

NORTH SYDNEY GIRLS HIGH SCHOOL



2021

Higher School Certificate

Practice HSC Examination

Biology

Total Marks – 100

General Instructions

- Reading Time – 5 minutes
- Working Time – 3 hours
- Write using blue or black pen
- Draw diagrams using pencil
- Calculators approved by NESA may be used
- Write your student number at the top of your multiple choice answer sheet AND Sections 2 and 3

Section I

20 Marks

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

Sections 2 and 3

80 Marks

- Attempt question 21 – 32
- Allow about 2 hours and 25 minutes for this part

Section 1

20 marks

Attempt Questions 1-20

Allow about 35 minutes for this part

Use the multiple-choice answer sheet provided for Questions 1-20. If you must use blank paper instead, clearly indicate an answer of EITHER A, B, C or D for each question from 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.

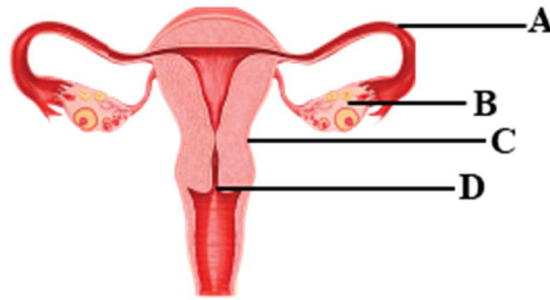
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A ☒ B ☒ C ☐ D ☐

correct →

1. The diagram below shows a female human reproductive system. Where would the corpus luteum be found?



- A. A
 - B. B
 - C. C
 - D. D
2. In humans, active immunity includes:
- A. the production of antibodies by T cells.
 - B. prevention of infection with the use of physical barriers such as skin and mucous membranes.
 - C. activation of the inflammatory response.
 - D. activation of B cells by helper T cells.
3. Two heterozygous parents are bred together to produce offspring. What percentage of the offspring would be heterozygous?
- A. 25%
 - B. 50%
 - C. 75%
 - D. 100%

4. Which of the following correctly identifies a part of the human eye and its function?

- A. The lens focuses incoming light so that an image falls on the optic nerve.
- B. The ciliary muscles contract or relax to modify the shape of the lens.
- C. The sclera detects incoming light energy and converts it to an electrical potential.
- D. The pupil protects the interior of the eye from damage from dust, scratches, or similar.

5. Which of the following statements about proteins is true?

- A. Proteins are composed of long chains of nitrogenous bases.
- B. Proteins contain phosphodiester bonds.
- C. Proteins provide structure and support for cells.
- D. Proteins are synthesized by RNA polymerase.

6. Which of the following best identifies the reproductive methods available to the organisms listed?

- A. Fungi reproduce through budding or spores.
- B. Plants reproduce through vegetative propagation.
- C. Bacteria reproduce through sexual or asexual reproduction.
- D. Protists reproduce through spores.

7. The DNA that exists in prokaryotic cells is:

- A. linear and double-stranded.
- B. circular and double-stranded.
- C. linear and single-stranded.
- D. circular and single-stranded.

8. Colour-blindness is an inherited disease. The Punnett square shows the F1 generation of offspring of a woman who is colour blind and a man with unaffected vision.

	X^B	Y
X^b	$X^B X^b$	$X^b Y$
X^b	$X^B X^b$	$X^b Y$

KEY

X^B = unaffected vision

X^b = colour blind

Which of the following conclusions can be drawn from the Punnett square?

- A. Any male offspring have a 50% chance of being colour blind.
- B. Colour-blindness is a dominant trait.
- C. Any female offspring have a 100% chance of being carriers for the condition.
- D. Any female offspring have a 100% chance of being colour blind.

9. In 1970, the most common type of corn grown in the USA was a variety known as TCMS corn. Around this time, the rapid spread of the fungus *Bipolaris maydis* led to almost 100% of corn crops in some states being wiped out. The economic losses totalled approximately 1 billion USD. Farmers attempting to recover from the disaster found that other corn varieties were able to be cultivated in previously infected fields.

The most significant biological factor contributing to the disaster was probably:

- A. genetic drift.
- B. artificial pollination.
- C. a lack of biodiversity.
- D. gene cloning.

10. Which cells are likely to be found in abundance in the lymph nodes?

- A. Muscle cells
- B. Red blood cells
- C. Macrophages
- D. Neurons

11. Which of the following describes a physiological adaptation to regulate internal body temperature?

- A. A kangaroo licks its paws to stimulate evaporative cooling.
- B. Fairy penguin chicks huddle in a group to conserve body heat.
- C. Blood vessels close to the skin dilate in hot temperatures.
- D. Polar bears possess thick layers of insulating fat.

12. The following poster was used as part of a breast cancer awareness campaign.

EARLY DETECTION IS THE BEST TREATMENT.

New York State is here
to help with increased
funding and more hours for
screenings during mornings,
evenings, and weekends.

**MAKE AN APPOINTMENT
TO GET SCREENED TODAY.**

What is the most effective way to assess the impact of this campaign?

- A. Compare data on the incidence of breast cancer before and after the campaign.
- B. Compare the number of women being screened for breast cancer before and after the campaign.
- C. Survey women in the population to find out their attitudes towards breast cancer.
- D. Compare the mortality rate of women before and after the campaign.

13. What is the difference between co-dominance and incomplete dominance?

	<i>Co-dominance</i>	<i>Incomplete dominance</i>
A.	Both traits appear in the phenotype	Neither trait appears in the phenotype
B.	The dominant allele partially masks the recessive allele	Neither allele blocks the expression of the other allele
C.	An intermediate phenotype occurs	An alternating phenotype occurs
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14. *Echeveria elegans* is a species of succulent whose leaves are coated with a wax which makes the plant's fleshy leaves appear to gleam in the sun.



Which of the following best explains how this wax coating helps the plants to maintain water balance?

- A. It increases transpiration from the leaves.
- B. It increases the water absorbed by the plant.
- C. It causes rain water to pool on the leaves.
- D. It reflects sunlight.

15. Some students were removing the epidermis from a leaf as part of a school experiment. One student spilled sap from inside the leaf onto their hand, which resulted in redness and swelling.

What mechanism in the plant could explain the development of the rash?

- A. Adaptive immunity
- B. Vasodilation
- C. Inflammation
- D. Innate immunity

16. Identify the INCORRECT statement from the list below.

- A. PAMPs stands for pathogen-associated molecular patterns
- B. Intracellular pathogens replicate in the interstitial fluid that bathes tissues
- C. The innate and adaptive immune responses can occur simultaneously
- D. Inflammation and phagocytosis are two elements of the innate immune response

17. Tahlia was vaccinated against measles just after her son Alex's birth. Specific antibodies that attack measles are transferred to Alex via Tahlia's breastmilk. When exposed to the measles virus, these antibodies prevent Alex from becoming ill. Which type of human defence to disease is responsible for Alex's immunity to measles?

- A. Physical barrier
- B. Chemical barrier
- C. Innate immune response
- D. Adaptive immune response

18. The following information refers to three different non-infectious diseases.

Duchenne muscular dystrophy is a rare X-linked condition characterised by progressive muscular degeneration and weakness.

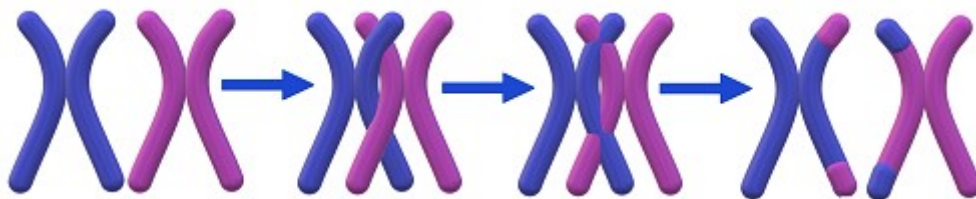
Keshan disease is a reversible form of congestive heart failure. It is caused by a lack of the element selenium in the body.

Arsenicosis is a condition that occurs due to exposure to high levels of arsenic. It can occur in people whose workplaces, homes or groundwater have been contaminated with industrial arsenic.

Which of the following shows the correct classification of these diseases?

