanzee populations in Western Africa, said: “These findings have important consequences for conservation. All great ape populations face unparalleled challenges from habitat loss, hunting and emerging infections, and conservation strategies need to be based on sound understanding of the underlying population structure.”

The map shows three distinct chimpanzee populations in Africa.



- (a) Discuss how the information provided above could be used to develop a conservation strategy for the African chimpanzee populations.

5

This image shows a full page of white paper with horizontal dashed lines, typical of primary-ruled notebook 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.

Question 30 continues on page 32

Question 30 (continued)

The Figures 1 and 2 show the genetic diversity in human populations across the globe and the migration of humans from their African origin.

Map of global human genetic diversity

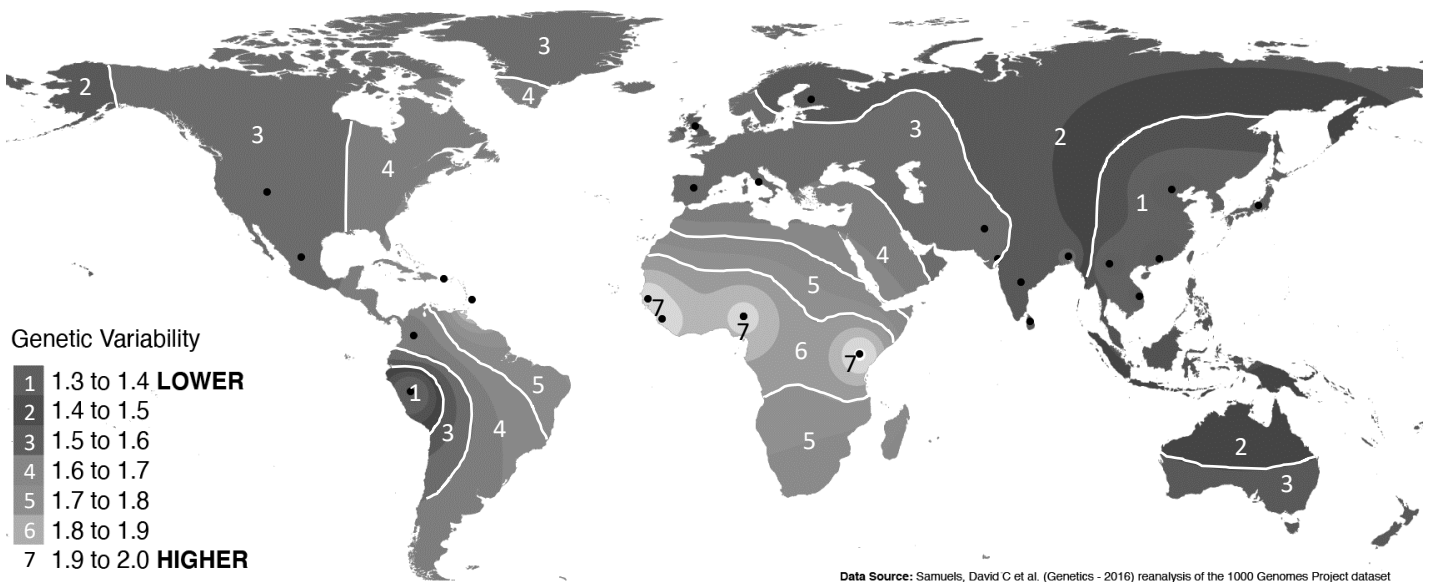


Figure 1: Global human genetic diversity. Genetic variability is given as relative frequency which represents the percentage of alleles in a population.

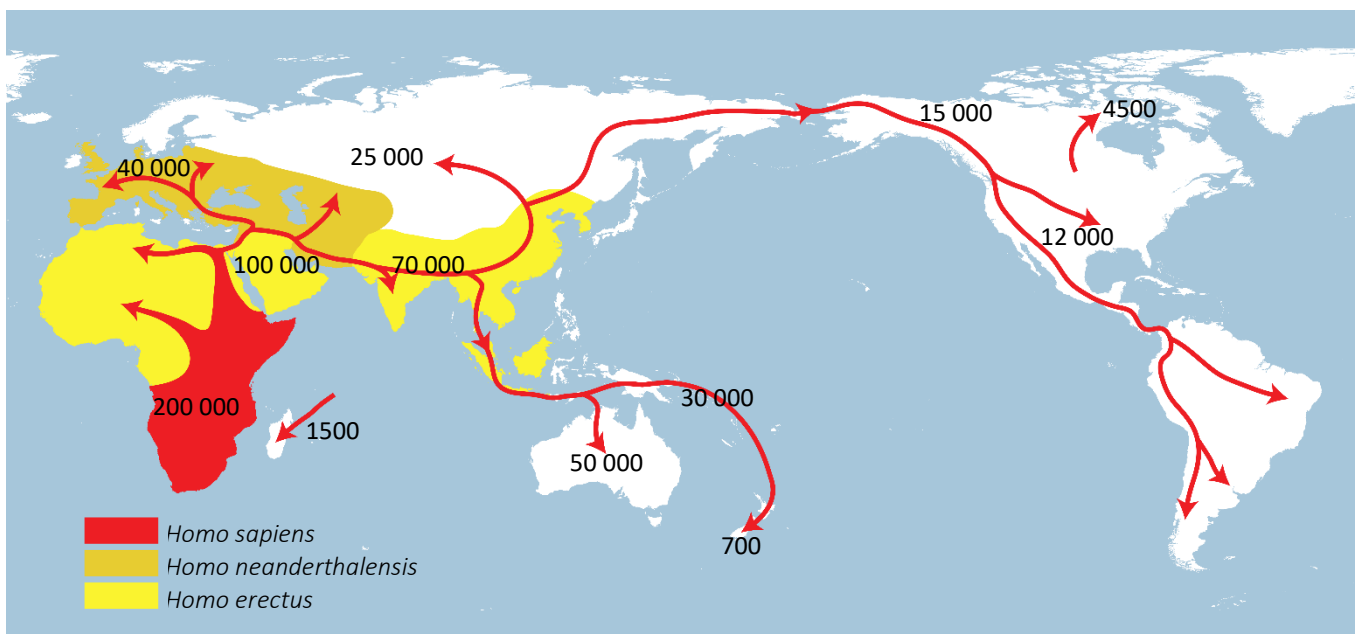


Figure 2: Human Migration patterns from African Origins. The numbers shown indicate how many years before present populations migrated.

Question 30 continues on page 33

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Student Number

Question 30 (continued)

- (b) DNA evidence suggests around 1000 humans (*Homo sapiens*) migrated from Africa into Asia and Europe. With reference to the information provided in Figures 1 and 2, explain why human genetic diversity in Africa is higher than the rest of the world.

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End of Question 30

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Student Number

Question 31 (4 marks)

Beehives can house up to 40 000 honey bees. Most of these bees are female worker bees. There is only one queen bee. She is a diploid female ($2n = 32$) and she is the bee that lays the eggs for the colony. The queen lays two types of eggs:

1. Fertilised eggs that produce females that become either worker bees or other queen bees.
2. Unfertilised eggs that produce male drone bees.

(a) Use the information provided to complete the table.

1

<i>Type of bee</i>	<i>Number of chromosomes</i>
Female worker bee	
Male drone bee	

(b) Explain why there is genetic variation between male drone bees, even though they are produced from fertilised eggs.

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Question 32 (8 marks)

Estimates of the rate at which DNA is damaged during replication and other stages in the cell cycle range from 10,000 to 30,000 times per day. The damage is usually repaired by a variety of DNA repair mechanisms so that cell function is maintained. If the rate of repair cannot keep up with the rate of damage, a permanent mutation will result.

With reference to the information above, assess the importance of accuracy in mitosis and DNA replication in the maintenance of cell function and the continuity of species.

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Student Number

Question 33 (11 marks)

Bt cotton is a genetically modified cotton that has had a gene inserted from *Bacillus thuringiensis* bacteria. A student wanted to investigate the effect Bt cotton had on soil biodiversity when grown in farms in Australia. Using research, the student found that Bt toxin was released into the soil when Bt cotton was grown. The student designed an investigation to test the effect of Bt cotton plants on soil biodiversity. Soil biodiversity was measured using the number and type of bacteria and fungi in the soil.

- (a) Complete the table for the investigation described. 3

Independent variable	
Dependent variable	
Experimental control	

- (b) Describe a method that the student can use to ensure the experimental design is valid. 4

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Question 33 continues on page 38

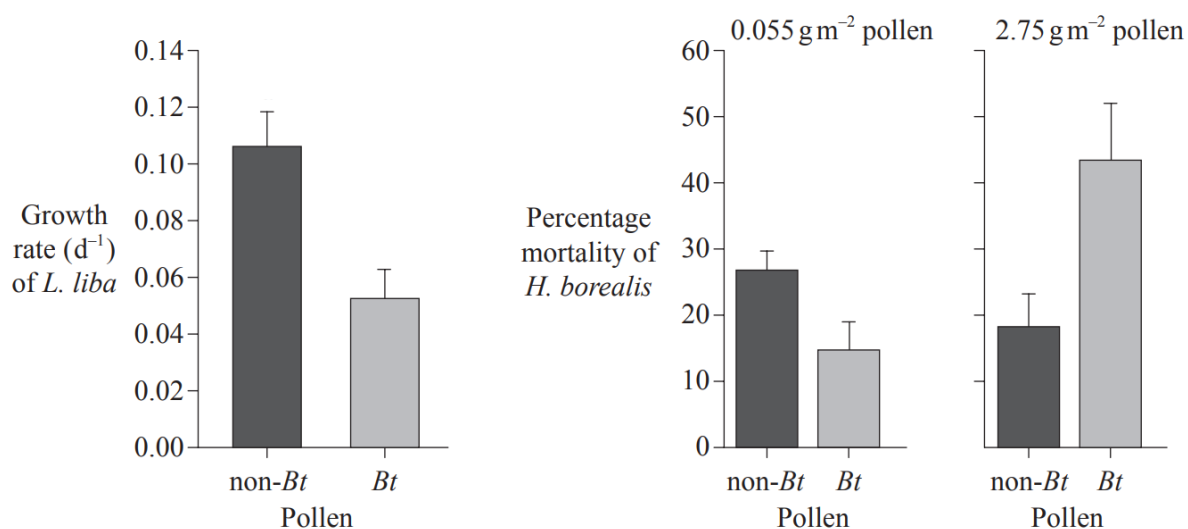
Question 33 (continued)

A different genetically modified organism used in agriculture is Bt corn. Pollen from these corn crops can accumulate in fresh water streams. *Lepidostoma liba* is a caddis fly larvae that feeds on this pollen. *Helicopsyche borealis* is an adult caddis fly that feeds on algae that contain pollen from the cotton.

Experiments were conducted to determine if *L. liba* and *H. borealis* were impacted by feeding on pollen debris in streams. The following measurements were taken:

- The growth of the *L. liba* larvae was measured after feeding on Bt and non-Bt pollen.
- The mortality rate of *H. borealis* was measured after it had eaten Bt and non-Bt pollen.

The bar charts show the impacts on both species of caddis fly, when tested with two concentrations of pollen. One concentration (0.055g m^{-2}) was based on the maximum amount of pollen found in streams. The other concentration was 50 times higher than this amount.



[Source: adapted from Rosi-Marshall, *et al.*, (2007), *Proceedings of the National Academy of Sciences*, **104**, pages 16204–16208. Copyright (2007) National Academy of Sciences, U.S.A.]

Question 33 continues on page 39

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Student Number

Question 33 (continued)

- (c) Using data in the bar charts, evaluate the effects of Bt corn pollen on both species of caddis fly.

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Barker
College

Biology

2024

TRIAL HIGHER SCHOOL
CERTIFICATE EXAMINATION

Staff Involved:

MARKING CRITERIA

AM THURSDAY 15TH AUGUST

- TKB - Mr Binet
- KIP - Mrs Prior
- ALP - Ms Pope

100 copies

Section I - Multiple Choice

Write your Student Number at the top of this page

Choose the best response and fill in the response oval completely

Start Here →	1	A ○	B ○	C ○	D ○	11	A ○	B ○	C ○	D ○
	2	A ○	B ○	C ○	D ○	12	A ○	B ○	C ○	D ○
	3	A ○	B ○	C ○	D ○	13	A ○	B ○	C ○	D ○
	4	A ○	B ○	C ○	D ○	14	A ○	B ○	C ○	D ○
	5	A ○	B ○	C ○	D ○	15	A ○	B ○	C ○	D ○
	6	A ○	B ○	C ○	D ○	16	A ○	B ○	C ○	D ○
	7	A ○	B ○	C ○	D ○	17	A ○	B ○	C ○	D ○
	8	A ○	B ○	C ○	D ○	18	A ○	B ○	C ○	D ○
	9	A ○	B ○	C ○	D ○	19	A ○	B ○	C ○	D ○
	10	A ○	B ○	C ○	D ○	20	A ○	B ○	C ○	D ○

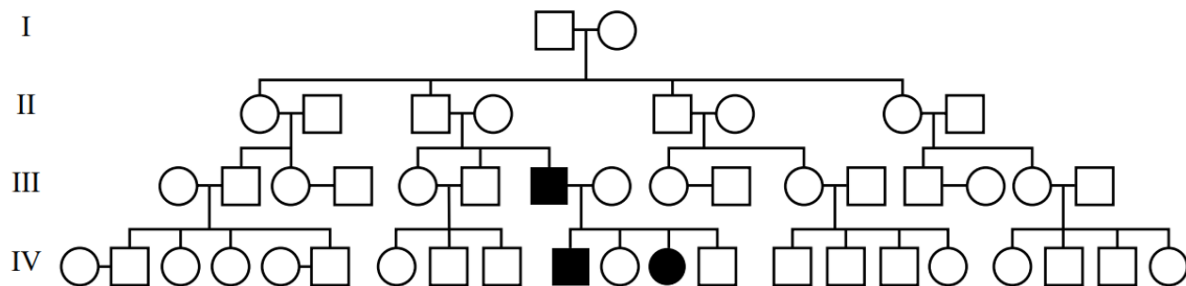
Marking Criteria for MC

Question number	Module	Description	Syllabus point	Band target	Answer
1	7	Asexual reproduction	7.2	2-3	B
2	5	Pedigree	5.4a	2-3	A
3	5	Internal and External fertilisation	5.1 a) i	2-3	D
4	5	Protein structure	5.3.3	2-3	C
5	5	Meiosis and mitosis	5.2.1	4-5	B
6	6	Viruses		3-4	B
7	7	Immune response	7.3	3-4	C
8	6	CRISPR ethics	6.3b	3-4	A
9	8	Adaptations and thermoregulation	8.1	5-6	B
10	7	Gene cloning	6.3 c)	3-4	D
11	6	Pathogen types	7.1	3-4	D
12	6	Mutation	6.1.2	4-5	B
13	6	Transgenics	6..2.1	4-5	D
14	6	Biotechnology	6.3.3	4-5	A
15	7	Disease	7.1.1	4-5	C
16	8	Homeostasis/ adaptations	8.1	4-5	C
17	5	Heredity	5.4.1	4-5	A
18	5	Protein synthesis	5.3.2	5-6	A
19	6	Bacterial growing	5.4.1	5-6	C
20	5	Chromosome number	5.2	5-6	D

1. Both plants and animals use a variety of mechanisms in the defence against pathogens. Which of the following is common to the defence systems of plants and animals?

