



NSW Education Standards Authority

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Centre Number

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Student Number

2025 HIGHER SCHOOL CERTIFICATE EXAMINATION

Biology

General Instructions

- Reading time – 5 minutes
- Working time – 3 hours
- Write using black pen
- Draw diagrams using pencil
- Calculators approved by NESA may be used
- Write your Centre Number and Student Number at the top of this page

Total marks: 100

Section I – 20 marks (pages 2–11)

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

Section II – 80 marks (pages 13–36)

- Attempt Questions 21–34
- Allow about 2 hours and 25 minutes for this section

Section I

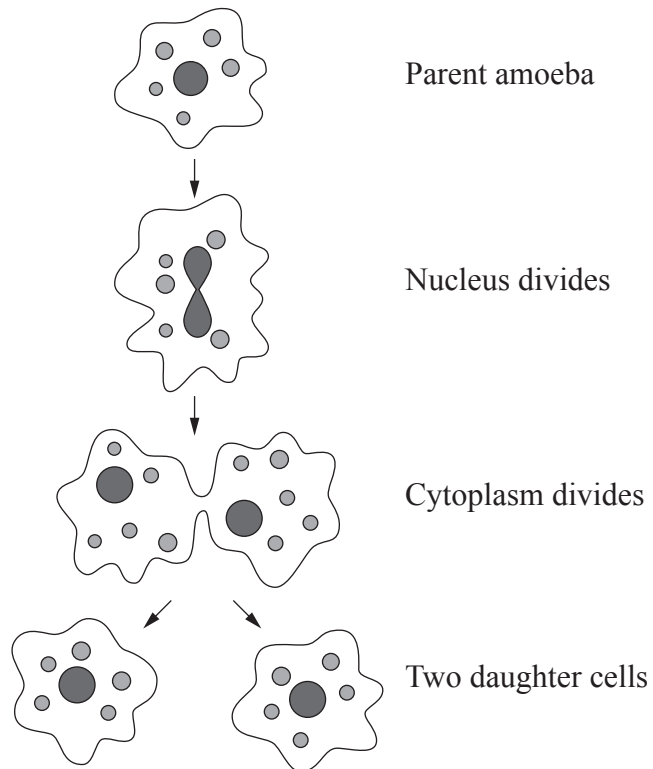
20 marks

Attempt Questions 1–20

Allow about 35 minutes for this section

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

- 1** Amoeba reproduce by the process shown.



© Achiichiii / Dreamstime.com

Which of the following is a characteristic of the daughter cells?

- A. Genetically different to parent amoeba
- B. Genetically identical to parent amoeba
- C. More organelles due to the cell division
- D. Fewer chromosomes than the parent amoeba

2 What type of mutagen is UV light?

- A. Biochemical
- B. Biological
- C. Chemical
- D. Electromagnetic

3 Which row in the table correctly identifies the role of phagocytes and lymphocytes?

	<i>Phagocytes</i>	<i>Lymphocytes</i>
A.	Engulf bacteria	Produce antibodies
B.	Engulf bacteria	Produce antigens
C.	Produce antibodies	Engulf bacteria
D.	Produce antigens	Produce antibodies

4 A storm randomly kills 80% of the frog population on an island. The allele frequencies in the frog population after the storm are notably different to those of the population before the storm.

What is the process that has led to the change in allele frequencies?

- A. Gene flow
- B. Genetic drift
- C. Natural selection
- D. Survival of the fittest

5 An infectious disease is spread through direct contact between hosts.

Under which conditions will this disease spread most rapidly?

- A. Low population density with infected individuals rarely dying from the disease
- B. High population density with infected individuals rarely dying from the disease
- C. Low population density with infected individuals quickly dying from the disease
- D. High population density with infected individuals quickly dying from the disease

- 6 Rabies is a viral disease spread by infected animals. If bitten by an infected animal, a person can be treated by receiving an injection of antibodies.

What type of immunity will this person have following the injection?

- A. Innate active
 - B. Natural passive
 - C. Acquired active
 - D. Acquired passive
- 7 An animal's body temperature and the air temperature of the animal's environment were measured every 4 hours, and the following data were recorded.

<i>Time</i>	<i>Body temperature (°C)</i>	<i>Air temperature (°C)</i>
4 am	41.3	19.2
8 am	41.1	18.8
12 pm	40.8	21.5
4 pm	41.4	26.4
8 pm	41.2	27.5
12 am	41.5	23.0

Based on this data, which row of the table indicates what type of animal it is and why?