	<i>Duchenne muscular dystrophy</i>	<i>Keshan disease</i>	<i>Arsenicosis</i>
A.	Nutritional	Environmental	Genetic
B.	Genetic	Nutritional	Environmental
C.	Genetic	Environmental	Environmental
D.	Environmental	Genetic	Nutritional

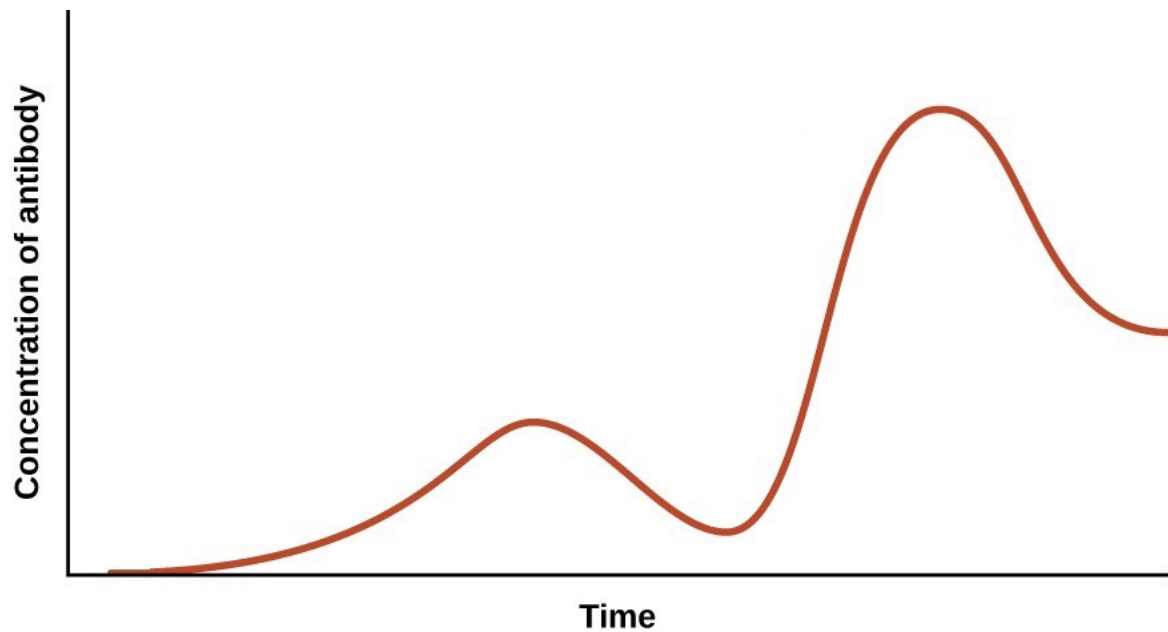
19. The diagram below shows a process that occurs during cell division.



Which of the following is correct?

	<i>Type of division</i>	<i>Outcome for offspring</i>
A.	Meiosis	Greater variety of possible alleles
B.	Meiosis	Greater variety of possible genotypes
C.	Mitosis	Greater variety of possible alleles
D.	Mitosis	Greater variety of possible genotypes

20. The graph below shows the changing concentration of an antibody in a patient's blood.



Which of the below correctly accounts for a component of the graph?

- A. T-cell activity is stimulated by inoculation with a vaccine.
- B. Passive immunity occurs more slowly than active immunity.
- C. Antigen-presenting cells exist in higher concentrations following secondary exposure to a pathogen.
- D. Existing memory B-cells rapidly proliferate to produce plasma cells.

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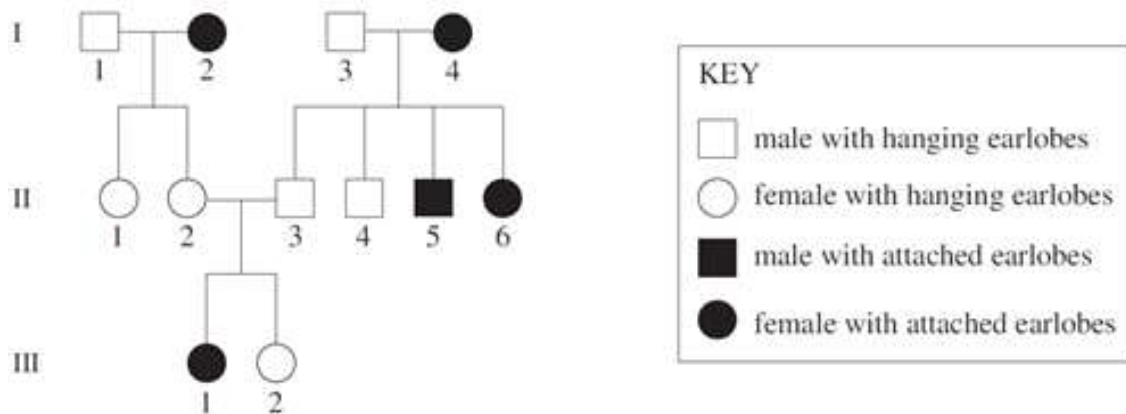
Student Number

Section 2

Answer the questions in the space provided. Show all relevant working.

Question 21 (4 marks)

The possession of one of two types of earlobes (hanging or attached) is sometimes used to study the inheritance of characteristics in humans. The pedigree shows the different types of earlobes present in three generations.



a) Identify the pattern of inheritance shown in the pedigree and justify your answer.

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b) Identify the genotype of III-1.

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Question 22 (6 marks)

Hearing disorders occur when the normal function of the ear is disrupted or impaired.

Technology can assist people who live with hearing disorders.

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[illegible]

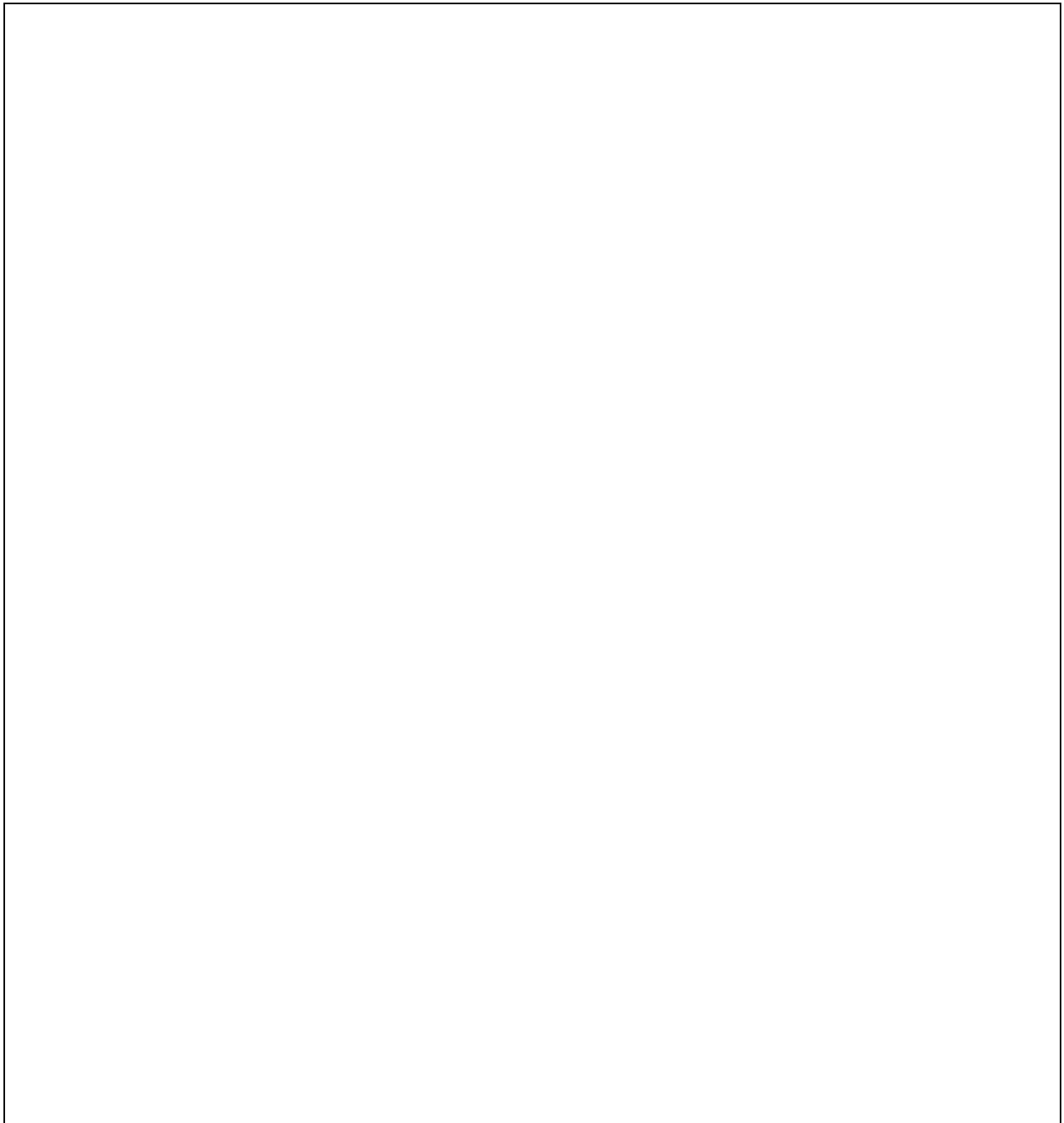
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[illegible]

Question 23 (6 marks)

Two students choose different activities to complete over 15 minutes. Student A eats an ice cream while Student B goes for a run. Afterwards, the students wondered how the two activities would affect their blood glucose levels.