- A. antibodies
- B. programmed cell death
- C. cell-mediated immunity
- D. interferon

2. The pedigree shows the inheritance of a rare autosomal dominant trait in a family called hereditary retinoblastoma. Prior to generation III, there was no occurrence of the condition in the family.



The appearance of hereditary retinoblastoma can be explained by

- A. mutation.
- B. selective breeding.
- C. invitro fertilisation.
- D. the misuse of antibiotics.

3. Select the row below which correctly contrasts the characteristics of internal and external fertilisation.

	Internal Fertilisation	External Fertilisation
A.	Many eggs produced Significant parental care of young	Few eggs produced Little parental care of young
B.	Many eggs produced Little parental care of young	Few eggs produced Significant parental care of young
C.	Few eggs produced Little parental care of young	Many eggs produced Significant parental care of young
D.	Few eggs produced Significant parental care of young	Many eggs produced Little parental care of young

4. A student described the structure of haemoglobin as follows:

“The haemoglobin molecule is made up of several polypeptides and each peptide is made up of a chain of amino acids.”

Which levels of protein structure has the student described?

- A. Primary and secondary
- B. Primary and tertiary
- C. Primary and quaternary
- D. Secondary and tertiary

5. Which row of the table correctly compares the processes of meiosis and mitosis?

	<i>Meiosis</i>	<i>Mitosis</i>
A.	produces diploid cells	produces haploid cells
B.	occurs in germ cells	occurs in somatic cells
C.	no genetic variation occurs	genetic variation increases
D.	the number of chromosomes doubles	the number of chromosomes remains the same

6. Viruses can be detected in sewage. Human faecal matter is the main source of pathogenic viruses in sewage. Infected individuals shed viral particles in their faeces.

An advantage of testing sewage for viral particles to control possible virus outbreaks is:

- A. Infected individuals can be prevented from shedding the virus.
- B. Infection in a community can be rapidly identified.
- C. Infected individuals can be located quickly.
- D. Sewage can be treated for the virus.

7. A girl is carrying a piece of wood. A small piece breaks off and becomes embedded in her finger. The next day, she notices an inflammatory response occurring in her finger.

In the region around the small piece of wood embedded in her finger

- A. mast cells would release antibodies.
- B. the skin tissue would become pale and cold.
- C. the capillaries would become more permeable.

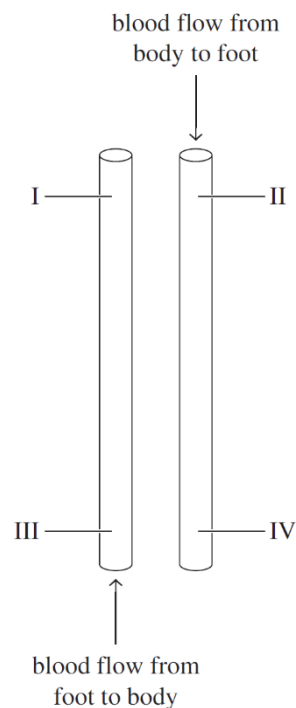
D. red blood cells would leave the blood vessels and engulf foreign material.

8. Researchers are exploring the ethical implications of using CRISPR-Cas9 for gene editing in humans.

Which scenario best illustrates a potential ethical dilemma associated with this technology?

- A. Using CRISPR-Cas9 to correct a genetic mutation responsible for a hereditary disease in an unborn foetus.
- B. Employing PCR to amplify DNA samples for forensic analysis in criminal investigations.
- C. Implementing gene therapy to treat a genetic disorder by introducing a functional gene into somatic cells.
- D. Utilizing Next-Generation Sequencing to sequence the genome of an endangered species for conservation purposes.

9. The diagram shows the blood vessels in the leg of a bird that wades in cold water.

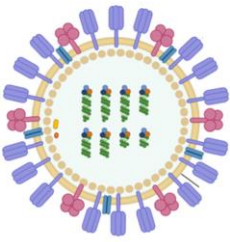
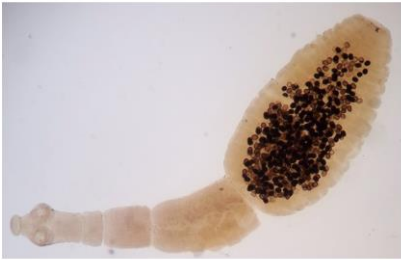
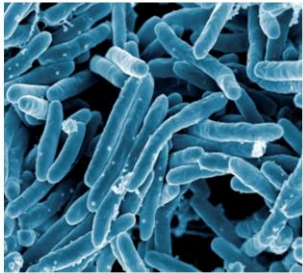


In which area is the blood temperature the highest?

- A. I

- B. II
- C. III
- D. IV

10. The pathogens responsible for four different diseases are illustrated. Note that images are not to scale.

	
Influenza	Giardiasis
	
Hydatid disease	Tuberculosis

(Images available under Creative Commons License: CC-BY-SA-4.0)

A newly synthesised general antibiotic would most likely be effective against:

- A. Influenza
- B. Giardiasis
- C. Hydatid disease
- D. Tuberculosis

11. During the process of gene cloning in bacteria, a plasmid is often used. Which of the following best describes the role of a plasmid in this process?

- A. It increases the mutation rate to produce genetic variability.

- B. It serves as a marker to identify successful cloning events.
- C. It provides the necessary enzymes for DNA replication.
- D. It acts as a vector to introduce new genetic material into the bacterial cell.

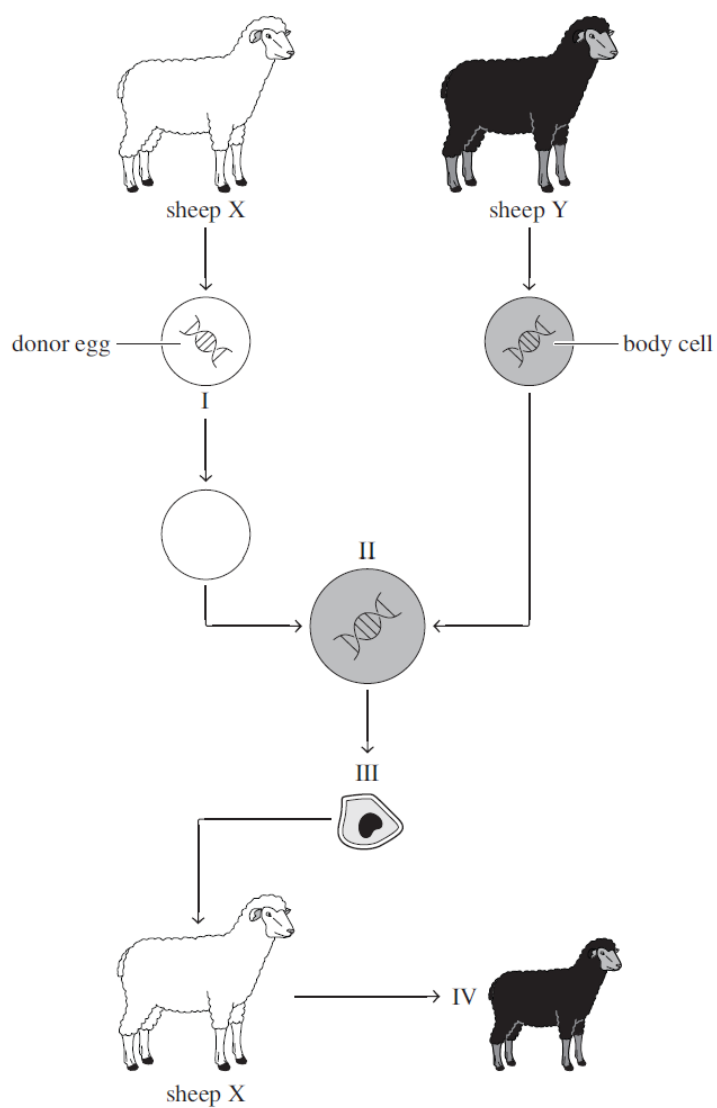
12. Errors that occur during meiosis can cause chromosomal mutations. One category of chromosomal mutation is aneuploidy, which refers to cells having an abnormal number of chromosomes. Which of the following is a likely cause of aneuploidy?

- A. Chromosome duplication during Metaphase I of meiosis
- B. Non-disjunction of chromosomes during Anaphase I of meiosis
- C. Chromosome inversion during Prophase I of meiosis
- D. A failure of cytokinesis in at the end of meiosis I

13. What is the initial impact of growing transgenic crops on biodiversity?

- A. Decreases biodiversity
- B. Maintains biodiversity
- C. Decreases biodiversity locally, but increases it globally
- D. Increases biodiversity

14. A simplified diagram of whole organism cloning is shown.



Which row of the table correctly identifies stages I-IV?

	<i>I</i>	<i>II</i>	<i>III</i>	<i>IV</i>
A	Removal of DNA	Fusion of cells	Embryo forms	Clone of sheep Y
B	Addition of DNA	Removal of DNA	Transfer to uterus	Clone of sheep X
C	Mutation of DNA	Fusion of cells	Embryo forms	Clone of sheep Y
D	Removal of DNA	Mutation of DNA	Embryo forms	Clone of sheep X

D. Affected individuals are only infectious while they are showing symptoms.

16. A group of scientists conducted a study to investigate whether changes in air temperature had any effect on the core body temperature of a particular animal. They measured the air temperature and the animal's core body temperature every six hours for two days. The table shows the results of these measurements.

<i>Time (hours)</i>	<i>Air temperature (°C)</i>	<i>Core body temperature (°C)</i>
0	15.1	36.9
6	17.3	37.1
12	19.4	37.3
18	22.4	37.4
24	16.3	37.2
30	17.9	37.2
36	20.0	37.4
42	23.7	37.5
48	17.1	37.3

It can be said that the animal is:

- A. poorly adapted to its environment.
- B. not an endotherm because its core body temperature is approximately 37°C.
- C. an endotherm because it maintains its core body temperature.
- D. an endotherm because its core body temperature varies considerably with the air temperature.

17. Several breeds of domestic dog exhibit a condition called merle, in which the coat has patches of coloured fur on a paler background of the same pigment. The mutant merle allele (M) causes the dilution of the fur pigment over the normal allele (m). The image on the right shows a heterozygote (Mm) red merle dog, with patches of brown on a background of lighter-coloured fur.

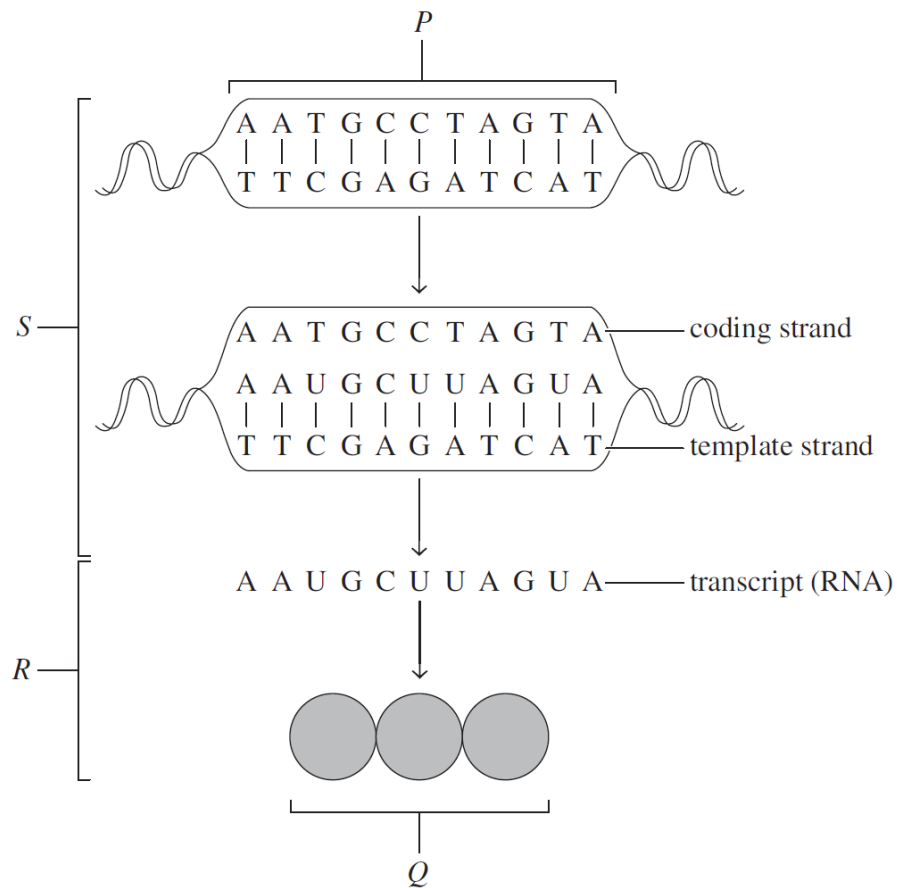
This type of inheritance is

- A. Incomplete dominance
- B. Codominance
- C. Sex linkage
- D. Simple Mendelian



(Image available under Creative Commons License: CC-BY-SA-2.0)

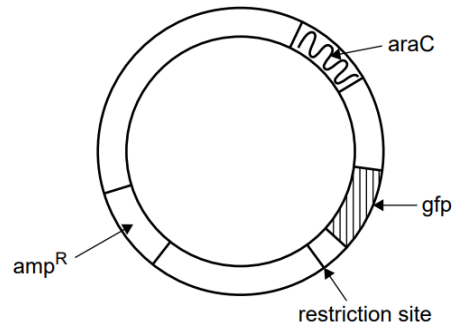
18. The diagram shows a simplified version of a process involving nucleic acids.