	<i>Type of animal</i>	<i>Reason</i>
A.	Ectotherm	Body temperature is around 41°C and varies with the air temperature.
B.	Ectotherm	Body temperature is around 41°C and is always above the air temperature.
C.	Endotherm	Body temperature is relatively constant despite changes in air temperature.
D.	Endotherm	Body temperature is relatively constant, and air temperature is relatively constant.

- 8 When a red camellia flower is crossed with a white camellia flower, all the offspring are covered in both red and white petals.

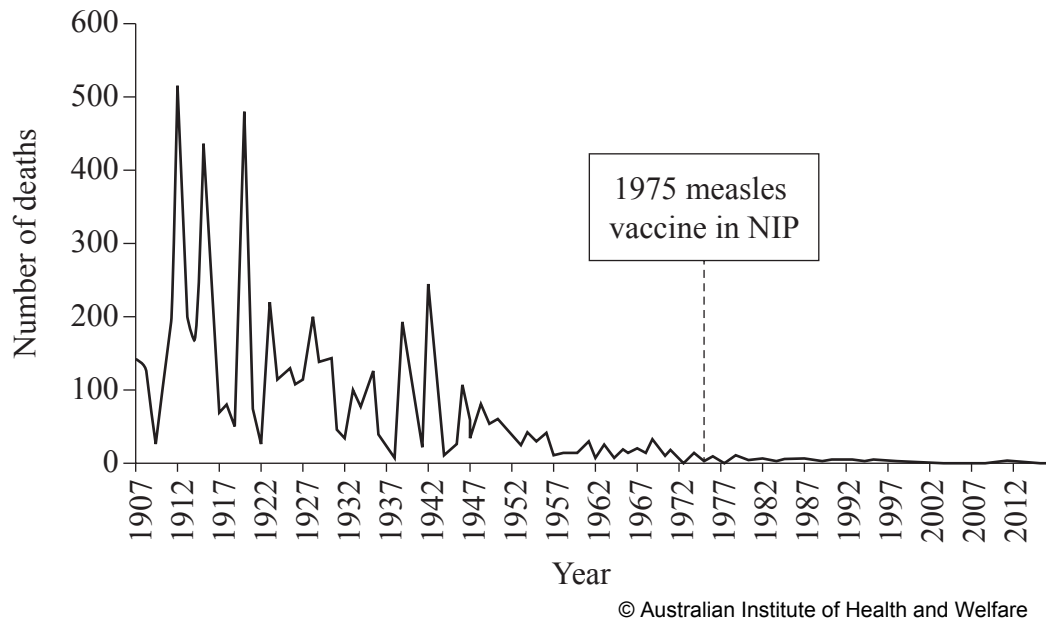
What is the reason for this occurrence?

- A. One gene is controlling multiple characteristics.
 - B. Environmental factors affect the phenotype of camellia flowers.
 - C. Alleles for both red and white colour in camellia flowers are recessive.
 - D. Petal colour in camellia flowers is controlled by a co-dominance pattern of inheritance.
- 9 Dialysis is used to assist people with loss of kidney function.

Which row of the table correctly describes the composition of blood before and after dialysis?

	<i>Blood before dialysis</i>	<i>Blood after dialysis</i>
A.	High urea and high glucose	Low urea and high glucose
B.	High urea and high glucose	High urea and low glucose
C.	Low urea and low glucose	Low urea and high glucose
D.	Low urea and high glucose	Low urea and low glucose

- 10** The graph shows the number of recorded deaths, due to measles, before and after the measles vaccine was included in the National Immunisation Program (NIP).