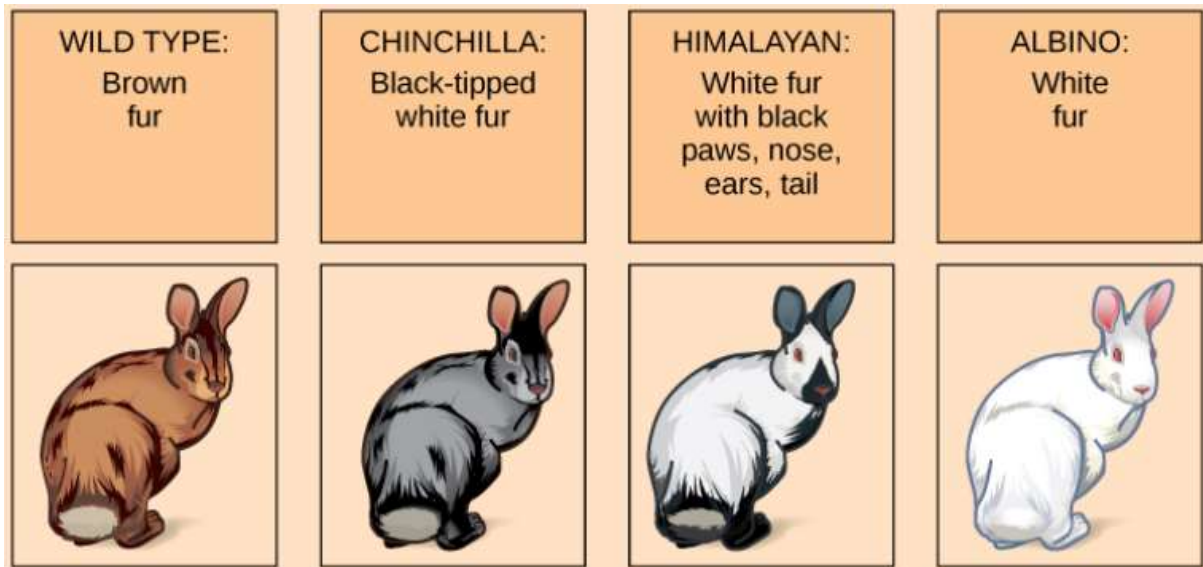
Draw a labelled flow chart or diagram to show the changes that take place in both Student A and Student B in response to their activities, including any changes in hormone levels and the role of named internal organs.

A large empty rectangular box with a thin black border, intended for the student to draw a flow chart or diagram showing the physiological responses to the activities of Student A and Student B.

Question 24 (8 marks)

Coat colour in rabbits is a monogenic trait controlled by multiple alleles. The diagram below shows the fur colour of purebred brown, chinchilla, Himalayan and albino rabbits.

The wild-type allele, B , is expressed as brown fur. The chinchilla allele, b^{ch} , is expressed as black-tipped white fur. The Himalayan allele, b^h , is expressed as black fur on the ears, feet and nose, with white fur elsewhere. Finally, the albino allele, b , is expressed as white fur. Brown fur is dominant over the chinchilla, Himalayan and albino fur colours. Chinchilla is incompletely dominant over Himalayan and albino, and Himalayan is dominant over albino.



- a) Explain how it is possible for two brown rabbits to produce albino offspring.

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- QUESTION 24 CONTINUES ON THE NEXT PAGE -

- b) A heterozygous Himalayan rabbit was crossed with a chinchilla rabbit. Use a Punnett square to determine the possible genotypes of the offspring and calculate the percentage of the offspring that can be expected to possess each genotype. 3

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- c) A breeder found that a chinchilla rabbit from his stock gave birth to a baby rabbit with light grey fur. Suggest how this might have occurred and justify your answer. 3

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END OF SECTION 2

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Student Number

Section 3

Answer the questions in the space provided. Show all relevant working.

Question 25 (9 marks)

Glucose-6-phosphate dehydrogenase deficiency (G6PDD) is a genetic disorder that occurs almost exclusively in males. This condition mainly affects red blood cells, which carry oxygen from the lungs to tissues throughout the body. In affected individuals, a defect in an enzyme causes red blood cells to break down prematurely.

Raymond comes from a family that has no record of G6PDD. Raymond is married to Cindy. Cindy has a brother called Dominic who is affected by G6PDD, as well as another brother, Harry, who is not affected by the condition. Their sister, Jillian, has had genetic testing completed and knows that she does not possess an affected allele. Cindy's father, Jack, is not affected by G6PDD but her mother, Fiona, is a carrier of the condition. Raymond and Cindy have recently had a son who they named Victor.

- a) State the genotypes for Dominic, Harry, Jillian and Fiona.

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- b) Construct a pedigree to show the occurrence of G6PDD in the family. Include a key.

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[illegible]

Question 26 (5 marks)

A sequence of DNA from the template strand of a particular gene is shown below.

TAC GGA TCT **AGA ATA AAA** CGG AAT GCT GGG **ACA CGG** GTA ACT

- a) The highlighted sections of DNA are introns. What do the other sections represent? **1**

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- b) Determine the sequence of the mature mRNA that would be produced from the above gene. **2**

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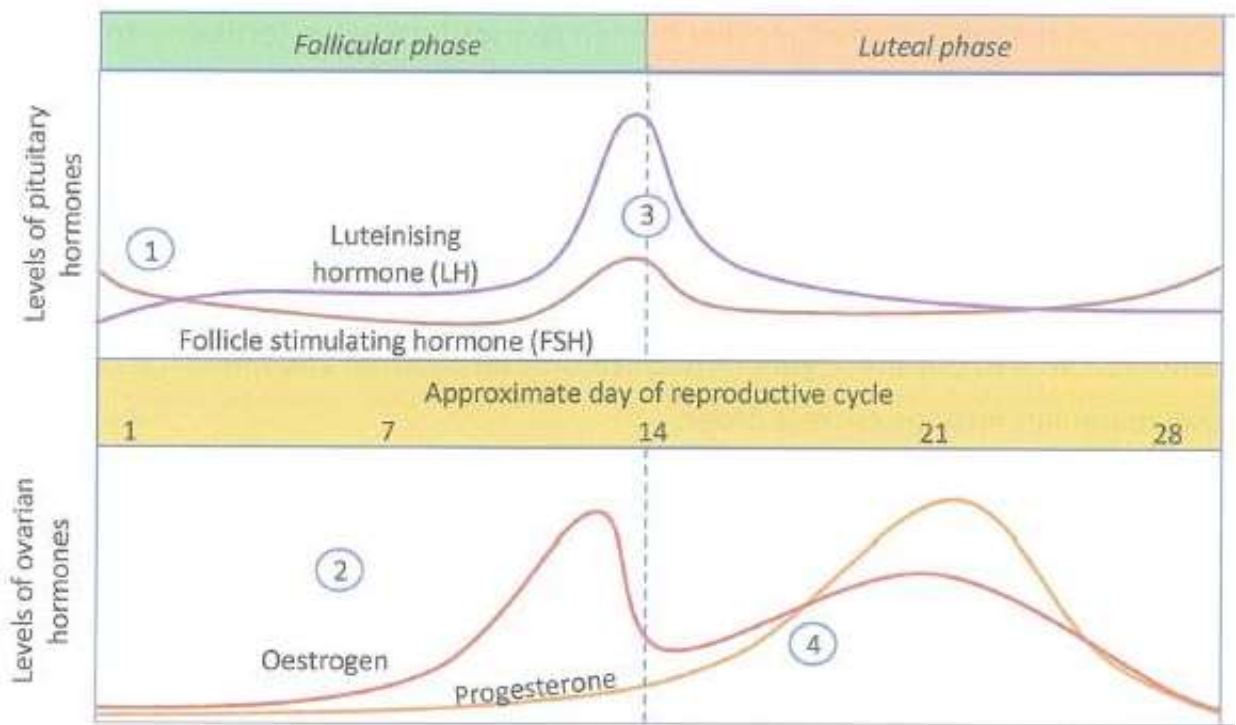
- c) Using the below mRNA codon table, state the sequence of amino acids that would be produced. **2**

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

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Question 27 (9 marks)

The diagram below shows the levels of pituitary and ovarian hormones present in the blood and different stages of the menstrual cycle.



a) At what approximate day of the reproductive cycle does ovulation occur?

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b) Explain the role of ONE hormone in bringing about ovulation. Include reference to the shape of the graph.

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- c) If an egg is fertilised following ovulation, high progesterone and oestrogen levels must be maintained in order to sustain a pregnancy. Describe how these high levels are achieved with reference to TWO named structures. 3

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- d) During labour, contractions of the uterus cause the posterior pituitary gland to release oxytocin. Oxytocin stimulates more uterine and muscle contractions to push the baby through the birth canal. 2

Explain why this mechanism is considered an example of a positive feedback loop.