Which row of the table correctly identifies the components of this process?

	<i>P</i>	<i>Q</i>	<i>R</i>	<i>S</i>
A.	DNA	polypeptide	translation	transcription
B.	DNA	polypeptide	transcription	translation
C.	polypeptide	RNA	translation	transcription
D.	DNA	RNA	transcription	translation

19. An example of a plasmid used in cloning is shown.



This plasmid contains a restriction site and the following three genes:

- amp^R - provides resistance to the antibacterial ampicillin
- gfp – encodes the green fluorescent protein (gfp), which fluoresces under UV light
- araC – encodes a protein required to promote the expression of gfp when arabinose is present

The results of the experiment are shown in the table.

Plate	W untransformed bacteria only	X untransformed bacteria only	Y transformed bacteria	Z transformed bacteria
Diagram of plate				
Added to plate	nutrient agar only	nutrient agar and ampicillin	nutrient agar, ampicillin and arabinose	nutrient agar and ampicillin
Description of result	lawn of bacteria	no growth	bacterial colonies present	bacterial colonies present

Which plate would contain bacteria that fluoresce under UV light?

- A plate W
- B plate X
- C plate Y
- D plate Z

20. An analysis of the quantity of nuclear DNA in different cells of a domestic dog was carried out, with the following results. (1 Gb = 1 billion base pairs)

Cell	I	II	III
No. base pairs	2.5 Gb	5 Gb	15 Gb

Which of the following gives a possible identification or location for each cell type?

	Cell I	Cell II	Cell III
A.	white blood cell	testis	liver cell
B.	ovary	red blood cell	liver tumour
C.	red blood cell	ovary	liver cell
D.	testis	muscle cell	liver tumour



Biology

Section II Answer Booklet

80 marks

Attempt Questions 21 - 31

Allow about 2 hours and 25 minutes for this part

Instructions:

- Answer the questions in the spaces provided. These spaces provide guidance for the expected length of response.
- Show all relevant working in questions involving calculations.
- Extra writing space is provided at the back of this booklet. If you use this space, clearly indicate which question you are answering.

Some general comments: Please note that while it is OK to use extra writing space, it is really important that you are very structured with how you use these pages and you need to clearly indicate on the exam paper that you have used extra writing space.

DO NOT write in the margins – this will be cut off during the scanning process in your next exam

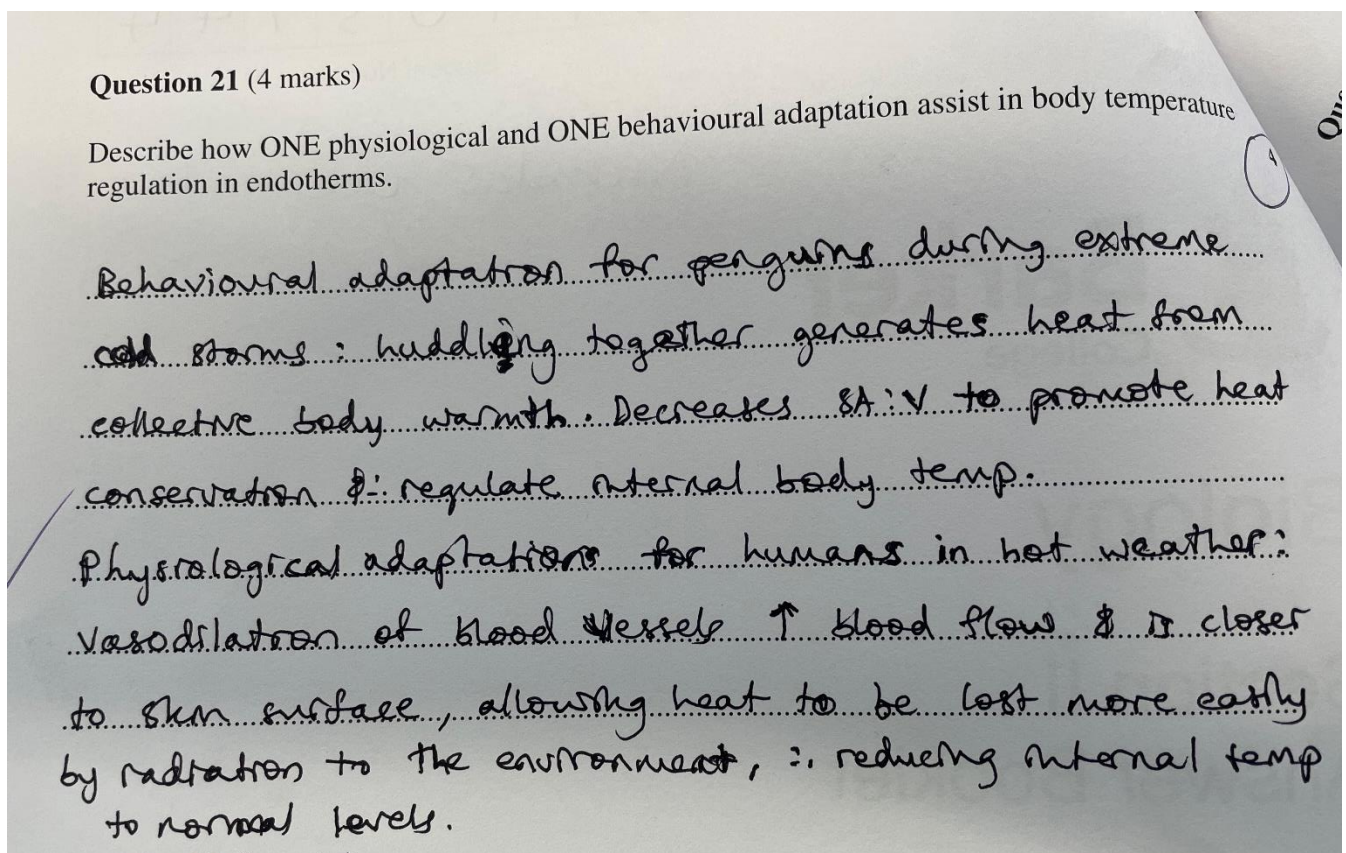
Question 21 (4 marks)

Describe how one physiological and one behavioural adaptation assist in body temperature regulation in endotherms. (4 marks)

Marking criteria:

Criteria	Marks
Identifies two relevant adaptations and makes a clear link to show how each adaptation assists in thermoregulation	4
Identifies two relevant adaptations and makes a clear link to show how ONE adaptation assists in thermoregulation	3
Identifies two relevant adaptations	2
Identifies one relevant adaptation	1

Sample answer:



Marker's comments:

Relevant adaptation needed and IDENTIFIED correctly in the category, & a LINK to thermoregulation

Marked generously

Question 22 (3 marks)

Draw a table that compares the forms in which DNA exists in eukaryotes and prokaryotes. Provide two features for each type of organism.

Marking criteria:

Criteria	Marks
Provides a correctly formatted table	3
Correctly compares two relevant features in each type of organism	
As above, missing one element	2
As above, missing two elements	1

Sample answer:

Cell type	DNA form
Prokaryote	-circular, coiled, double stranded nucleoid, chromosomal DNA
Eucaryote	- Chromosome in nucleus that is double stranded & packaged as a coil around histone proteins - Also has mitochondrial DNA – non nuclear , in a ring form

Question 22 (3 marks)

Draw a table that compares the forms in which DNA exists in eukaryotes and prokaryotes. Provide TWO features for each type of organism.

Eukaryotes DNA	prokaryotes DNA
- linear shape - bound to histone proteins	- circular shape - free/naked
- contained within nucleus	- not contained within nucleus

Marker's comments:

Tables should have clear column headings, some did not even mention DNA anywhere in the answer. At HSC this would not be assumed – so be careful to give ALL relevant info in your answer

1 element each and an answer could get 3 if it was well explained as a feature

Question 23 (2 marks)

The extract is from the website of a plant nursery that specialises in edible and medicinal native plants.

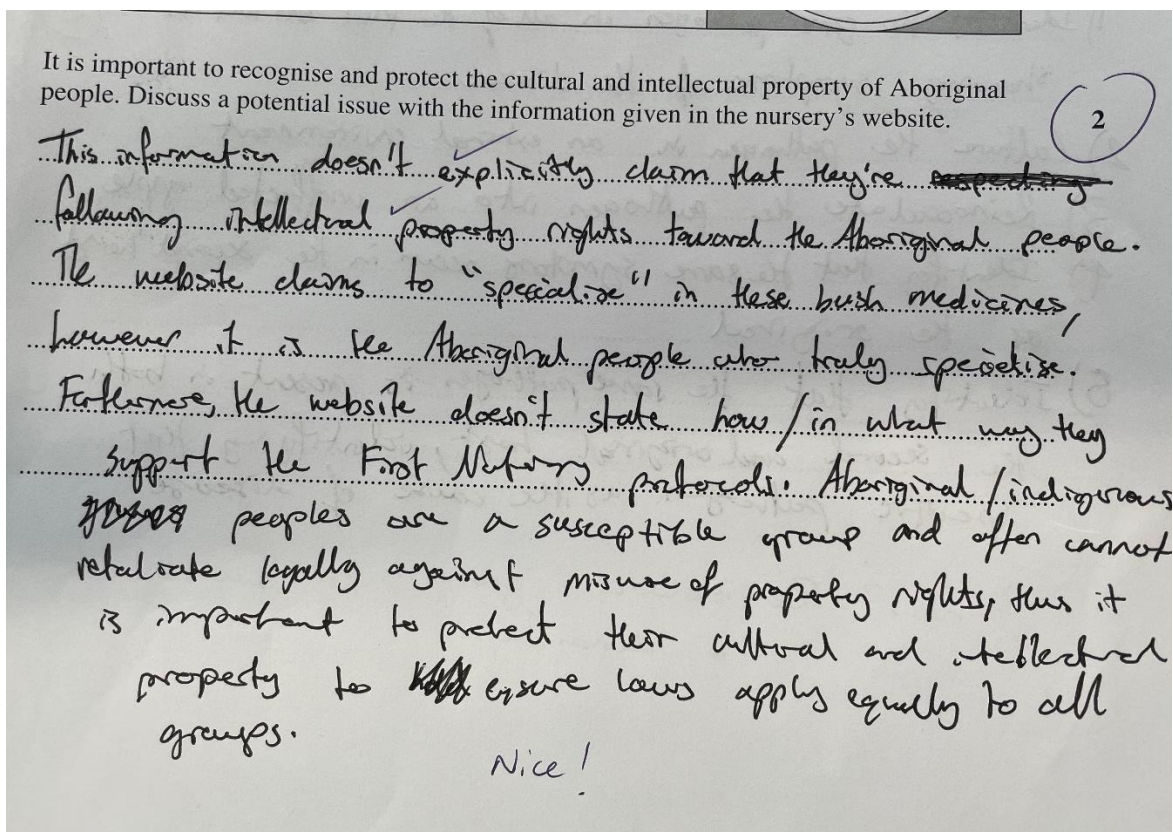
We specialise in edible and medicinal native plants that have been used by countless generations of First Nations peoples. We offer the general public a chance to share in the culture of 'bush tucker'. We certify that all of our plants are disease-free.	We support First Nations peoples' protocols in all of our biological materials.
--	--

It is important to recognise and protect the cultural and intellectual property of Aboriginal people. Discuss a potential issue with the information given in the nursery's website. 2

Marking criteria:

Criteria	Marks
Identifies an issue	2
Discusses the issue in relation to the cultural or intellectual property of Aboriginal people	
Identifies an issue	1

Sample answer:



Marker's comments:

Generally really well done

Note that some would have been worthy of many more marks as they were excellent – and this sort of qu would usually be worth more marks .

So ensure you learn more detail if you gave a brief response

Question 24 (4 marks)

Several farmers noticed a disease affecting their apple crops. The fruit developed slowly and began to rot on the tree before ripening. The farmers approached academics at the local agricultural college for help in determining what was causing the problem.



(Image available under Creative Commons License: CC-BY-SA-4.0)

The academics thought this would be a good assignment to set their post-graduate students.

Outline the steps the students should use to determine the cause of the disease.

Marking criteria:

Criteria	Marks
Outlines features of all four Koch's Postulates with reference to the stimulus.	4
Outlines features of three of Koch's Postulates with reference to the stimulus.	3
Outlines features of two of Koch's Postulates with reference to the stimulus. OR Describes all four postulates without reference to the stimulus	2
Outlines features of one of Koch's Postulate with reference to the stimulus. OR Describes at least two postulates without reference to the stimulus	1

Sample answer:

Several farmers noticed a disease affecting their apple crops.

The fruit developed slowly and began to rot on the tree before ripening. The farmers approached academics at the local agricultural college for help in determining what was causing the problem.



The academics thought this would be a good assignment to set their post-graduate students.

isolation in pure culture
→ inject into a diff. host
→ observe symptoms
→ isolation + identify
(Image available under Creative Commons License: CC-BY-SA-4.0)

Outline the steps the students should use to determine the cause of the disease.