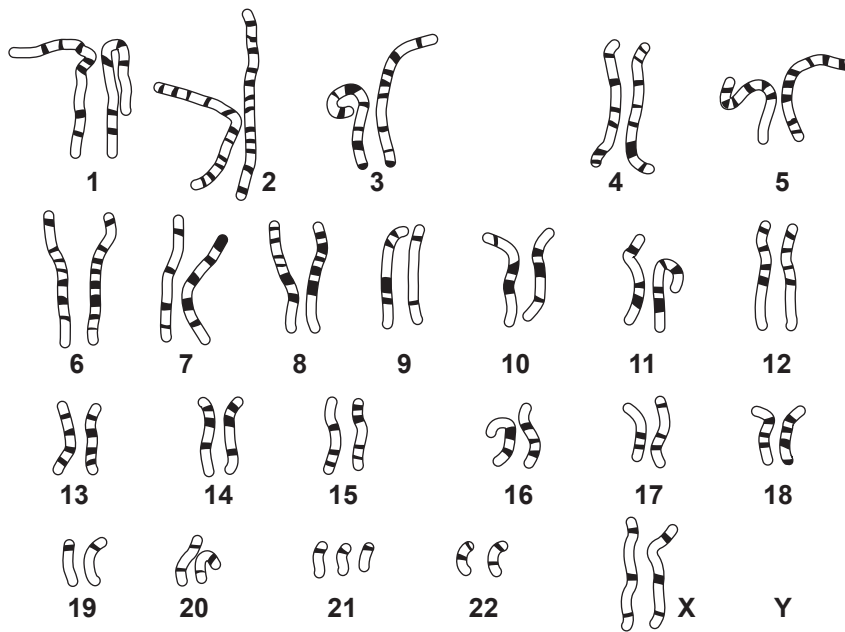
Which of the following is a trend shown in the graph?

- A. Most people have been immunised against measles since 1975.
 - B. Over the last 100 years the number of deaths has consistently fallen.
 - C. The number of measles-induced deaths has fallen to near zero since measles vaccine was added to the NIP.
 - D. The National Immunisation Program was the primary reason for the great reduction in measles-induced deaths.
- 11** In 2018, the Victorian government reported the target of vaccinating more than 95% of children below the age of five had been achieved.

What is the benefit of achieving a 95% vaccination rate for an infectious disease?

- A. Only 5% of individuals will catch the disease.
- B. Only 5% of individuals will be protected by the vaccine.
- C. This will protect the remaining 5% who are not vaccinated.
- D. The vaccinated individuals can transfer immunity to the remaining 5%.

- 12 The following represents a karyotype for an individual with Down syndrome.



© National Down Syndrome Society

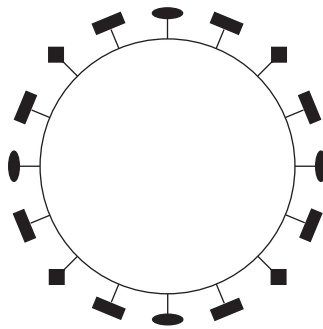
What conclusions can be drawn about the individual from this karyotype?

- A. A male with a deletion mutation
 - B. A female with a deletion mutation
 - C. A male with a chromosomal mutation
 - D. A female with a chromosomal mutation
- 13 The prevalence of a non-infectious disease has remained constant for over 10 years. A new treatment for this disease prolongs the life of people with the disease, but does not cure them.

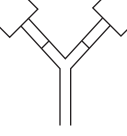
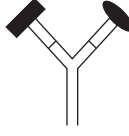
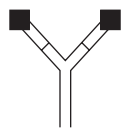
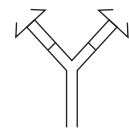
Which row in the table shows the effect of the treatment on both the incidence and prevalence of this disease?

	<i>Change in incidence</i>	<i>Change in prevalence</i>
A.	None	Increases
B.	None	Decreases
C.	Increases	None
D.	Decreases	None

- 14 A pathogen that produces an immune response is shown.



Which antibody will be produced as a response to the pathogen?

- A. 
- B. 
- C. 
- D. 