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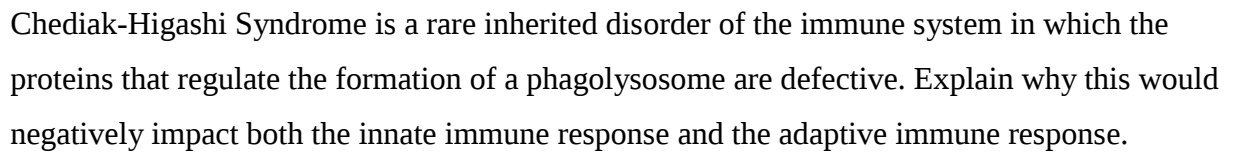
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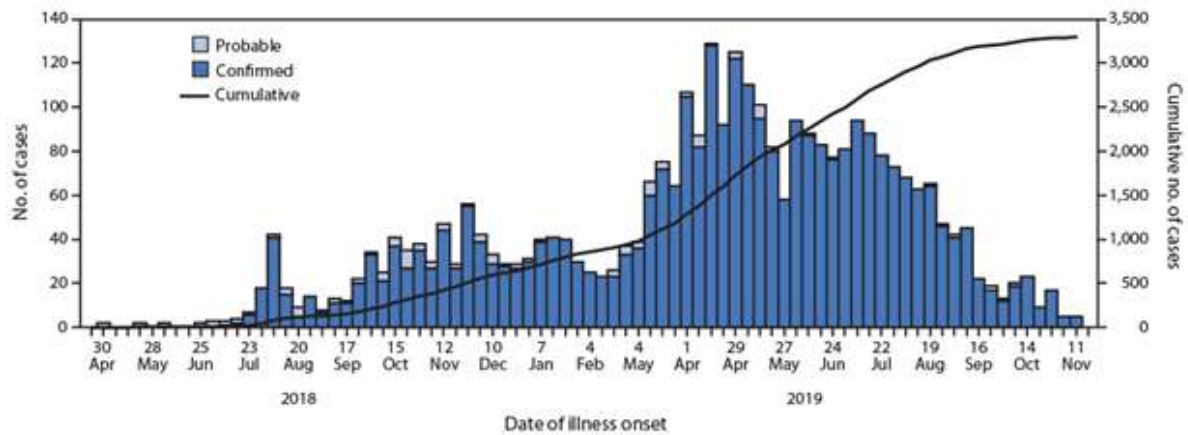
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The diagram below shows the process of phagocytosis.

This image shows a single sheet of white paper with ten horizontal dashed lines, typical of primary-ruled notebook paper. The lines are evenly spaced and extend across the width of the page. There are no margins, text, or other markings on the paper.

Question 29 (7 marks)

The graph below depicts cases of Ebola Virus Disease measured during an outbreak in the Democratic Republic of Congo between 2018-2019.



The World Health Organization issued the following statement regarding their measures to control the outbreak:

The public health response... for the Ebola virus disease outbreak in the provinces of North Kivu and Ituri seeks to take into account the new strategy to scale-up the response in order to interrupt the epidemic. It focuses on the following:

- 1. Detection and rapid isolation of cases;*
- 2. Intensification of rapid multidisciplinary public health actions around any confirmed case;*
- 3. Strengthening community engagement;*
- 4. Strengthening the health system and effective coordination of the activities of local and international partners.*

Public health officials struggled to effectively implement these control measures early in the outbreak due to difficulty accessing remote areas, socio-political unrest and armed conflict in the region.

a) Evaluate the effectiveness of the public health measures used to control the outbreak.

3

b) Explain how any TWO measures identified by the WHO's statement may have contributed to controlling the outbreak.

4

This image shows a full page of white paper with ten horizontal dashed lines, typical of primary school handwriting practice paper. The lines are evenly spaced and extend across the entire width of the page. There is no text or other markings on the paper.

Question 30 (4 marks)

Describe the process of DNA replication with reference to the roles of at least TWO named enzymes.

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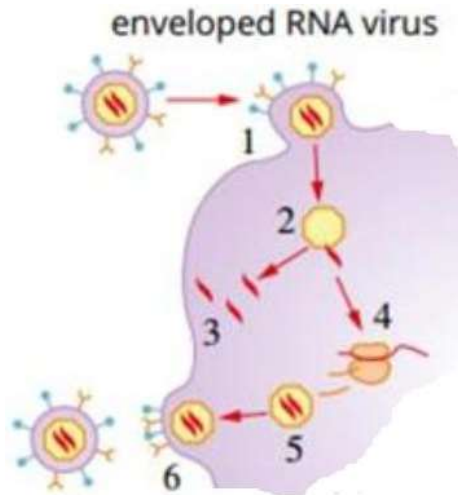
Question 31 (6 marks)

Evaluate the impact of scientific knowledge on the manipulation of plant and animal reproduction in agriculture.

This image shows a blank sheet of white paper with horizontal ruling lines. The lines are evenly spaced and extend across the width of the page. There are no margins, text, or other markings on the paper.

Question 32 (12 marks)

The diagram below represents the life cycle for an enveloped RNA virus. The host cell depicted is a human cell.



a) Describe the process shown to occur at stage 4.

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b) Assess the importance of the process in part a to this enveloped RNA virus.

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- c) The infected person received a vaccination several months earlier containing the modified antigen shown below.

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The infected person experienced only minor symptoms and recovered more quickly than expected. Using your understanding of the human immune system, explain why this occurred.

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END OF SECTION 3

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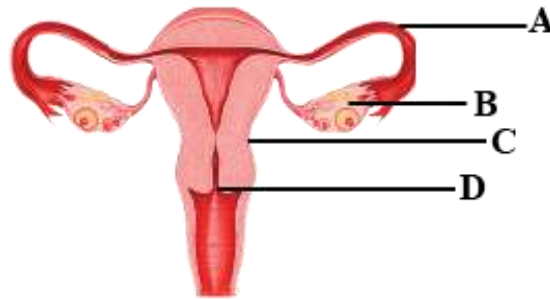
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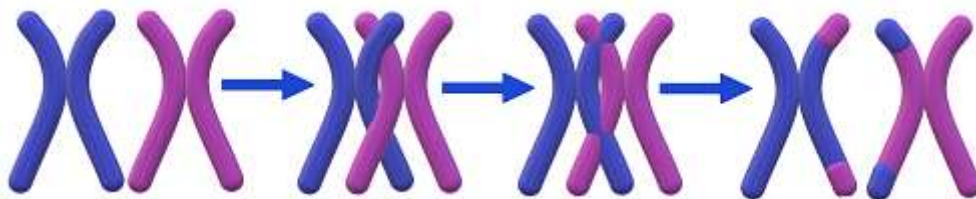
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B.	Genetic	Nutritional	Environmental
C.	Genetic	Environmental	Environmental
D.	Environmental	Genetic	Nutritional

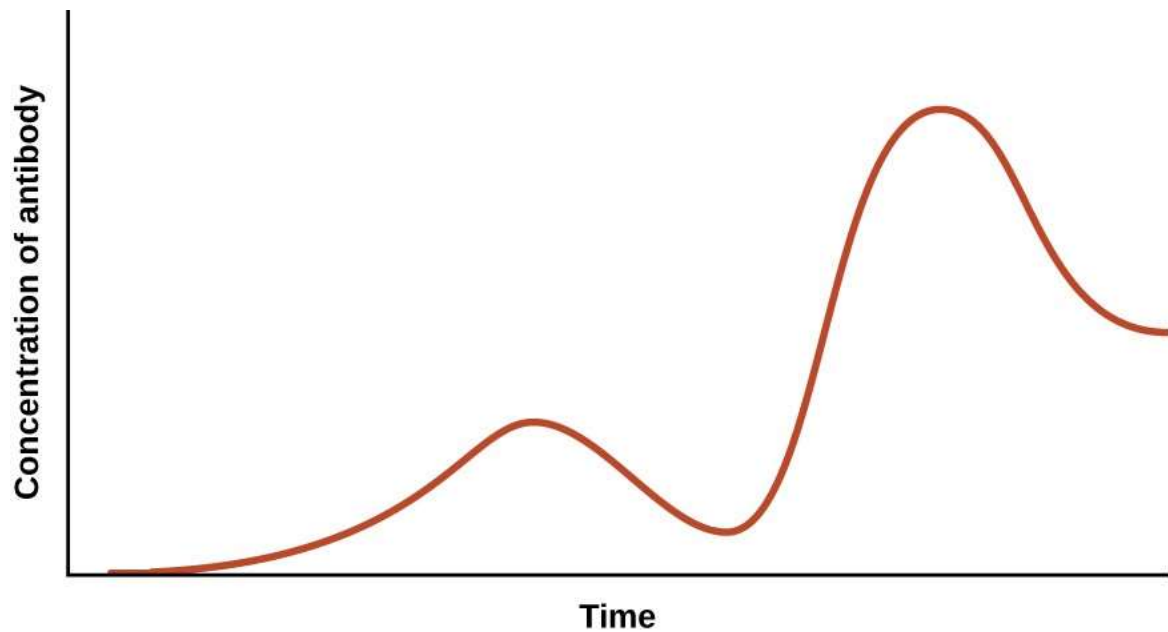
19. The diagram below shows a process that occurs during cell division.



Which of the following is correct?

	<i>Type of division</i>	<i>Outcome for offspring</i>
A.	Meiosis	Greater variety of possible alleles
B.	Meiosis	Greater variety of possible genotypes
C.	Mitosis	Greater variety of possible alleles
D.	Mitosis	Greater variety of possible genotypes

20. The graph below shows the changing concentration of an antibody in a patient's blood.



Which of the below correctly accounts for a component of the graph?

- A. T-cell activity is stimulated by inoculation with a vaccine.
- B. Passive immunity occurs more slowly than active immunity.
- C. Antigen-presenting cells exist in higher concentrations following secondary exposure to a pathogen.
- D. Existing memory B-cells rapidly proliferate to produce plasma cells.