4

1. students should first isolate this pathogen causing the fruit to rot in pure culture within a lab
2. Once isolated, the pathogen would be injected into another disease-free apple (host)
3. symptoms of this new host should be observed and compared to the original host. If the new apple develops rotting before ripening.
4. ~~if~~ after these symptoms are observed, the new host's pathogen would be isolated in pure culture in a lab.
5. students would compare both original and new pathogens. If both pathogens are the same, the disease is identified and the cause of disease would be found via identifying the known pathogen.

Marker's comments:

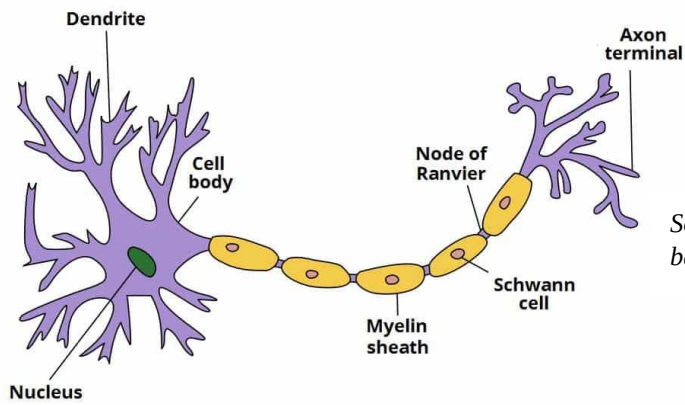
Was either done well – or terrible.

Little in between

LEARN the procedure principals for Koch's postulates

Question 25 (13 marks)

The image shows a typical neurone.



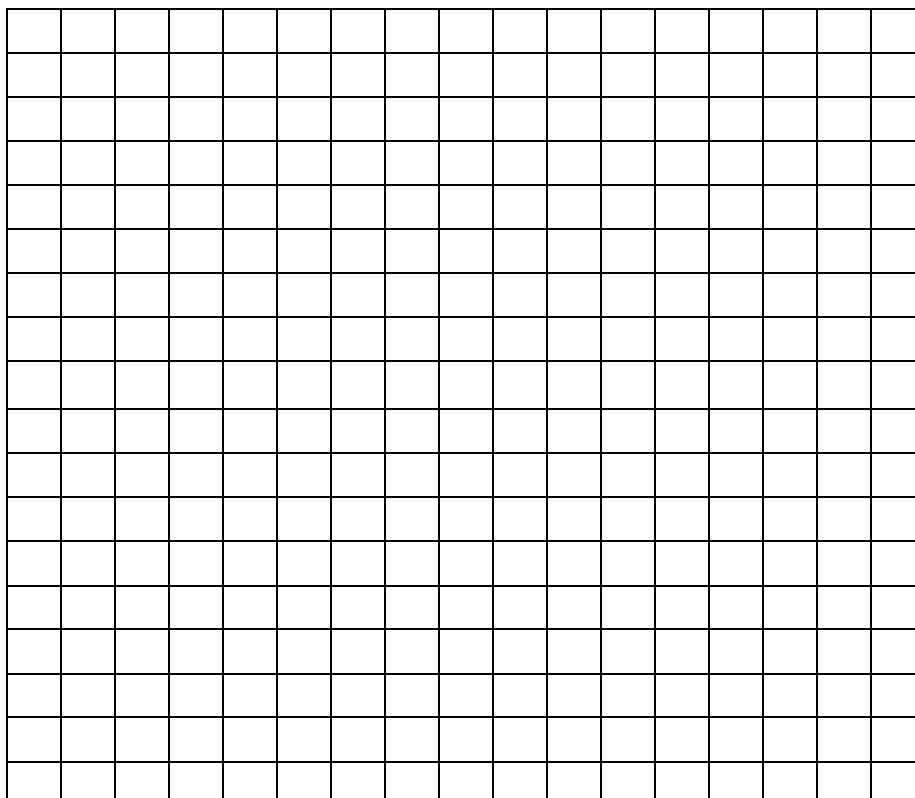
Source: <https://teachmeanatomy.info/the-basics/ultrastructure/nerves/>

To ensure consistent nerve impulse transmission, neurones require a myelin sheath with an even diameter. The data in the table show the relationship between the thickness of the myelin sheath and the time it takes for nerve conduction to occur. The thickness of the myelin sheath is measured in the number of layers. Myelin is made up of protein and fatty substances.

Impact of myelin sheath diameter on conduction velocity in neurons

Number of wraps in myelin sheath	Conduction velocity (ms^{-1})
1	0.6
2	1.2
3	1.5
4	1.6
5	1.8

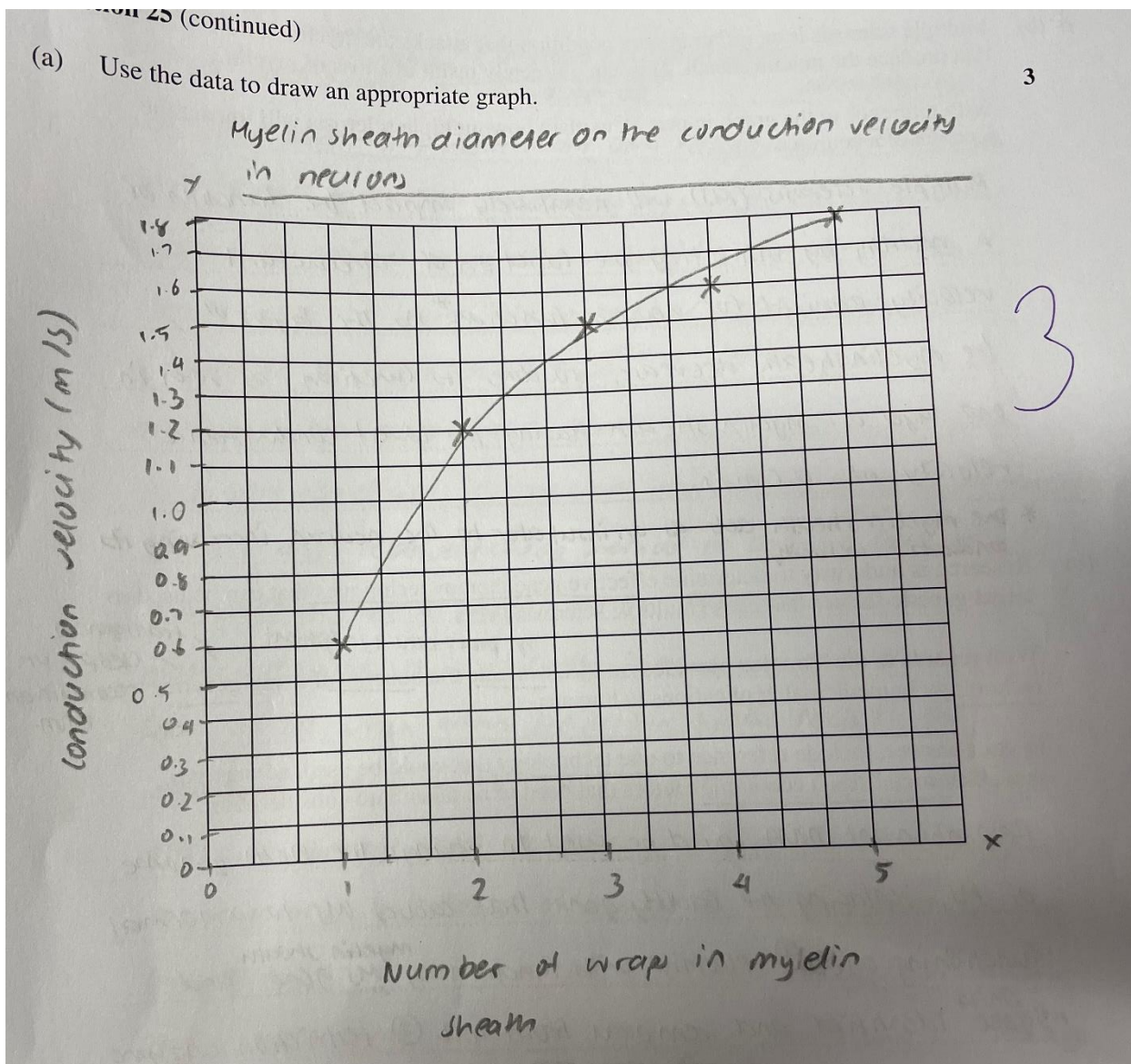
a) Use the data to draw an appropriate graph. (3 marks)



Marking criteria:

Criteria	Marks
Provides a correctly formatted line graph with no errors	3
Provides a line graph with up to two minor errors	2
Attempts a graph with some relevant information OR Provides a column graph	1

Sample answer:



Marker's comments:

Surprisingly few students scored full marks in this question. The most common error was the lack of appropriate curve of best fit, followed by students providing a column graph. Note that these are continuous data (ie both variables are NUMBERS) and therefore the graph needs to be a line graph. A curve of best fit should not extend beyond the data points (ie especially not started at 0,0) and in Biology we do not put arrow heads on a curve of best fit.

If you did not get 3/3 in this question, PLEASE take on board the feedback – you may be throwing away easy marks in your final exam.

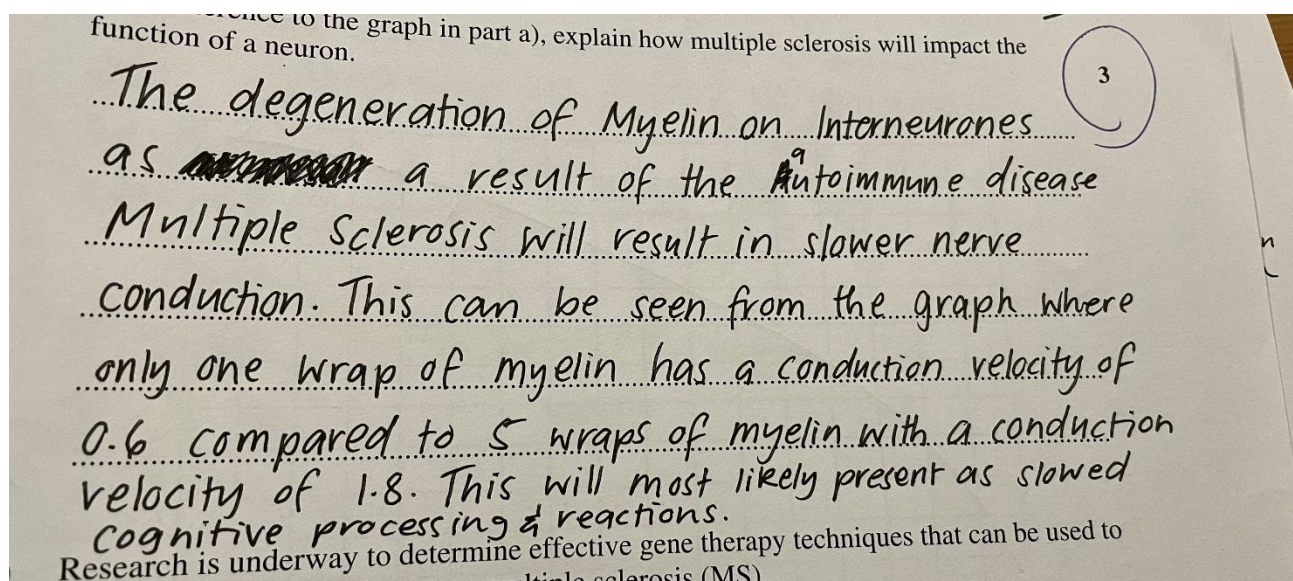
b) Multiple sclerosis is an inflammatory condition that attacks the myelin sheath, or the cells that produce the myelin sheath. This can ultimately result in a loss of myelin.

With reference to the graph in part a), explain how multiple sclerosis will impact the function of a neuron. (3 marks)

Marking criteria:

Criteria	Marks
Uses the data to explain how the function of the neuron will be impacted	3
Sketches in general terms how neuron function will be impacted with a weak link to the data	2
Describes a trend in the graph OR Sketches in general terms how neuron function will be impacted	1

Sample answer:



Marker's comments:

To get full marks here students needed to include correct reference to the trend in the graph and provide detail regarding how this will impact the function of the neurone. Most marks lost were either due to lack of graph reference or reference to impact on function. READ THE QUESTION.

c) Research is underway to determine effective gene therapy techniques that can be used to target genetic factors that cause multiple sclerosis (MS).

With regards to the stimulus provided on MS, evaluate the benefits of using genetic technology in medicinal applications in humans.

In your answer, include reference to one technology that could be used, advantages, as well as social factors AND economic factors that need to be taken into consideration. (8 marks)

Marking criteria:

Criteria	Marks
Extensively describes the processes of one relevant technology. Identifies advantages for the technology Identifies social and economic factors for the technology Includes reference to the stimulus Includes a clear judgement, along with logical progression of ideas and use of appropriate scientific terminology	8
Thoroughly describes the processes of one relevant technology. Identifies at least two advantages of the technology Identifies at least one social and one economic factor for the technology Includes reference to the stimulus Includes a clear judgement	7
Describes the processes of one relevant technology with sound detail. Identifies one advantage for the technology Identifies at least one social and one economic factor for the technology May include reference to the stimulus Includes a clear judgement	6

Describes features of the technology Identifies one advantage for the technology Identifies at one relevant factor for each technology May include reference to the stimulus	5
Describes at least one feature of one relevant technology Identifies one advantage for one technology and/or one relevant factor May include a link to the stimulus	4
Sketches in general terms a feature of one relevant technology Identifies an advantage or a factor for one technology OR A good description of social and economic factors regarding biotechnology in general	3
Identifies a relevant technology Provides detail of the process or an advantage or a factor	2
Provides some relevant information	1

Sample answer:

- (c) Research is underway to determine effective gene therapy techniques that can be used to target genetic factors that cause multiple sclerosis (MS).

↳ inflammatory condition

With regards to the stimulus provided on MS, evaluate the benefits of using genetic technology in medicinal applications in humans.

In your answer, include reference to one technology that could be used, advantages, as well as social AND economic factors that need to be taken into consideration.