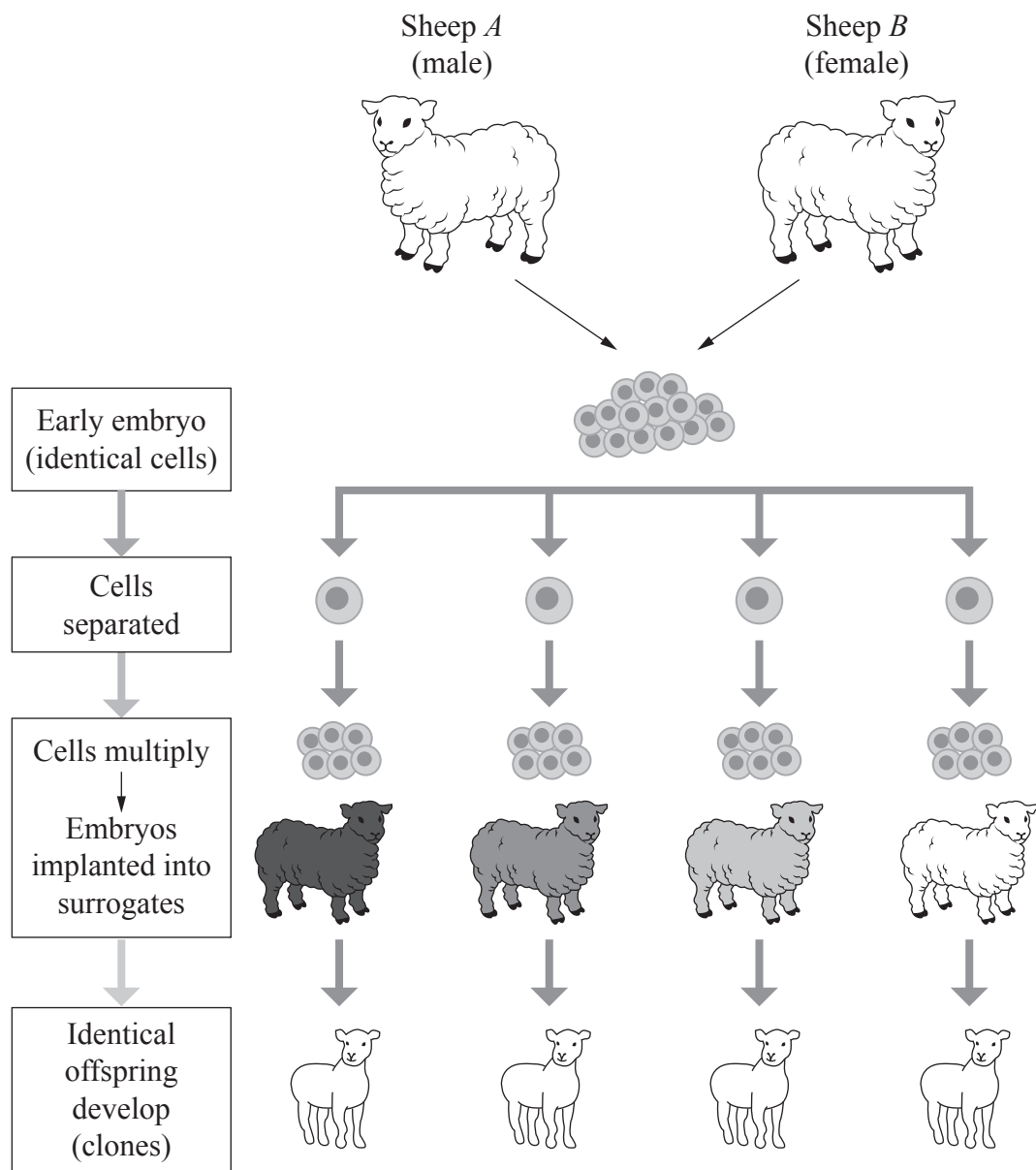
- 15 Cochlear implants assist with hearing. The following are five steps involved in the process.

1. The sound signal is turned into electrical impulses.
2. The implant sends electrical impulses to the electrodes in the cochlea.
3. Sounds are picked up by the microphone.
4. The auditory nerve picks up and sends electrical impulses to the brain.
5. The electrical impulses are transmitted across the skin to the implant.

Which is the correct order for this process?

- A. 1, 4, 3, 2, 5
- B. 1, 3, 2, 4, 5
- C. 3, 1, 5, 2, 4
- D. 3, 1, 2, 5, 4

- 16 The diagram shows a process that was used to make multiple clones in sheep.

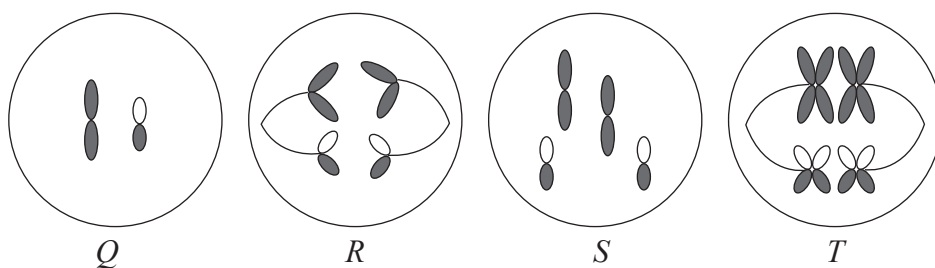


© VCE BioNinja

The identical offspring are clones of

- A. each other.
- B. only sheep *B*.
- C. the surrogates.
- D. both sheep *A* and *B*.