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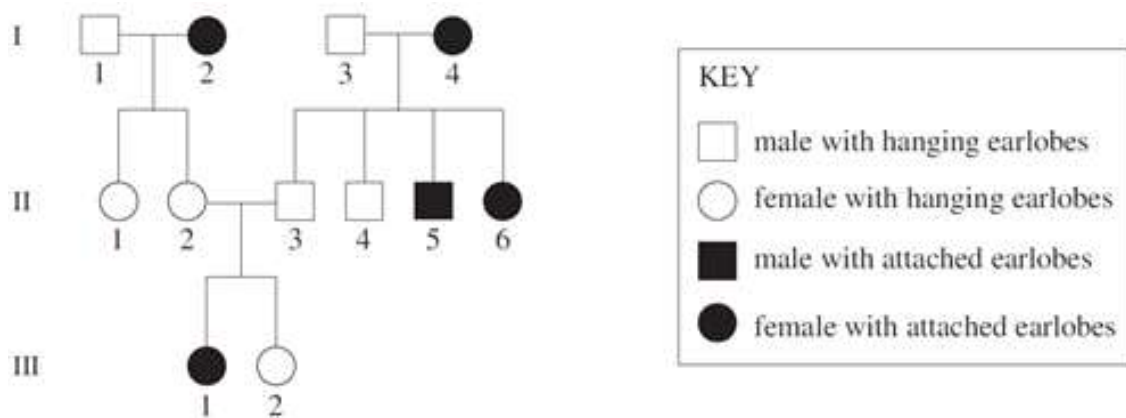
Student Number

Section II Part A

Answer the questions in the space provided. Show all relevant working for questions involving calculations.

Question 21 (4 marks)

The possession of one of two types of earlobes (hanging or attached) is sometimes used to study the inheritance of characteristics in humans. The pedigree shows the different types of earlobes present in three generations.



a) Identify the pattern of inheritance shown in the pedigree and justify your answer.

3

Identifies the inherited characteristic and relates the genetic analysis to the pedigree chart	3
Identifies one feature of the characteristic with specific reference to the pedigree chart	2
Provides some relevant information	1

E.g. Autosomal recessive. Parents do not show trait but offspring III-1 does → recessive. If X linked, all of female I-4's sons would have the trait as they would inherit her affected allele. Since not all sons have trait → autosomal recessive.

1

Question 22 (6 marks)

Hearing disorders occur when the normal function of the ear is disrupted or impaired.

Technology can assist people who live with hearing disorders.

- a) Name ONE hearing disorder and describe how the normal function of the ear is disrupted or impaired in this scenario.

3

1mk identifies hearing disorder e.g. sensorineural hearing loss

2mk describes how normal function of the ear is disrupted or impaired e.g. damage to the inner ear (or hair cells) or the nerve from the ear to the brain that is required for sound to be converted to and transmitted as electrical energy. This interferes with the nerves signals that allow the brain to interpret sound.

Better responses identified the structure damaged (1) and related this to how it impaired function (1); however, as the impaired function was targeted for part b, links to the resulting symptoms (e.g. hard to hear faint and high pitched sounds) were accepted for the 2nd mark.

Mark deduction if incorrect component of ear identified

- b) Suggest a suitable technology to assist people living with this disorder and justify its use.

3

1mk suggests a suitable technology e.g. cochlear implant

1mk describing function of the technology e.g. cochlear implant involves picking up sound vibrations and transforming them into electrical energy that stimulates the cochlea/auditory nerve thus allowing for sound to be interpreted by the brain

1mk justification that links the above to impaired function e.g. this is suitable as individuals with SNHL have a damaged cochlea/auditory nerve and are unable to transform the sound into nerve impulses efficiently.

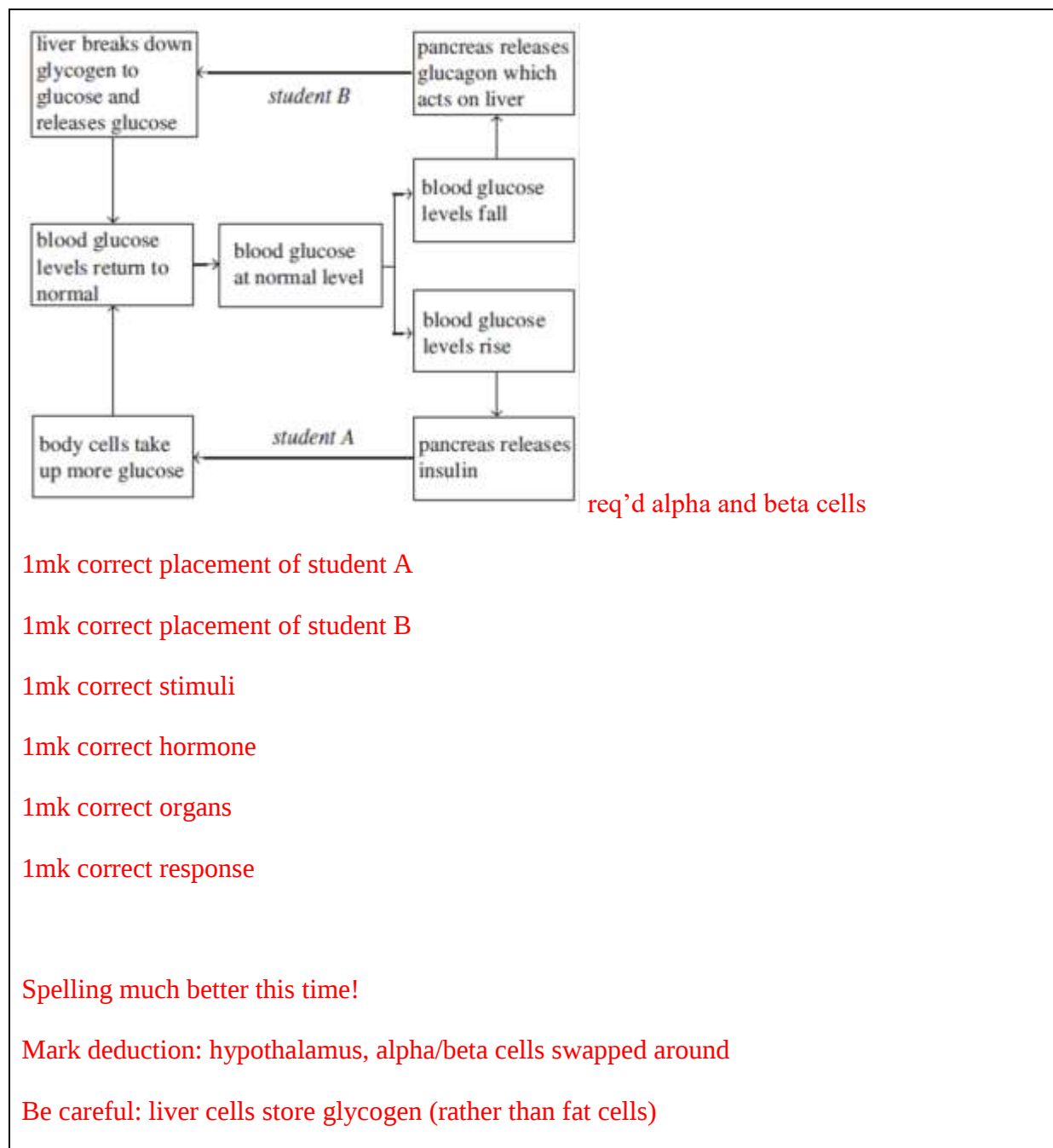
Unless you specified the below in your answer => mark deduction:

- Hearing aids are only suitable for mild SNHL cases i.e. individuals that still have some function of their inner ear
- Cochlear implants are only suitable for profound CHL cases i.e. individuals with heavily impaired outer and middle ear

Question 23 (6 marks)

Two students choose different activities to complete over 15 minutes. Student A eats an ice cream while Student B goes for a run. Afterwards, the students wondered how the two activities would affect their blood glucose levels.

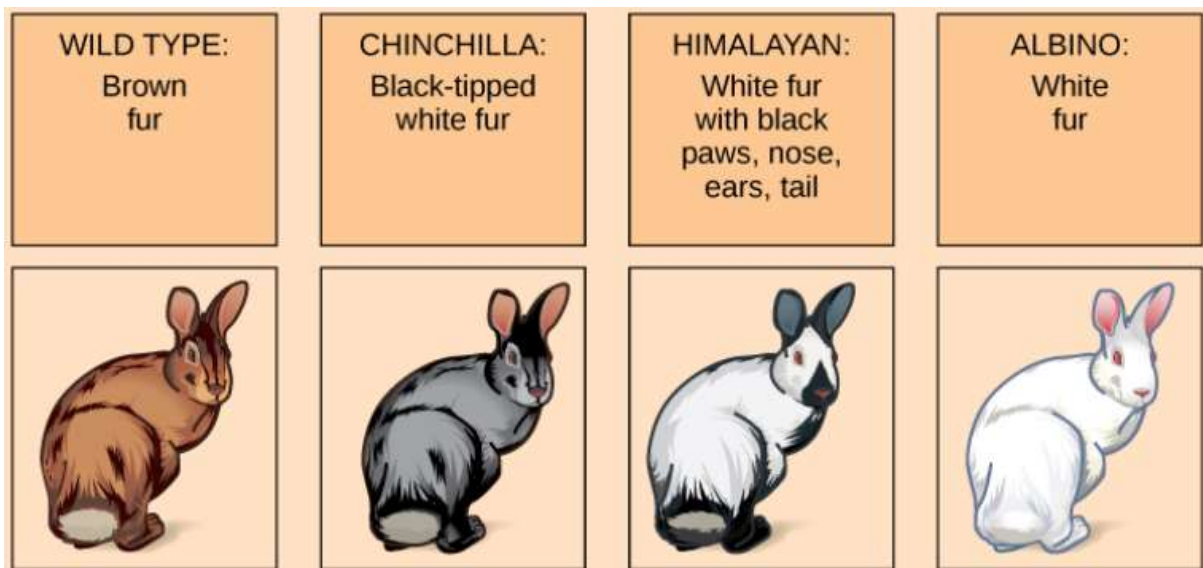
Draw a labelled flow chart or diagram to show the changes that take place in both Student A and Student B in response to their activities, including any changes in hormone levels and the role of named internal organs.