Stimulus:

Multiple sclerosis is caused by inflammation that attacks the myelin sheath of neurons or the cells that produce the myelin sheath.

Inflammation is caused by mast cells that release histamine, causing redness and swelling. However, inflammation does allow for lymphocytes to go to the infected area.

Therefore, for this condition, it is essential that gene therapy techniques only target

the cells that are causing the disadvantages

here this reduces the efficiency of nerve impulses that are crucial to the functioning of the body.

PCRISPR

Beautifully neat handwriting

Question 25 continues on page 23

inflammation that attacks the myelin sheath of neurons. Therefore, CRISPR technology can be a useful technology to treat this condition as it fixes the specific mutation in genes that is causing the condition, without altering the entire DNA sequence. Genetic technology, such as CRISPR, is beneficial in medical applications as they can cure genetic diseases that are often incurable with normal medicine. As well, they can be more effective at treating the root of the cause of conditions to minimise symptoms for patients. As well, ~~transgenes~~ some technologists can produce medicines at a fast and efficient rate, for example the use of ~~transgenes~~ to produce insulin for patients with diabetes. CRISPR is a technology that cuts the DNA at the site of mutation with the Cas 9 enzyme, ^{End of Question 25} and replaces the fragment of DNA that has a mutation with the correct sequence, using a template strand. For multiple sclerosis, CRISPR can be used to cut out the mutation causing the inflammatory response and replace it with the normal sequence, hence curing the condition. ~~Although this techn~~

not relevant

⊛ continue on next page ⊛

Although CRISPR is advantageous at fixing mutations in DNA, there are numerous social and economic factors that must be considered. Economically, CRISPR is a very expensive technology as it requires many parts that are not easily distributed in the medical field. Therefore, there are concerns of equity of access to this technology as only those that can afford it can use it. Socially, CRISPR is a very new technology that not many people know about. Many individuals are concerned with the manipulation of human DNA as they are worried people may go too far with the technology & alter DNA for reasons beyond medical help such as making 'super humans'.

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Therefore, genetic technology can be very beneficial for treating ~~the~~ medical conditions but there are concerns that people may take advantage of these technologies or that they are too expensive for normal distribution to society.

The answer below includes a plan and sub headings. Sub headings are a good idea for a question like this one.

In your answer, include reference to one technology that could be used, advantages, as well as social AND economic factors that need to be taken into consideration.

8

- Genetic Technology
- Medical applications
- benefits
- Examples: CRISPR
- Explain CRISPR
- Relate to stimulus and multiple stakeholders
- Benefits/advantages socially
- Benefits/disadvantages economically
- Final evaluation

Genetic technology: Genetic technology is a beneficial field of ~~very~~ genetic engineering in science as it allows us to manipulate and influence genes for the benefit of humans and society. However, also have some disadvantages.

Medical Applications: Genetic technology can be applied to medical ~~or~~ situations as techniques such as gene therapy can target genetic factors and alter genes that cause diseases, preventing and reducing harm of diseases to improve individuals' health.

CRISPR: The ~~CRIS~~ CRISPR technique is a useful genetic technology that can be used in medicine to

↑ nice to see a plan! great work.

Question 25 continues on page 23

Question 25 (continued)

target and removes genes that cause disease. It is done by using Guide RNA, made by scientists, which is the complementary base pairing of a specific gene which is the one that is being removed. It attaches itself to this gene through base pairing. Then the Cas-9 enzyme which has been made to identify this guide RNA, identifies and cuts this segment which is the guide RNA, attached to the intended gene, so this gene is removed. Finally, then a new gene which is the normal/unfaulty gene, is attached to this segment to replace this faulty gene.

CRISPR and Multiple Sclerosis: Multiple sclerosis is as stated in the stimulus is a genetic factor, which attacks the myelin sheath and results in loss of myelin, which negatively impacts neuron function as it affects conduction velocity, altering its transmission of electrical impulses/messages.

the CRISPR technique can target and remove the gene causing the disease and replace it with a normal healthy gene, improving neuron function and lifestyles of those with the disease or potentially those who aren't born yet with the gene.

Social Implications: This will increase jobs for those working on the CRISPR technology and provide happier and more productive lifestyles for those who had the gene which is beneficial, although it could result in social dispute over the altering of genes, especially in foetuses.

Economical Implications: This technology is very expensive and will be expensive to use on a wide scale and for financially struggling individuals which is disadvantageous. Although it may be beneficial at reducing financial strain on the health industry and government as less people will be affected by multiple sclerosis.

Evaluation: Therefore, CRISPR genetic technology, despite some disadvantages, is beneficial in medical applications as it can help prevent and reduce the harm from diseases (such as MS) which can lead to more healthy individuals and have social and political benefits.

YOU NEED TO PLAN YOUR RESPONSES



HARDLY ANYONE planned answers to this question. The question given was highly scaffolded and told you exactly what to include in the response. Even if you weren't sure about which biotechnology to discuss, you could still access a number of marks if you were able to include detail relevant to other parts of the question. PLEASE PLEASE PLEASE plan your responses. Those students that included a plan tended to be the ones that scored 5 + marks.

To get full marks you needed to identify and describe a relevant technology. CRISPR is the best one for this question. A number of students identified CRISPR but then sadly did not briefly describe the process. YOU NEED TO describe processes in these longer questions. This is your chance to showcase your scientific understanding.

Common features of better responses:

- Included a plan
- Did not restate the question or repeat waffly vague sweeping statements. You need to stick to the facts in science.
- Addressed all parts of the question (because they PLANNED) (do you hear the point I am trying to make?)
- Gave specific details and examples regarding relevant factors. Statements like 'playing God' are vague.
- Ended with a strong, clear judgement.
- Planned their response

To improve in long questions such as this one please review content that you feel are your weak areas and then sit down and figure out how you can tweak your exam technique to help you squeeze out some extra marks (eg add annotating questions and planning to your repertoire). You will get at least two long questions in your final exam.

Question 26 (4 marks)

The image shows a selection of breakfast foods that are high in sugar.

BAKER'S DELIGHT APPLE & CINNAMON SCROLL	MUFFIN BREAK BANANA BERRY MUFFIN	UNCLE TOBY'S YOGURT & HONEYCOMB BAR	KELLOGG'S K-TIME TWISTS	SANITARIUM UP & GO BREAKFAST STRAWBERRY
				
7TSP PER SERVING	9TSP PER SERVING	2.5TSP PER SERVING	3TSP PER SERVING	4.5TSP PER SERVING
6g PER 100G	5.5g PER 100G	7.5g PER 100G	8.5g PER 100G	2g PER 100G

Source: https://www.sugarbyhalf.com/how_much_sugar_is_too_much

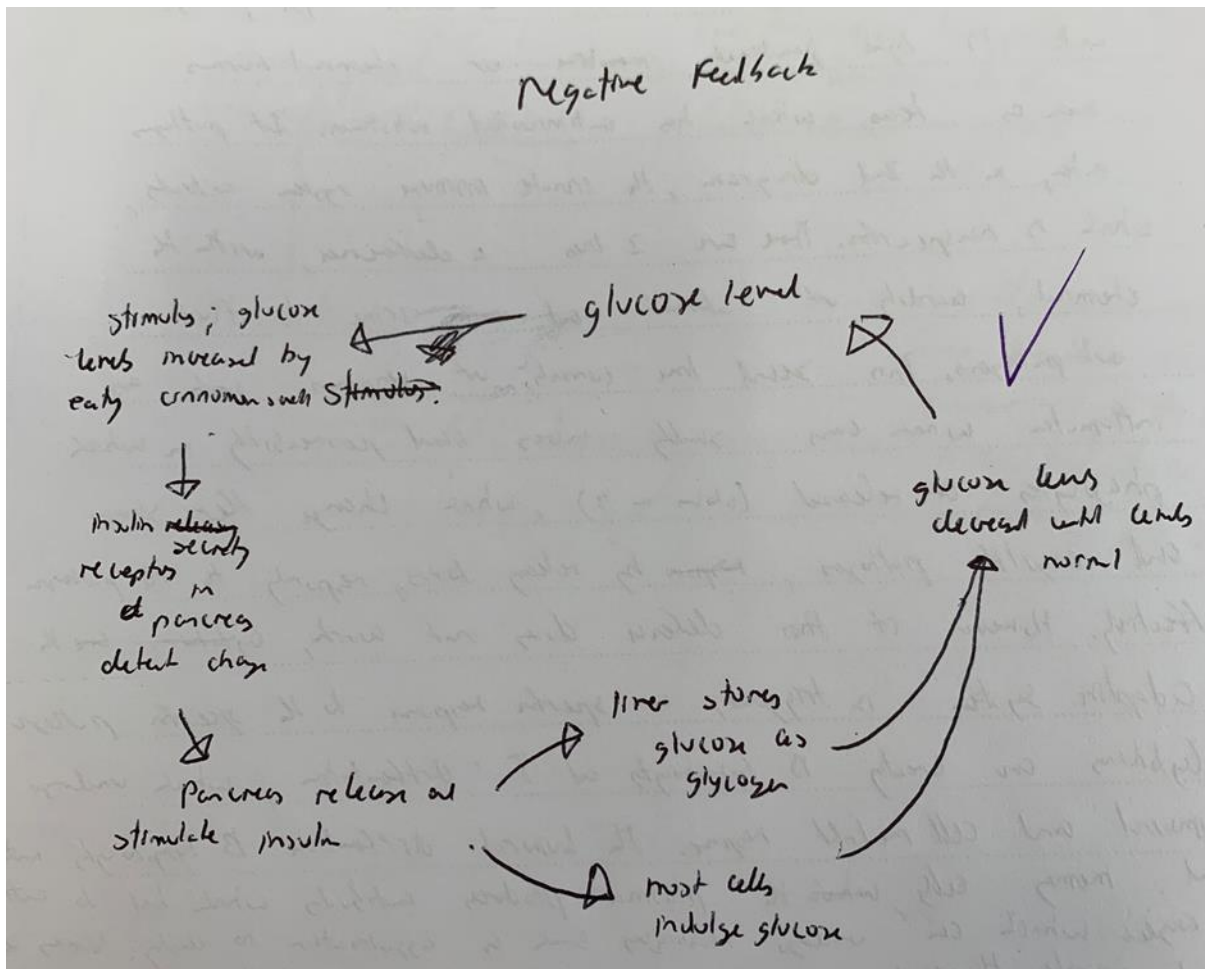
Construct a feedback loop to show how the human body responds after eating a cinnamon scroll. 4

Construct a feedback loop to show how the human body responds after following eating schedule A.

Marking criteria:

Criteria	Marks
Provides an appropriate feedback loop with all required detail.	4
Provides a feedback loop with no stimulus, labels missing	3
Provides a feedback loop with included 2-3 errors	2
Attempts a feedback loop with some relevant information	1

Sample answer:



Marker's comments:

For full marks:

Include some reference to stimulus.

Indicate an increase in BGL as a result of stimulus.

Pancreas releases insulin.

Insulin increases uptake of glucose into cells, while in the liver, glucose is converted to and stored as glycogen.

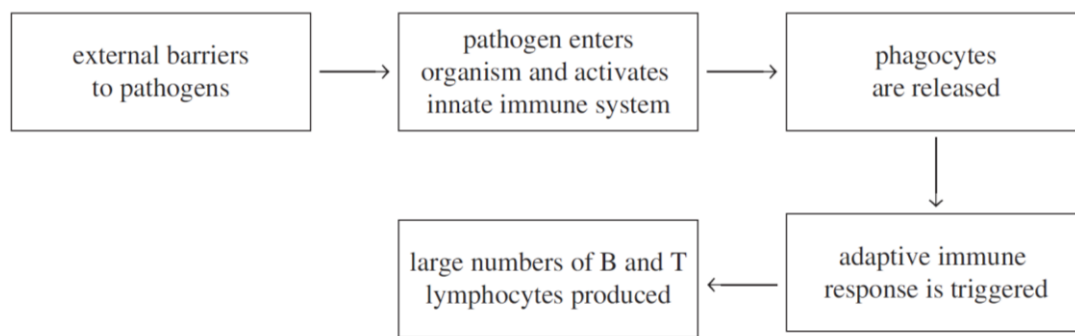
Resulting in a decrease in BGL.

Many students got confused with the stimulus response pathway and did not provide a feedback loop (and only half was needed).

No marks lost or gained for including the drop in BGL being corrected.

Question 27 (7 marks)

The diagram shows part of the human immune system's response to a pathogen.



Explain how the innate and adaptive immune systems respond to pathogens in the human body. In your answer, refer to the stages shown in the diagram. (7 marks)

Marking criteria:

Criteria	Marks
Provides extensive detail regarding features of the innate and adaptive immune systems. Includes thorough reference to the stimulus. All 5	7
Provides thorough detail regarding features of the innate and adaptive immune systems. Includes detailed reference to the stimulus. 4-5	6
Provides features of the innate and adaptive immune systems. Includes reference to the stimulus 3-4	5
Provides features of the innate and adaptive immune systems. Includes weak reference to the stimulus 2-3	4
Explains how one feature of the innate or adaptive immune system responds after infection.	3
Sketches in general terms a feature of the innate or adaptive immune system	2
Provides some relevant information	1

Sample answer:

Marker's comments:

Responses need to be planned.

The question asked for the stages of the diagram to be referenced in your response and this was done very poorly.

For full marks:

Each stage needed to be referenced

Explain (cause and effect) how the innate/adaptive immune system responds

What happens to the pathogen as a result of this response.

Most students listed the response and loosely linked to some parts of the stimulus with no apparent explanation.

The plan was written for you in the stimulus and very few students used it to their advantage. I read many brain dumps rather than well constructed responses.

Question 28 (6 marks)

The information given relates to the disease Dengue Fever.

The dengue fever virus can be spread by two species of mosquito: the Dengue mosquito (*Aedes aegypti*) and the Asian Tiger mosquito (*Aedes albopictus*). Both species are active during the day.

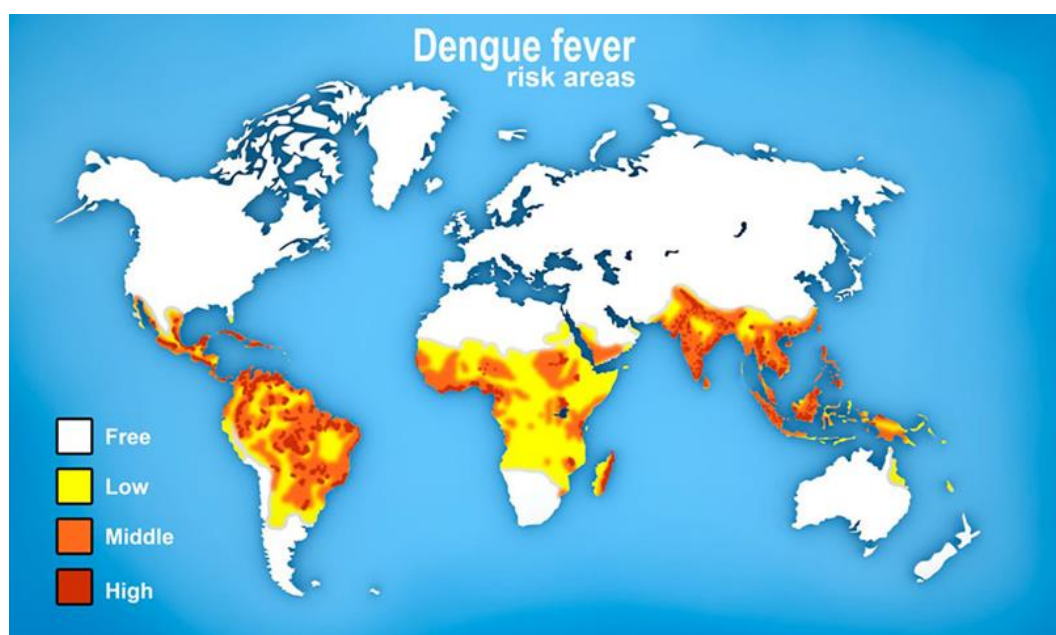
Dengue affects infants, children and adults.

People develop dengue fever after being bitten by a mosquito that is infected with the virus. The virus is not spread directly from person to person. The mosquito becomes infected when it bites a person who has dengue virus in their blood. The virus multiplies inside the mosquito and the mosquito will infect other people when it bites them.

People with dengue fever develop illness between 3 and 14 days (usually 4-7 days) after being bitten by an infectious mosquito. The fever typically lasts around 6 days.

The warning signs which occur 3-7 days after the first symptoms include: severe abdominal pain, rapid breathing, blood in vomit, persistent vomiting, bleeding gums, fatigue and restlessness.

There is no specific treatment for dengue fever. There is currently no vaccine to prevent initial dengue infection. Patients should seek medical advice, rest and drink plenty of fluids.



- (a) With reference to the map, explain how a change in climate could affect the spread of dengue fever.

2

Marking criteria:

Criteria	Marks
Includes a clear link to the stimulus.	2
Provides a link between a change in climate and the spread of dengue.	
Sketches in general terms how a change in climate could spread dengue without clear reference to the stimulus.	1

Sample answer:

Question 28 (continued)

- (a) With reference to the map, explain how a change in climate could affect the spread of dengue fever.

It is evident from the map that the mosquito lives and thrives in hot humid climates, as indicated by the disease's high prevalence in Indonesia and India. With the rising temp, that cause as a consequence of climate change, the mosquito could migrate into more countries that accumulate the hot weather. This spreading the disease even further and more globally.

Question 28 (continued)

- (a) With reference to the map, explain how a change in climate could affect the spread of dengue fever.

The global distribution map of dengue fever indicates a high prevalence of the disease near the equator. Since the disease is entirely spread by mosquitoes, those areas of higher temperatures and humidity are at the greatest risk. Therefore, with climate changes heating the globe, dengue fever may spread further across the world as conditions become increasingly favorable for mosquitoes.

Marker's comments:

Reference to the map was accepted if you made a statement that shows you have looked at the map i.e. Dengue Fever risk is highest near the equator (better answers may name specific countries). BUT you should make specific reference to the map i.e. "As seen on the map,..."

Don't just say something random like "in the jungle" without showing that you have used the map.

You also need to make reference to a **specific** change in climate i.e. temperature **increases**, temperature **decreases**, **increase** in rainfall, etc. A change in climate does not necessarily mean temp increase so if that is what you mean then say so!

Finally, you need to state how that change would impact the spread of Dengue i.e. increase the spread or decrease the spread, not just "affect the spread".

- (b) Outline TWO measures that can be taken by individuals and TWO measures that can be taken by public health authorities in Australia to limit the spread of dengue fever. 4

Marking criteria:

Criteria	Marks
Outlines four relevant measures	4
Outlines three relevant measures	3
Outlines two relevant measures	2
Outlines one relevant measure OR includes some relevant information	1

Sample answer:

- (b) Outline TWO measures that can be taken by individuals and TWO measures that can be taken by public health authorities in Australia to limit the spread of dengue fever.

4

- Personal hygiene
- Wear full clothing
- Campaigns

One measure that can be taken by individuals is to wear appropriate clothing. ~~Another measure that can be taken by individuals is to wear appropriate clothing.~~ This means ~~the~~ wearing ~~appropriate~~ clothing that covers your entire body to minimise skin exposed to mosquitoes. Another individual measure might be to limit time spent outside, ~~or~~ or considering going outside when it is cooler. One measure that can be taken by public health authorities, may be the utilisation of campaign advertising. The aim would be to alert people of what they can do to minimise the risk of being bitten by mosquitoes. Another measure ~~that can be taken~~ could be to issue people with mosquito nets for their hats to cover their necks and/or face. These measures would all aid in limiting the incidence of dengue fever and therefore its spread.

End of Question 28

Beautiful answer!

- (b) Outline TWO measures that can be taken by individuals and TWO measures that can be taken by public health authorities in Australia to limit the spread of dengue fever.

↳ public health campaigns, pesticides

To minimise the risk of individuals spreading dengue fever, they can wear mosquito repellent that repels the mosquitoes from biting the individual. As mosquitoes are a vector to the disease, the best measure is to avoid getting bitten. Therefore individuals can also remain indoors on warm days to reduce their chances of getting bitten and hence spreading the disease. For public authorities, to prevent the spread of dengue fever they can introduce public health campaigns that educate individuals on the risks of being bitten by mosquitoes, encouraging them to wear mosquito repellent or seek medical attention if they have caught the virus or having the symptoms of the virus such as abdominal pain or blood in vomit. As well, public health authorities can administer pesticides to reduce the mosquito population, killing all that have been infected with dengue fever to reduce its ability to spread as without mosquito as a vector, there is no dengue fever spread.

End of Question 28

Marker's comments:

For this question, you need TWO measures individuals can take and TWO measure public health authorities can take. These measures must be **realistic** and must also show that they would **limit the spread** of Dengue, as this is what the question asks. Dengue is a mosquito-borne disease (MBD) so measures that are useful for bacterial diseases and other viruses are not effective here. This question should be set out using subheadings and numbered points underneath to show that you have two measures for each.

Note: We need to understand that our government response to COVID was extreme, in the face of a serious global pandemic. Measures used in this instance cannot be applied to every disease e.g. closing borders and compulsory quarantine. Please understand as well that Dengue is NOT endemic to Australia. We have some of the mosquitoes that can transmit the disease in Far North Queensland, but the disease is only transmitted when a person infected with Dengue (most likely picked up overseas) is bitten by one of these, then that mosquito infects another person. The risk in FNQ is therefore low, as most people don't have Dengue. Avoiding travel to FNQ is not a necessary precaution, and moving everyone out is a little unrealistic!

This question asks you to OUTLINE. While this does not require as much detail as an explain or discuss, it does need more than simply identifying the measure.

Good responses for individuals:

- Wearing insect repellent to prevent mosquitoes from biting.
- Wearing long, clothing that minimises exposed skin to prevent being bitten. (Also – light coloured as dark attracts mosquitoes, and loose fitting as they can bite through tight clothing)
- Use of mosquito nets or screens on windows to prevent mosquitoes biting.
- Staying indoors during the day, when mosquitoes are most active.
- Avoiding areas that are known to attract mosquitoes
- Limiting travel to areas that have HIGH risk e.g. India, Brazil, etc.

Not accepted:

- Personal hygiene – mosquitoes are MORE attracted to people with fewer microbes on their skin, and to the scent of soap, perfume, lotions, deodorant, etc.
- Quarantine/Isolation – these measures can be effective against diseases that are transmitted through the air, but not by mosquito-borne diseases (MBD). Dengue is not COVID! Unless the facility is air tight against mosquitoes, this will not be an effective measure. Mosquitoes can fly in to a facility, become infected, then fly out again.
- Vaccination – there is no vaccine to prevent initial infection (read the stimulus!)

Good measures for public health authorities:

- Public health campaigns to educate people about the mode of transmission of Dengue and actions they can take to prevent the spread. *Note that education and awareness of a disease alone do not stop the spread – they need to teach people how to prevent infection.*
- Use of pesticides to kill mosquitoes and thus remove the vector.
- Removal of stagnant water in the environment e.g. draining swamps, removing fountains, water tanks, etc.
- Introduction of GE mosquitoes into the environment, interfering with reproduction and reducing vector population
- Pre-screening of individuals travelling to Australia from high-risk areas to ensure they are not infected

Not accepted:

- Enforced quarantine/isolation of individuals: this is ineffective (see above) but also an extreme measure that would not normally be accepted
- Banning travel to high-risk areas of the world – extreme and the government won't do this. Same as closing borders – this was only in COVID due to the global pandemic and threat to our health system

- Likewise for banning people from high-risk areas from travelling to Australia.
- Passing laws preventing people from going outside – this is far too extreme and would not happen. Also ineffective as mosquitoes can bite you inside!
- Dengue does not enter Australia in food or animals – people infected with it bring it in.
Exception - A handful of students wrote particularly well about screening at ports, spraying with insecticides etc. This acknowledged that there is a (SMALL) chance a mosquito carrying Dengue could be brought in via luggage or in a ship etc. This differed from general responses about inspecting fruit so received the mark. But – Dengue mostly enters a country in people!
- Vaccination – PHAs cannot encourage vaccination as there is no vaccine.
Exception – a couple of students had excellent responses stating that PHAs could invest in research and development of a new vaccine for Dengue. While this is unlikely at this point, these responses were specific to the question and showed understanding of the information provided and the role of PHAs.

Question 29 (3 marks)

Haemophilia A is a recessive blood clotting disorder that arises from a defect in the gene which is carried on the X chromosome.

A couple is considering starting a family. However, the father suffers from Haemophilia A. The mother is healthy with no family history of the disease.

What is the probability that a potential grandson will have Haemophilia A if they have a daughter who partners with an affected man?

Marking criteria:

Criteria	Marks
Correctly states the probability, supported by a relevant Punnet square (with a clear link made between the information in the Punnet square and the answer)	3
Provides a correct Punnet square and answer, with no link between the working and the answer	2
Attempts a Punnet square with some relevant information, showing basic understanding of sex-linkage	1

Sample answer:

Haemophilia A is a recessive blood clotting disorder that arises from a defect in the gene which is carried on the X chromosome.

A couple is considering starting a family. However, the father suffers from Haemophilia A. The mother is healthy with no family history of the disease.

What is the probability that a potential grandson will have Haemophilia A if they have a daughter who partners with an affected man? Show all relevant working.

3

As the mother has no family history of Haemophilia A, it can be assumed that her genotype is $X^H X^H$. The father has Haemophilia A, so his genotype is $X^h Y$.

Key:

X^H = normal

X^h = Haemophilia A

$$X^H X^H \times X^h Y$$

	X^H	X^H	
X^H	$X^H X^H$	$X^H X^h$	$X^H Y$
X^h	$X^h X^H$	$X^h X^h$	$X^h Y$

100% normal sons

100% carrier daughters.

All daughters of the couple will be carriers of Haemophilia A, with the genotype $X^H X^h$. If one of their daughters partnered with a man with Haemophilia A (genotype $X^h Y$), a son would have a 50% chance of having Haemophilia A, as shown in the Punnett square below

$X^H X^h \times X^h Y$

	X^h	Y
X^H	$X^H X^h$	$X^H Y$
X^h	$X^h X^h$	$X^h Y$

Daughters: 50% $X^H X^h$, 50% $X^h X^h$
 Sons: 50% $X^H Y$, 50% $X^h Y$
 Haem. A. $\therefore$ there is a 50% chance of a grandson having Haem. A.

Marker's comments:

To achieve full marks, you need to show all working (best responses included two punnet squares – one for each generation). At least one was required, with a LINK between the Punnet square working and your answer. This could include circling/pointing an arrow to the grandson with Haemophilia A OR a clear indication of the genotype required for this, then clearly shown in the Punnett square. With no clear link, a maximum of 2 marks could be achieved. This was penalised in your last assessment task, so it is a shame that this feedback was not put into practice.

On the whole, most students seemed to understand this question.

Common mistakes for those who didn't:

- Not understanding that the condition is on the X-chromosome. This needs to be shown as X^H for the dominant trait (no Haemophilia A) and X^h for the recessive trait (Haemophilia A). Note that you could use different letters for the alleles. A maximum of 1 mark was given if not shown as sex-linked.