Question 24 (8 marks)

Coat colour in rabbits is a monogenic trait controlled by multiple alleles. The diagram below shows the fur colour of purebred brown, chinchilla, Himalayan and albino rabbits.

The wild-type allele, B , is expressed as brown fur. The chinchilla allele, b^{ch} , is expressed as black-tipped white fur. The Himalayan allele, b^h , is expressed as black fur on the ears, feet and nose, with white fur elsewhere. Finally, the albino allele, b , is expressed as white fur. Brown fur is dominant over the chinchilla, Himalayan and albino fur colours. Chinchilla is incompletely dominant over Himalayan and albino, and Himalayan is dominant over albino.



a) Explain how it is possible for two brown rabbits to produce albino offspring.

2

The two brown rabbits could be heterozygous i.e. $Bb \times Bb$ meaning there is 25% chance of having albino offspring i.e. bb

Must include one of the below to access full marks:

- % chance
- Punnett square
- States only if offspring inherits both recessive alleles

Incorrect terminology

- Heterozygous dominant
- Allele does not equal gene

- QUESTION 24 CONTINUES ON THE NEXT PAGE -

- b) A heterozygous Himalayan rabbit was crossed with a chinchilla rabbit. Use a Punnett square to determine the possible genotypes of the offspring and calculate the percentage of the offspring that can be expected to possess each genotype. 3

heterozygous Himalayan $b^h b$ (not $B b^h$, $b^h b^{ch}$)

chinchilla $b^{ch} b^{ch}$ (not $B b^{ch}$, $b^h b^{ch}$, $b^{ch} b^h$)

	b^h	b
b^{ch}	$b^{ch} b^h$	$b^{ch} b$
b^{ch}	$b^{ch} b^h$	$b^{ch} b$

50% $b^{ch} b^h$ and 50% $b^{ch} b$

2mk correct Punnett square

1mk percentage offspring (no mark for phenotype or ratio)

Mistake carried (m.c.) if you had incorrect genotype for one of the parents

Those that gave me multiple Punnett squares => multiple attempts => no marks

Did not need to justify why you chose the genotypes for the parents. 3

- c) A breeder found that a chinchilla rabbit from his stock gave birth to a baby rabbit with light grey fur. Suggest how this might have occurred and justify your answer.

1mk suggestion of how this might have occurred e.g. chinchilla crossed with Himalayan or albino resulting in $b^{ch} b^h$ OR $b^{ch} b$ offspring (accept mention of either one or both)

2mk justification (must talk give relevant genotype) e.g. chinchilla is incompletely dominant over Himalayan and albino (1) meaning $b^{ch} b^h$ OR $b^{ch} b$ would give rise to a blended grey phenotype (1)

While it was not required, better responses used Punnett Squares to show/justify this.

Mark deduction:

- Mixing codominance with incomplete dominance
- Heterozygous chinchilla rabbit

c) The chinchilla rabbit (i.e. genotype $b^{ch}b^{ch}$) may have been bred with a rabbit with the albino allele (i.e. genotype $Bb, b^{ch}b, b^{ch}b, bb$) to produce an offspring that is heterozygous (i.e. $b^{ch}b$). Because the chinchilla allele is incompletely dominant to the albino allele, an intermediate phenotype will be expressed (i.e. light grey fur). This is shown in the punnett squares below:

	b^{ch}	b^{ch}
B	Bb^{ch}	Bb^{ch}
b	$b^{ch}b$	$b^{ch}b$

	b^{ch}	b^{ch}
b^{ch}	$b^{ch}b^{ch}$	$b^{ch}b^{ch}$
b	$b^{ch}b$	$b^{ch}b$

	b^{ch}	b^{ch}
b^{ch}	$b^{ch}b^{ch}$	$b^{ch}b^{ch}$
b	$b^{ch}b$	$b^{ch}b$

~~$b^{ch}b^{ch}$~~

	b^{ch}	b^{ch}
b	$b^{ch}b$	$b^{ch}b$
b	$b^{ch}b$	$b^{ch}b$

Note: only had to suggest one cross.

END OF PART A

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Student Number

Section 3

Answer the questions in the space provided. Show all relevant working.

Question 25 (9 marks)

Glucose-6-phosphate dehydrogenase deficiency (G6PDD) is a genetic disorder that occurs almost exclusively in males. This condition mainly affects red blood cells, which carry oxygen from the lungs to tissues throughout the body. In affected individuals, a defect in an enzyme causes red blood cells to break down prematurely.

Raymond comes from a family that has no record of G6PDD. Raymond is married to Cindy. Cindy has a brother called Dominic who is affected by G6PDD, as well as another brother, Harry, who is not affected by the condition. Their sister, Jillian, has had genetic testing completed and knows that she does not possess an affected allele. Cindy's father, Jack, is not affected by G6PDD but her mother, Fiona, is a carrier of the condition. Raymond and Cindy have recently had a son who they named Victor.

- a) State the genotypes for Dominic, Harry, Jillian and Fiona.

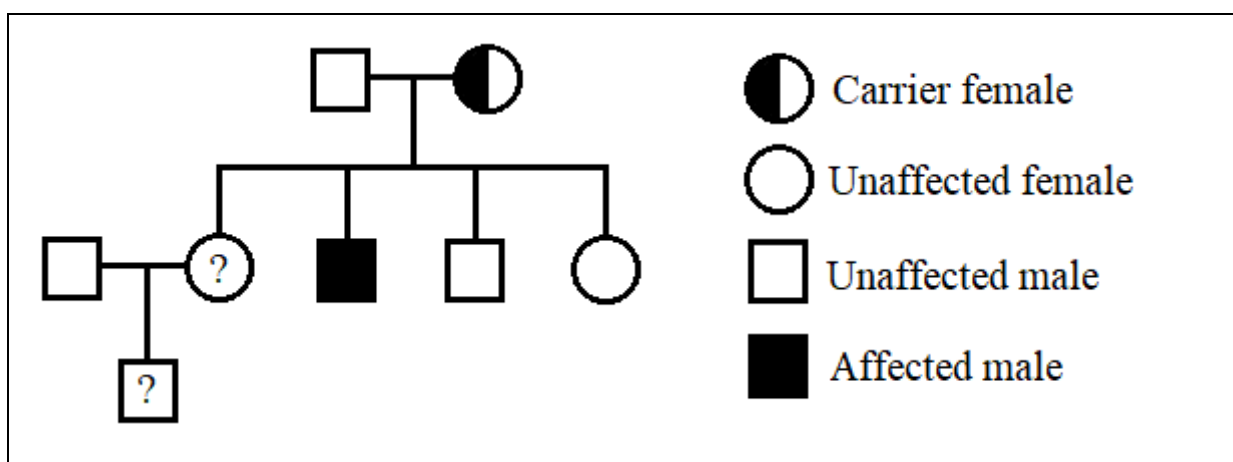
2

Dominic: X^yY Jillian: XX Minus one mark if X Y notation not used

Harry: XY Fiona: X^xX

- b) Construct a pedigree to show the occurrence of G6PDD in the family. Include a key.

3



1 mk key, 2 mks pedigree. It must be indicated that Victor's phenotype is unknown at this stage. Carriers not required to be shown.

c) Analyse the likelihood that Victor will be affected by G6PDD.

4

It is possible that Cindy is a carrier of the condition if she inherited an affected X chromosome from her mother. (1 mk) If this is the case, Victor has a 50% chance of also inheriting an affected X chromosome and being affected by G6PDD. (1 mk)

However Cindy may have inherited an unaffected X from her mother instead. (1 mk) If this is the case, there is no chance Victor will be affected with G6PDD. (1 mk)

Punnet squares not required but percentage chance must be explicitly stated.

Question 26 (5 marks)

A sequence of DNA from the template strand of a particular gene is shown below.