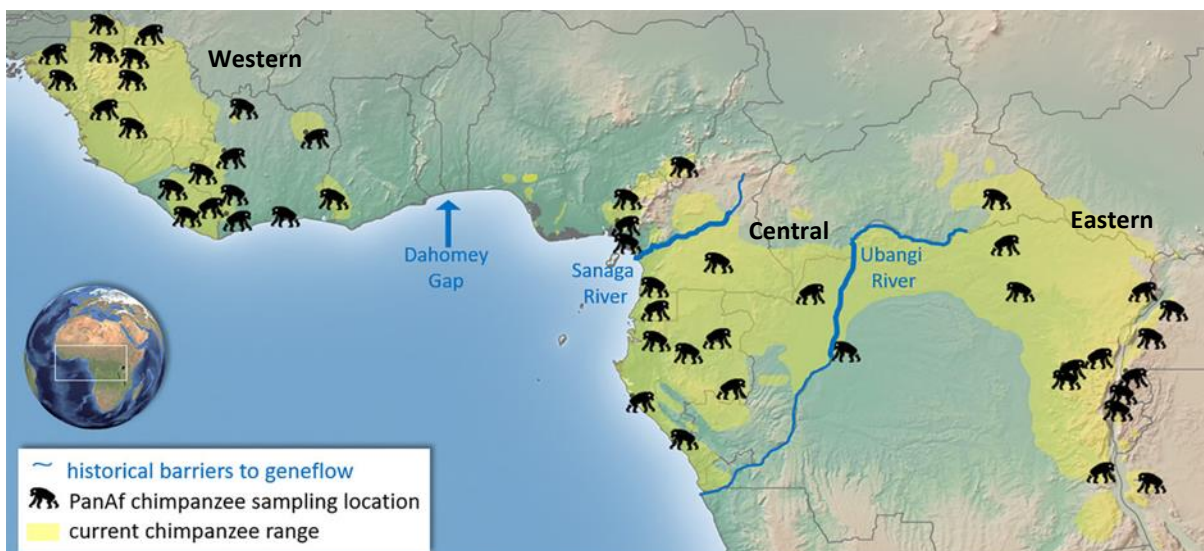
- Placing an allele on the Y chromosome. This shows a fundamental misunderstanding of sex-linkage – the point is that they affect males and females differently as there is NO allele on the Y chromosome.
- The question specifically asks the probability that a *grandson* has the condition. This means that you can look only at the males and see that there is a 50% chance a male will have the condition. Some students wrote that there was a 25% overall chance that they would have a grandson with the condition. This **was** accepted only if the wording was such that it incorporated the overall chance of having a male and him having Haemophilia. You could **not** say “there is a 25% chance that a grandson will have the condition”

Question 30 (11 marks)

Common chimpanzees in equatorial Africa have long been recognized as falling into three distinct populations or sub-species: western, central and eastern chimpanzees. These populations are genetically hugely diverse.

Dr Rory Bowden from the Department of Statistics at Oxford University, who led a study on the diversity in chimpanzee populations in Western Africa, said: “These findings have important consequences for conservation. All great ape populations face unparalleled challenges from habitat loss, hunting and emerging infections, and conservation strategies need to be based on sound understanding of the underlying population structure.”

The map shows three distinct chimpanzee populations in Africa.



- Discuss how the information provided above could be used to develop a conservation strategy for the African chimpanzee populations.

Marking criteria:

Criteria	Marks
Thoroughly discusses issues related to the conservation of the chimpanzees with a clear link to the stimulus. Shows detailed understanding of relevant biological processes.	5
Discusses issues related to the conservation of the chimpanzees with a clear link to the stimulus. Shows detailed understanding of relevant biological processes.	4
Discusses some issues related to the conservation of the chimpanzees with a link to the stimulus. Shows some understanding of relevant biological processes	3
Identifies issues related to conservation of chimpanzees	2
Provides some relevant information	1

Sample answer:

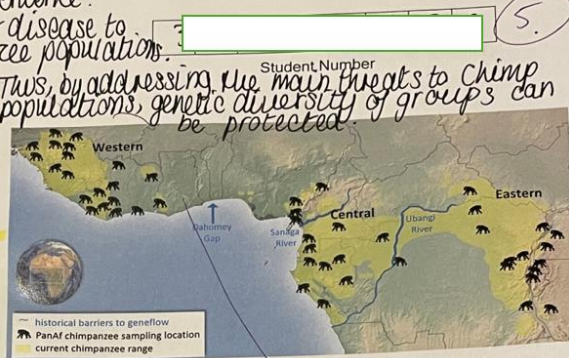
* continued sentence:
opportunity for disease to
reach chimpanzee populations.

Question 30 (10 marks)

Common chimpanzees in equatorial Africa have long been recognized as falling into three distinct populations or sub-species: western, central and eastern chimpanzees. These populations are genetically hugely diverse.

Dr Rory Bowden from the Department of Statistics at Oxford University, who led a study on the diversity in chimpanzee populations in Western Africa, said: "These findings have important consequences for conservation. All great ape populations face unparalleled challenges from habitat loss, hunting and emerging infections, and conservation strategies need to be based on sound understanding of the underlying population structure."

The map shows three distinct chimpanzee populations in Africa.



- (a) Discuss how the information provided above could be used to develop a conservation strategy for the African chimpanzee populations.

Based on the main challenges listed above, habitat loss, hunting and emerging infections, conservation strategies need to address them as they "have important consequences for conservation". Habitat loss can be addressed by creating national parks which prevent deforestation, protecting the chimps which live in the area.

- ✓ Hunting laws can be administered and fines for those who disobey the rules. Conservation workers and volunteers can patrol regularly to keep an eye out for suspicious behaviour.
- ✓ Emerging infections can be monitored by conservation workers. Prevention measures such as quarantine before entering the area, cleaned shoes, washed clothes, and strict rules about what you can bring into the reserve can prevent disease.

Marker's comments:

Some general thoughts after reading the question.

Three separate populations, each in a relatively small range.

Use genetic technologies to establish a benchmark of the current allele frequency/genetic diversity within the population.

Maintaining or increasing genetic diversity in these populations – could mean transferring animals from one population to another.

Improving habitats – allowing corridors for interbreeding and therefore gene flow to maintain and increase genetic diversity.

Increased genetic diversity can help reduce the risk of emerging infections and disease.

Education, legislation, eco-tourism for the local human population to help reduce habitat loss, hunting and risk of disease transfer between humans and chimpanzees.

Habitat restoration through reforestation.

Hunting bans along with education of the local population.

Aid from NGOs or UN, payment for eco-tourism.

General comments

Many responses did not demonstrate a clear understanding of a conservation strategy.

Many responses spent too much space re-writing the question.

There was also much discussion of population genetics and differences between sub-species, but no reference to habitat loss, hunting or emergent infections.

There seems to be an assumption that if we can increase genetic diversity in the chimpanzee populations, this will make them more resistant to habitat loss and better able to resist being slaughtered by hunters.

It doesn't matter how genetically diverse a population is...if the animals don't have anywhere to live and if they are being hunted indiscriminately, they are doomed!

Many answers did not effectively use the stimulus material provided:

Habitat loss, hunting, emergent infections, three populations (sub-species) that are genetically diverse (different from each other).

Discussion including these points, along with a demonstration of detailed understanding of relevant biological processes would provide enough for full marks in this question.

Mark distribution

Marks	5	4	3	2	1	0
% in cohort	7	14	31	31	12	5

b) The Figures 1 and 2 show the genetic diversity in human populations across the globe and the migration of humans from their African origin.

Map of global human genetic diversity

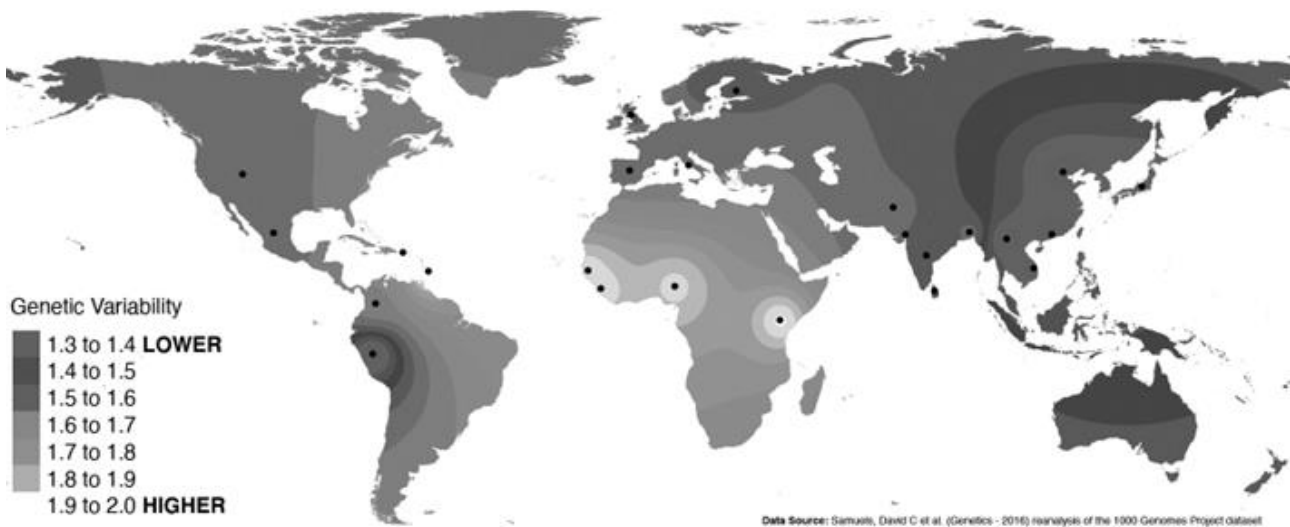


Figure 1: Global human genetic diversity. Genetic variability is given as relative frequency which represents the percentage of alleles in a population.

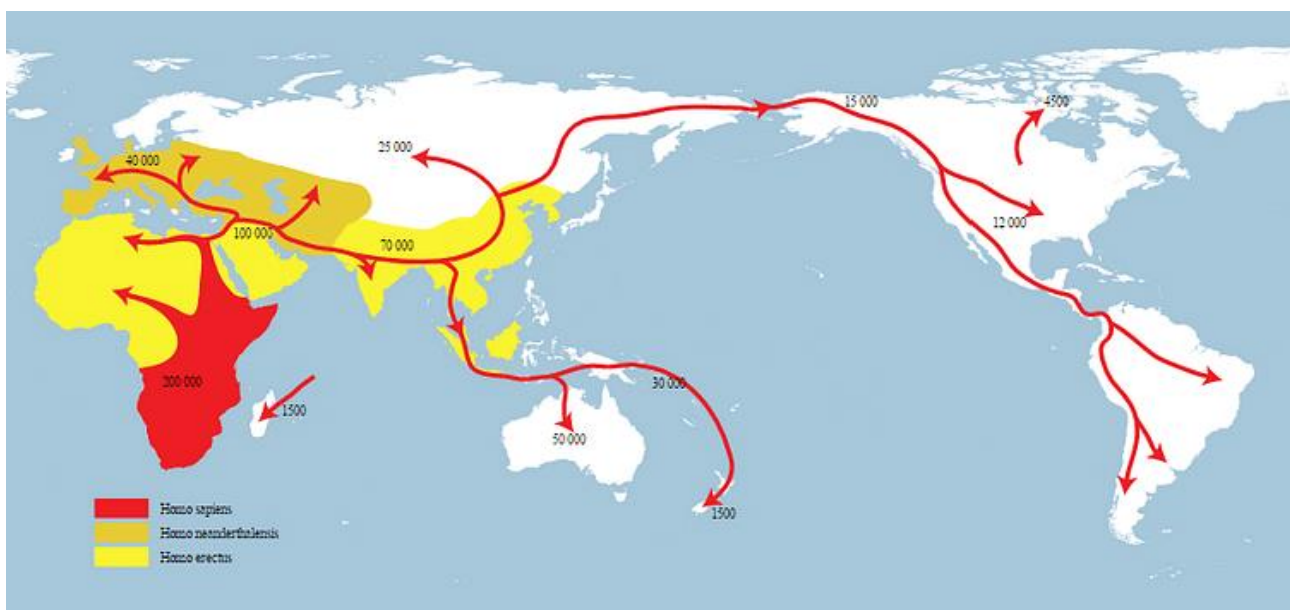


Figure 2: Human Migration patterns from African Origins. The numbers shown indicate how many years before present populations migrated.

DNA evidence suggests around 1 000 humans (*Homo sapiens*) migrated from Africa into Asia and Europe. With reference to the information provided in Figures 1 and 2, explain why human genetic diversity in Africa is higher than the rest of the world.

5

Marking criteria:

Criteria	Marks
Describes a biological process that reduces allele frequency Includes clear reference to the stimulus Clear justification as to why diversity is higher in Africa	5
Describes a biological process that reduces allele frequency Clear link to the stimulus	4
Describes a biological process that reduces allele frequency	3
Sketches in general terms a relevant biological process	2
Provides some relevant information	1

Sample answer:

5

- (b) DNA evidence suggests around 1000 humans (*Homo sapiens*) migrated from Africa into Asia and Europe. With reference to the information provided in Figures 1 and 2, explain why human genetic diversity in Africa is higher than the rest of the world.

5

Fig 1: The Map shows that the highest genetic diversity within humans is within the African continent. Figure 2 indicates that Africa also has the oldest origin of people. Inhabitation of humans, 200,000 yrs. Based on this information and the suggestion that a small group of approx 1000 individuals migrated from Africa to Asia and Europe, it can be inferred that this group did not contain the variety of alleles found throughout and instead, the group only contained a select few. This is called the founder effect, where the 'founding group' had a select few alleles that were ~~not~~ increased in the population. Then created a whole new population with only these alleles. This, the two maps give evidence towards the idea that Africa was the original population, containing the most diversity. ✓

End of Question 30

Marker's comments:

Some general thoughts after reading the question.

Describe processes - Founder effect/Bottle neck. Migration – link to the impact on allele frequency. Clear reference to the stimulus.

General comments

Many responses spent too much space re-writing the question.

Some answers were very difficult to read and therefore difficult to give marks.

Some responses mis-interpreted the numbers in Figure 2 – as numbers of Homo sapiens, as opposed to Years Before Present.

Homo sapiens – if students could write the genus and species with a capitalised genus and a lower-case species name and underlined, (to replace italics) this would give you some provide some good cred in the eyes of the marker. There were many responses that wrote homo sapiens, along with any number of misspellings. Frustrating for the Biological Purist searching for perfection in an answer!

Responses had to refer to information in Figures 1 and 2 - generally well done.

Figure 1 shows that the population in Africa has the highest genetic diversity. The rest of the world has a lower genetic diversity.

Figure 2 shows that the population in Africa has been there since 200,000 years before present. 100,000 years before present, there was a migration out of Africa. The information provided suggests that this was just 1000 individuals.

This is an example of a Founder or Bottleneck Effect. Subsequent populations derived from this will have a loss of genetic variation, as shown in Figure 1.

Mark distribution

Marks	5	4	3	2	1	0
% in cohort	17	16	27	19	17	4

Question 31 (4 marks)

Beehives can house up to 40 000 honey bees. Most of these bees are female worker bees. There is only one queen bee. She is a diploid female ($2n = 32$) and she is the bee that lays the eggs for the colony. The queen lays two types of eggs:

1. Fertilised eggs that produce females that become either worker bees or other queen bees.
2. Unfertilised eggs that produce male drone bees.

a. Use the information provided to complete the table (1 mark)

Type of bee	Number of chromosomes
Female worker bee	
Male drone bee	

Marking criteria:

Criteria	Marks
Correctly states the number of chromosomes in both parts of the table	1

Sample answer:

Female – 32

Male – 16

Marker's comments:

As per answers. Generally well done by students.

- b. Explain why there is genetic variation between male drone bees, even though they are produced from fertilised eggs. (3 marks)

Marking criteria:

Criteria	Marks
Describes a process that causes genetic variation and provides a clear link to relate this to variation in male bees	3
Sketches in general terms how a biological process causes genetic variation	2
Identifies a biological process that causes genetic variation	1

Sample answer:

- (b) Explain why there is ^{unfertilised?} genetic variation between male drone bees, even though they are produced from fertilised eggs.

Gametes are produced by meiosis. Meiosis ^{contributes to} introduces genetic variation through crossing over and independent assortment. Crossing over refers to ^{each} the arms of homologous chromosomes crossing over with the arms of another homologous chromosome and exchanging DNA. This contributes to genetic variation as ^{new allele combinations are} ~~offspring can have new~~ ~~allele combinations~~ introduced into the gene pool. Furthermore, independent assortment refers to when homologous chromosomes line up on the equator of the cell, independently of each other. This further contributes to genetic variation as new allele combinations are created and introduced into the gene pool. Finally, variation can also be introduced via mutations. **Excellent!**

Students were required to describe events in the context of the question that produce genotypic variation, such as:

- eggs are produced by meiosis
- mutation produces new alleles
- crossing over mixes the alleles of linked genes.

Marker's comments:

To gain full marks in this question students needed to identify an event/process that causes genetic variation, briefly describe this process AND explain how this process produces variation. E.g crossing over in meiosis. Adjacent chromatids in homologous chromosomes cross over each other, break where they touch and recombine on opposite chromatids. This process produces new combinations of alleles leading to greater variation. Simply identifying processes only received 1 mark as per marking criteria

Question 32 (8 marks)

Estimates of the rate at which DNA is damaged during replication and other stages in the cell cycle range from 10,000 to 30,000 times per day. The damage is usually repaired by a variety of DNA repair mechanisms so that cell function is maintained. If the rate of repair cannot keep up with the rate of damage, a permanent mutation will result.

With reference to the information above, assess the importance of accuracy in mitosis and DNA replication in the maintenance of cell function and the continuity of species. (8 marks)

Marking criteria:

Criteria	Marks
Describes with examples the importance of mitosis and DNA replication see text book pages 79-81 of textbook. Relates this to cell function and continuity of species Describes the processes – mitosis and DNA replication Demonstrates a clear understanding of the terms cell function and continuity of species Explains mutations lead to inaccuracies in polypeptide synthesis and how this affects cell function and continuity of species Reference to the stimulus	7-8
Addresses all of above except for one or in minimal detail	5-6
Addresses a number of above, some missing, poor detail	3-4
Does not really address the question, misses most of above, but some reasonable descriptions	2
Describes one feature relevant to the question	1
Has not dealt with the question or provided relevant information	0

Sample answer:

Here is an example of how the question should have been answered:

Mitosis allows genetic information to be passed from generation to generation through the production of identical daughter cells. It must occur accurately so that new cells have the same chromosome number and genetic makeup as the parent cells. Mitosis is important in the growth of multicellular organisms from embryo to adult as all cells need to work together and perform specific tasks. Mitosis is important for the repair of damaged tissue and replacement of worn out cells. Accurate mitosis ensures replacement of cells like for like. Other examples could be genetic stability and asexual reproduction.

Accurate DNA replication ensures the production of the correct proteins and enzymes to ensure an organism functions properly and can reproduce. Correct enzymes ensure correct cell metabolism.

Brief descriptions of mitosis and DNA replication (nor simply naming stages) e.g descriptions of unwinding, unzipping, free nucleotides bonding AND; chromosomes line up at centre of cell, divide at centromere, one half of each chromosome moves to either side of cell. Daughter cells contain identical information to parent cell.

Definition of mutation. Reference to stimulus in some way.

Discussion of how mutations can alter polypeptide production by producing a different polypeptide which produces a different protein which will then have a different function or no function. This could lead to death

of organism which then affects continuity of species. Or if an enzyme is not produced a chemical reaction doesn't take place and cell function is affected.

Marker's comments:

Most students seemed to think the question was asking about mutations and different types of mutations. As a result they missed the point of the question. Many students also spent a lot of time restating the question and did not offer any analysis.

The question was asking about mitosis and DNA Replication. Students had to say why these 2 processes were important and relate them to cell function and continuity of species.

Simple descriptions of the processes were required.

There needed to be reference to the stimulus about mutations and then a discussion of how mutations can affect cell function and continuity of species

Question 33 (11 marks)

Bt cotton is a genetically modified cotton that has had a gene inserted from *Bacillus thuringiensis* bacteria. A student wanted to investigate the effect Bt cotton had on soil biodiversity when grown in farms in Australia. Using research, the student found that Bt toxin was released into the soil when Bt cotton was grown. The student designed an investigation to test the effect of Bt cotton plants on soil biodiversity. Soil biodiversity was measured using the number and type of bacteria and fungi in the soil.

a) Complete the table for the investigation described. (3 marks)

Independent variable	
Dependent variable	
Experimental control	

Marking criteria:

Criteria	Marks
Accurately completes three cells in the table	3
Satisfactorily completes two cells in the table	2

CSatisfactorily completes one cell in the table	1
---	---

Sample answer

- (a) Complete the table for the investigation described.

3

Independent variable	Cotton crop (Bt vs normal)
Dependent variable	Soil biodiversity
Experimental control	normal cotton crop.

Marker's comments: (VPT)

A spread of marks across the cohort. You have to be careful when stating the variables/control and be SPECIFIC. It is not enough to write 'Bt cotton' for the IV. What about it? The colour? The size? In this case it was presence/absence of Bt cotton/toxin. Many students got an experimental control confused with a controlled variable.

- b) Describe a method that the student can use to ensure the experimental design is valid (4 marks)

Marking criteria:

Criteria	Marks
Provides a thorough method that includes: appropriate detail, clear independent and dependent variable, controlled variables, logical steps, consistent use of tense, method clearly tests that aim of the investigation, includes suitable equipment	4
Provides a relevant method with 1 -2 errors	3
Provides a relevant method with 3 -4 errors	2
Attempts a method with some relevant information	1

Sample answer:

(b) Describe a method that the student can use to ensure the experimental design is valid.

4

LS ✓
T ✓

1. 12 plant pots are filled with 200g of soil. - same? CV?
2. 3 pots are labelled 'control'. 3 other pots are labelled '4 seeds', 3 other pots are labelled '8 seeds' and the last 3 are labelled '12 seeds'
3. 4 regular cotton IV seeds are placed into the pots each pot labelled 'control'
4. 4 BT cotton seeds are placed into each pot labelled '4 seeds', 8 BT cotton seeds into the pots labelled '8 seeds' and 12 BT cotton seeds in the pots labelled '12 seeds'
5. The plants are then watered every 3 days for 4 weeks. CV.
6. After the 4th week soil from each pot labelled control was put under a microscope and the amount of bacteria and fungi was recorded in a table and averaged.
Question 33 continues on page 38 DV
7. Step 6 was repeated for each subsequent group of pots.

Marker's comments: (VPT)

Overall, students need to take care to ensure methods are VALID. Some students discussed repeating the experiment to make it valid. Repetition improves reliability. Some did not make the IV clear, so it was therefore hard to deem their method valid. I was looking for at least 2 controlled variables. Again these needed to be clear. 'Same conditions' is too vague. Better=Same type of soil, same amount of water etc

Tip: when writing your method, indicate what your IV, DV and CV are by stating this after you have named them. It makes it easier on the marker to find this information and if they are debating if to award a mark, it may tip in your favour. I didn't mark down for methods that we're not written in point/numbered form, if the method was logical. Once again, it is best to write in point form.

I used: IV to indicate where I found your independent variable

DV for dependent variable

CV for controlled variables

LS for logical sequence

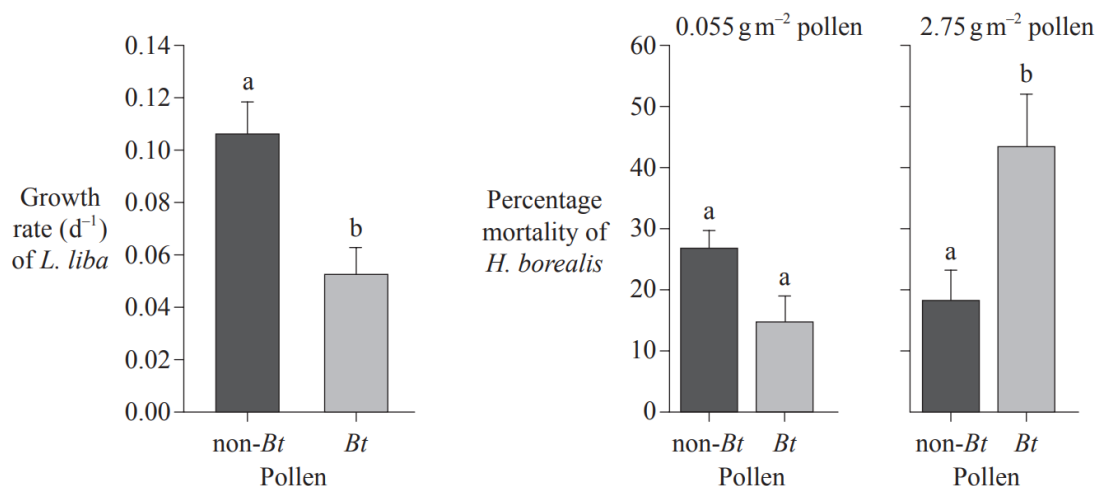
T for correct tense

- c. A different genetically modified organism used in agriculture is Bt corn. Pollen from these corn crops can accumulate in fresh water streams. *Lepidostoma liba* is a caddis fly larvae that feeds on this pollen. *Helicopsyche borealis* is an adult caddis fly that feeds on algae that contain pollen from the cotton.

Experiments were conducted to determine if *L. liba* and *H. borealis* were impacted by feeding on pollen debris in streams. The following measurements were taken:

- The growth of this larvae was measured after feeding on Bt and non-Bt pollen.
- The mortality rate of *H. borealis* was measured after it had eaten Bt and non-Bt pollen.

The bar charts show the impacts on both species of caddis fly, when tested with two concentrations of pollen. One concentration (0.055g m^{-2}) was based on the maximum amount of pollen found in streams. The other concentration was 50 times higher than this amount.



[Source: adapted from Rosi-Marshall, *et al.*, (2007), *Proceedings of the National Academy of Sciences*, **104**, pages 16204–16208. Copyright (2007) National Academy of Sciences, U.S.A.]

Using data in the bar charts, evaluate the effects of Bt corn pollen on both species of caddis fly (4 marks)

Marking criteria:

Criteria	Marks
Includes specific reference to all three bar charts Uses the data to make a clear judgement regarding the impact of pollen on both caddis flies.	4
Includes specific reference to most bar charts Uses the data to make a judgement regarding the impact of pollen on both caddis flies.	3

Attempts a judgement supported by some data	2
Identifies a relevant trend in the data	1

Sample answer:

L. liba ①

The L. liba caddisfly larvae feed on pollen from Bt corn crops. This significantly lowers these larvae's growth rate. Flies feeding on Bt corn only ~~reach~~ grow at a rate of about 0.05 d^{-1} compared to those feeding on non-Bt corn who grow at a rate of about 0.10 d^{-1} . Therefore, Bt corn pollen significantly negatively impacts the L. liba caddis fly as their growth rates are lowered as larvae, which could impact their function in the longer term.

H. borealis

The H. borealis adult caddis flies feed on algae containing Bt corn pollen. ~~At the maximum concentration found in stream,~~ this fly's mortality rate is higher ~~for non-Bt~~ ^{End of Paper} pollen at about 25% compared to Bt pollen at about 15%. Thus, at concentrations consumed in the water stream, these flies are benefitted because there is a lower mortality rate in consuming Bt pollen leading to less deaths. However, at a concentration 50 times higher (2.75 g m^{-2}), Bt corn pollen consumption leads to significantly higher death rates at over 80% compared to about 18% of non-Bt.

Therefore, in this situation considering the concentration of Bt pollen in the stream, L. liba larvae are negatively impacted by Bt corn pollen where as H. borealis are positively impacted due to lower mortality rates.

Marker's comments: (VPT)

Broad spread of marks. Overall, this question was done OK.

My marking abbreviations:

J: evaluation

D: data

1/2/3: graph reference

Many answers were set out quite well and logical, so it was easy to follow the evaluation. Make sure your evaluations are clear. When a question asks you to use data, it's best to use data straight from the stimulus (that is what it is there for). Some people were giving me their own calculations and in some cases I couldn't work out where they came from. Take values from the graphs themselves. Some students lost marks as their values did not seem to correspond with the graphs. If your calculations were clear, I still may have awarded you the mark but wrote on your paper to take care in the HSC.

End of Section II