TAC GGA TCT **AGA ATA AAA** CGG AAT GCT GGG **ACA CGG** GTA ACT

- a) The highlighted sections of DNA are introns. What do the other sections represent? **1**

exons

- b) Determine the sequence of the mature mRNA that would be produced from the above gene. **2**

AUG CCU AGA GCC UUA CGA CCC CAU UGA (minus 1 mark per error)

- c) Using the below mRNA codon table, state the sequence of amino acids that would be produced. **2**

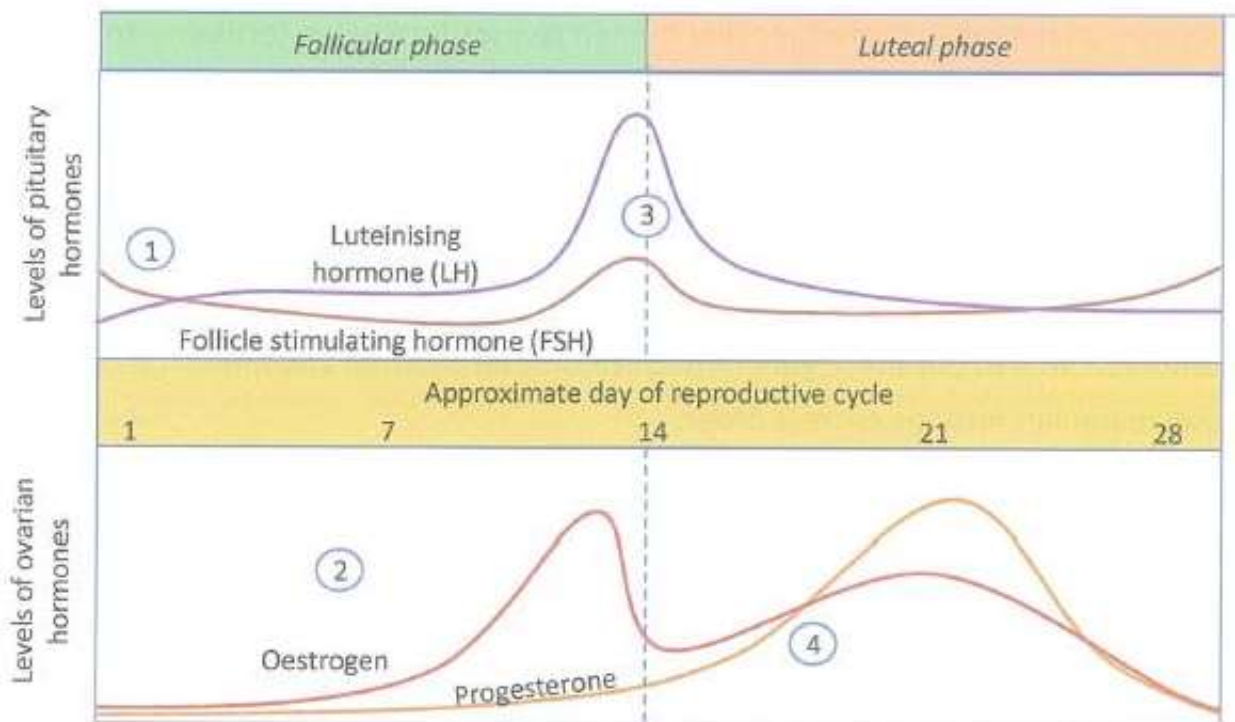
		Second letter				
		U	C	A	G	
First letter	U	UUU } Phe UUC } UUA } Leu UUG }	UCU } UCC } Ser UCA } UCG }	UAU } Tyr UAC } UAA Stop UAG Stop	UGU } Cys UGC } UGA Stop UGG Trp	U C A G
	C	CUU } CUC } Leu CUA } CUG }	CCU } CCC } Pro CCA } CCG }	CAU } His CAC } CAA } Gln CAG }	CGU } CGC } Arg CGA } CGG }	U C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

Met - Pro - Arg - Ala - Leu - Arg - Pro - His

Minus 1 mark per error (STOP is not an amino acid so this counts as an error)

Question 27 (9 marks)

The diagram below shows the levels of pituitary and ovarian hormones present in the blood and different stages of the menstrual cycle.



a) At what approximate day of the reproductive cycle does ovulation occur?

1

14 (13 also accepted)

b) Explain the role of ONE hormone in bringing about ovulation. Include reference to the shape of the graph.

3

Identify hormone (1 mk)

Reference to feature of graph (1 mk)

Link to role in ovulation (1 mk) NOT just menstrual cycle

Eg: luteinising hormone levels peak at day 13-14 of the reproductive cycle. This acute rise in LH triggers the release of the egg from the follicle.

- c) If an egg is fertilised following ovulation, high progesterone and oestrogen levels must be maintained in order to sustain a pregnancy. Describe how these high levels are achieved with reference to TWO named structures. 3

1 mk - progesterone from corpus luteum

1 mk - progesterone from placenta

1 mk - oestrogen secretion sources – must cover both pre- and post-placenta formation.

Sample answer:

Progesterone is secreted during the early stages of pregnancy by the corpus luteum, until the placenta develops later in the pregnancy. After this point, progesterone is primarily secreted by the placenta and the corpus luteum is reabsorbed. Oestrogen is secreted by the ovaries, the corpus luteum (until it breaks down) and the placenta.

- d) During labour, contractions of the uterus cause the posterior pituitary gland to release oxytocin. Oxytocin stimulates more uterine and muscle contractions to push the baby through the birth canal. 2

Explain why this mechanism is considered an example of a positive feedback loop.

1 mk - outline positive feedback loop concept

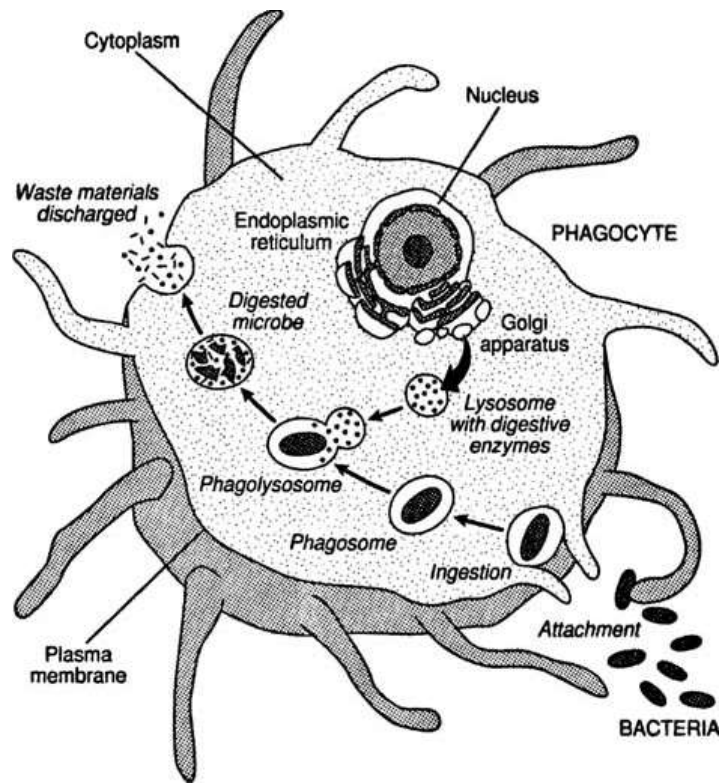
1 mk - relate to oxytocin/contraction mechanism

Sample answer:

A positive feedback loop has a response that strengthens the original stimulus. Since oxytocin release is stimulated by contractions, and the release of oxytocin causes more contractions, the response strengthens the original stimulus.

Question 28 (4 marks)

The diagram below shows the process of phagocytosis.



Chediak-Higashi Syndrome is a rare inherited disorder of the immune system in which the proteins that regulate the formation of a phagolysosome are defective. Explain why this would negatively impact both the innate immune response and the adaptive immune response.

Effect on innate response (2 mks)

Effect on adaptive response (2 mks)

NOTE: specificity required for full marks – ie ‘the adaptive response would not be activated’ is not as specific as ‘clonal selection processes that lead to proliferation of suitable T cells and B cells would not begin as quickly’.

Sample answer:

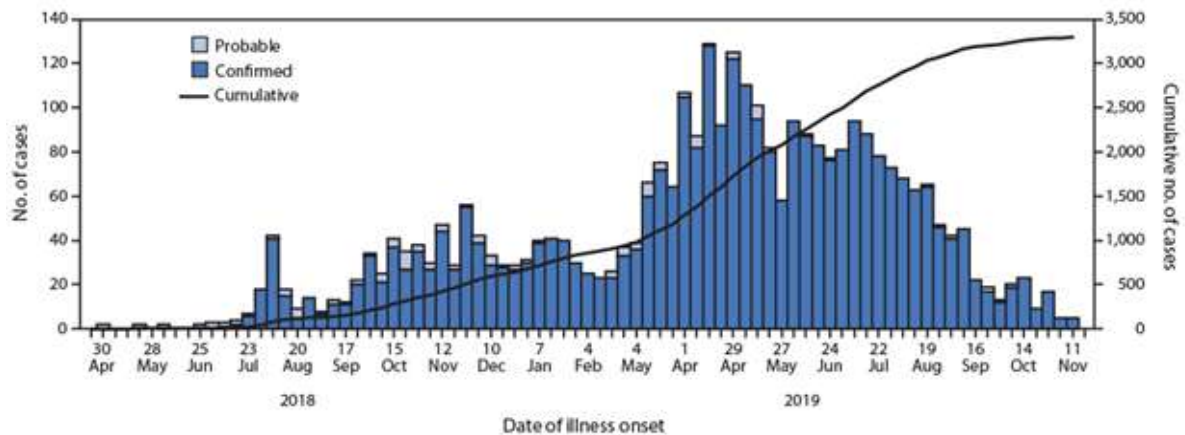
If the proteins that regulate phagolysosome function are defective, then phagocytes cannot break down microbes. Macrophages play a role in the innate immune response by responding to sites of infection and indiscriminately destroying non-self particles. They cannot perform this

role without phagolysosomes and hence the innate immune response would be limited to processes that don't require phagocytosis eg: complementary proteins, inflammation.

The adaptive immune response would also be affected because the breakdown of pathogens is necessary to allow phagocytes to function as antigen-presenting cells. Antigen presentation allows more rapid activation of clonal selection processes that lead to the proliferation of B-cells and T-cells specific to the invading pathogen. As a result the adaptive immune response would be significantly hampered.

Question 29 (7 marks)

The graph below depicts cases of Ebola Virus Disease measured during an outbreak in the Democratic Republic of Congo between 2018-2019.



The World Health Organization issued the following statement regarding their measures to control the outbreak:

The public health response... for the Ebola virus disease outbreak in the provinces of North Kivu and Ituri seeks to take into account the new strategy to scale-up the response in order to interrupt the epidemic. It focuses on the following:

- 1. Detection and rapid isolation of cases;*
- 2. Intensification of rapid multidisciplinary public health actions around any confirmed case;*
- 3. Strengthening community engagement;*
- 4. Strengthening the health system and effective coordination of the activities of local and international partners.*

Public health officials struggled to effectively implement these control measures early in the outbreak due to difficulty accessing remote areas, socio-political unrest and armed conflict in the region.

a) Evaluate the effectiveness of the public health measures used to control the outbreak. 3

- evaluation: they didn't work at first, but then they did (1 mk)

- links to data (2 mk – quantitative + qualitative)

b) Explain how any TWO measures identified by the WHO's statement may have contributed to controlling the outbreak. 4

Explanation (2 mks each) - MUST provide link between measure and mechanism for lowering spread. Point 1 and Point 3 had the highest % of students scoring full marks.

Sample answer:

Detection and rapid isolation of cases minimises the time infectious individuals spend in the community, thereby lowering the window of opportunity for transmission to occur to another individual. Strengthening community engagement means the public are more likely to understand and cooperate with existing public health measures, hence increasing the proportion of the population taking the recommended precautions to limit spread and therefore increasing the likelihood these methods will be effective at a population level.

BE EXPLICIT IN YOUR LINKS.

“... controlling the outbreak through minimising contact with infectious individuals, thereby limiting the spread” is not as good as “... controlling the outbreak through minimising contact with infectious individuals, thereby limiting the opportunities for the pathogen to be transmitted from one individual to another, hence limiting the spread.”

Please stop writing about every disease like it is COVID-19. The question had no mention of contact tracing, coughing, or venues/areas of concern, so there should have been no reason to mention those.

Question 30 (4 marks)

Describe the process of DNA replication with reference to the roles of at least TWO named enzymes.

- explanation of process (2 mks)
- answer includes role of TWO named enzymes (1 mk each)

Good answers – note that many people forgot to mention RNA primers being replaced by DNA. This did not result in a deduction for this particular question as it was only out of 4.

Sample answer:

DNA replication is carried out in the nucleus prior to cell division. It begins when helicase unzips the double helix and separates the two DNA strands. Primase then places an RNA primer on each strand which provides a starting point for DNA polymerase to proceed along the original strands, placing complementary bases in sequence to form a new strand. This process occurs continuously in the 5' to 3' direction for the leading strand, however it occurs discontinuously on the lagging strand, thus forming fragments of DNA called Okazaki fragments that must be later fused together by ligase to form a single continuous strand. RNA primers are removed and replaced with DNA. These processes continue until the entire length of the DNA has been replicated and two identical, double-stranded DNA molecules have been produced.

Question 31 (6 marks)

Evaluate the impact of scientific knowledge on the manipulation of plant and animal reproduction in agriculture.

- description of how plant and animal reproduction has been manipulated in agriculture - must include BOTH plants and animals AND specific techniques (3 mks)
- use of examples for provided techniques eg cloning of banana plants through vegetative propagation (2 mks)
- evaluation of impact (note: MUST be specific - how has KNOWLEDGE affected MANIPULATION) (1 mk)

READ THE QUESTION. Transgenic species (golden rice came up a lot) were not relevant to the question as they are not an issue of manipulating reproduction. The question also did not ask about advantages/disadvantages, the environment, biodiversity or ethical considerations – it asked only how knowledge has impacted manipulation of reproduction.

Sample answer:

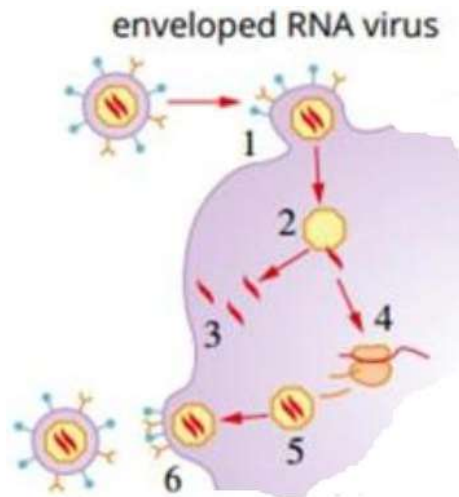
Increased understanding of the inheritance of traits by offspring and of reproductive mechanisms within plant and animal species have allowed extensive manipulation of gene pools in agriculture, ultimately leading to increased yield, quality and uniformity of plant and animal products.

Plants used in agriculture have been selectively bred by breeding parents with desirable traits, usually through artificial pollination (the mechanical dusting of pollen from one plant onto the stigma of another). This produces offspring who share the desirable traits of their parents. Hybridisation involves cross-breeding parents from different plant varieties in this manner to produce a new variety (eg Federation wheat which boasts drought- and disease-resistance alongside high grain quality).

Selective breeding has also been used to manipulate the traits of livestock. Jersey cows and Friesian cows have been crossed to produce offspring which produce a high yield of high quality milk. Belgian blue cattle, which produce a high yield of lean beef, are the result of many generations of selective breeding prioritising high muscle mass. Artificial insemination (introduction of semen from the selected father directly into the reproductive tract of the female parent) has allowed selective breeding to occur regardless of geographical distance and with lower risk of disease or injury to parent organisms.

Question 32 (12 marks)

The diagram below represents the life cycle for an enveloped RNA virus. The host cell depicted is a human cell.



a) Describe the process shown to occur at stage 4.

4

Full description of translation required:

- mRNA read to make polypeptide
- mRNA read as sequence of 3 bases (1 codon)
- matched to COMPLEMENTARY anticodon (on tRNA)
- specific amino acid to specific anticodon

Sample answer: During translation, an mRNA code is used by a ribosome to produce a polypeptide. The ribosome reads the mRNA in sequences of 3 bases (codons), beginning with a start codon. Each codon has a complementary anti-codon which exists on a tRNA molecule, and each anti-codon is associated with a specific amino acid which is attached to the other side of the tRNA molecule. Anti-codons bind with their complementary codons, at which point the ribosome catalyses the formation of a peptide bond between the two adjacent amino acids that have been placed. This process continues codon by codon, with tRNA molecules that have already placed their amino acid moving away to be recycled, until a chain of amino acids has been formed. The process ends when a stop codon is reached.

b) Assess the importance of the process in part a to this enveloped RNA virus.

2

- vital to virus replication (1 mk) (Note: 'vital' by itself was not accepted - needed reference to producing new copies/replication)

- BECAUSE the process produces new copies of the envelope (protein coat) (1 mk)

c) The infected person received a vaccination several months earlier containing the modified antigen shown below.

6



The infected person experienced only minor symptoms and recovered more quickly than expected. Using your understanding of the human immune system, explain why this occurred.

- outline of what a modified antigen is (recognised by immune system but does not allow viral replication)

- reference to exterior features shared by the enveloped virus and by the modified antigen

- description of primary exposure immune response, including production of antibodies and formation of memory cells (2 mks)

- comparison to secondary exposure immune response – some detail needed.

- relation to stem (ie prevention of serious symptoms + quick recovery from virus)

Sample answer:

The modified antigen shares the external features of the virus but not the RNA inside the envelope. Vaccination with this modified antigen would stimulate an immune response but not allow replication of the virus. In this primary immune response, fragments of the modified antigen would stimulate the proliferation of B cells (producing plasma cells and therefore antibodies) and T cells suited to the destruction/removal of the virus. This process would also produce memory B and T cells which persist in the body after the infection has cleared. Upon reinfection with the actual virus, the memory cells would allow a stronger and faster response

to the presence of the antigen, reaching a higher maximum concentration of antibodies and reaching that peak faster than in the primary immune response. The result is that the infected person's immune system would destroy the virus more quickly than that of an unvaccinated individual, resulting in only minor symptoms and a quick recovery.

END OF SECTION 3