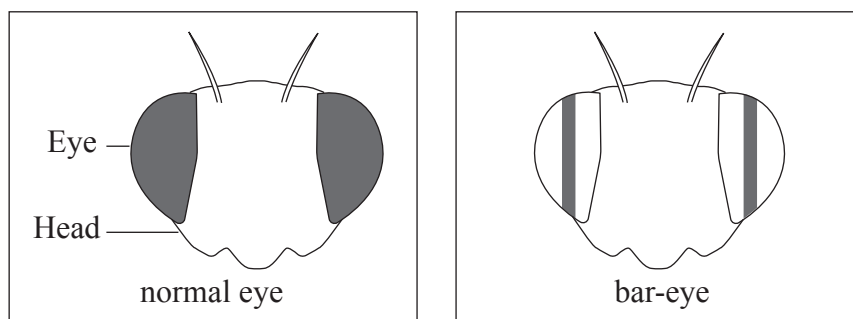
- 17 Some phases of cell division in an organism are shown.



What is the correct sequence of the process?

- A. Q, S, R, T
 B. Q, R, S, T
 C. S, T, R, Q
 D. S, R, T, Q
- 18 The fruit fly, *Drosophila melanogaster*, normally has large round eyes. A mutation of the eye shape gene, found on the X-chromosome, causes the eye to be a narrow slit (bar-eye), which is a dominant allele for eye shape.

Offspring were produced when a bar-eyed male was crossed with a normal female. Males are XY and females are XX.



Which row in the table shows the correct percentage of male and female offspring produced with bar-eye?

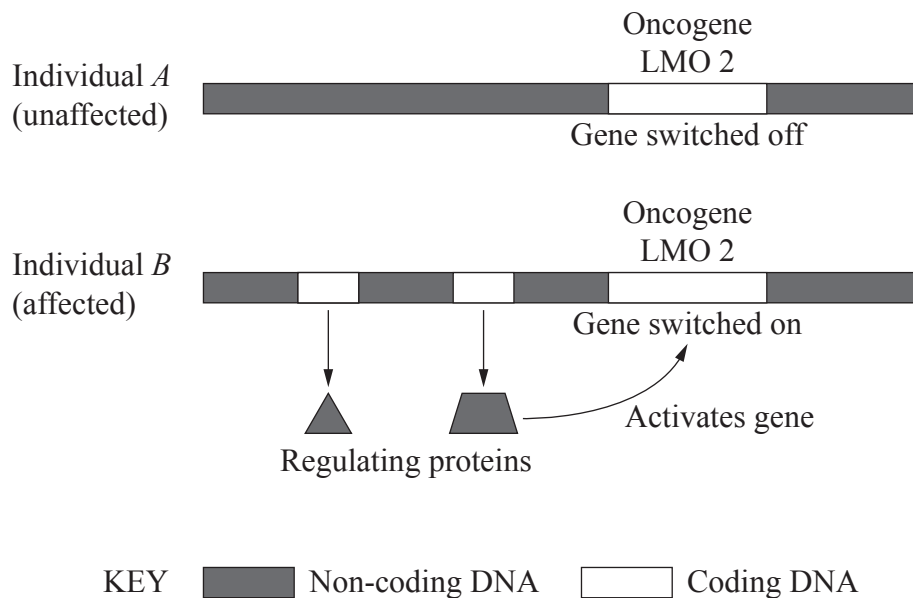
<i>Percentage of offspring with bar-eyes</i>		
	<i>Males</i>	<i>Females</i>
A.	100	100
B.	0	100
C.	100	0
D.	50	0

- 19 The grasshopper has an average genome size of 120 million base pairs. 42% of these base pairs contain cytosine and guanine.

What is the number of DNA nucleotides with a thymine base found in each cell?

- A. 25.2 million
B. 34.8 million
C. 69.6 million
D. 120 million
- 20 Researchers studying T-cell acute lymphoblastic leukaemia (T-ALL) examined a section of DNA in individuals *A* and *B*.

In individual *B*, they found proteins that can regulate the expression of oncogene LMO 2. The following diagram represents the sections of DNA from the two individuals.



Based on this information, which of the following statements is the best explanation of the cause of T-ALL?

- A. T-ALL is caused by an inactive Oncogene LMO 2.
B. The regulating proteins are the direct cause of T-ALL.
C. The regulating proteins have no effect as they are made on non-coding DNA.
D. The regulating proteins can activate the Oncogene LMO 2, causing the condition.

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Centre Number

Biology

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Student Number

Section II Answer Booklet

80 marks

Attempt Questions 21–34

Allow about 2 hours and 25 minutes for this section

Instructions

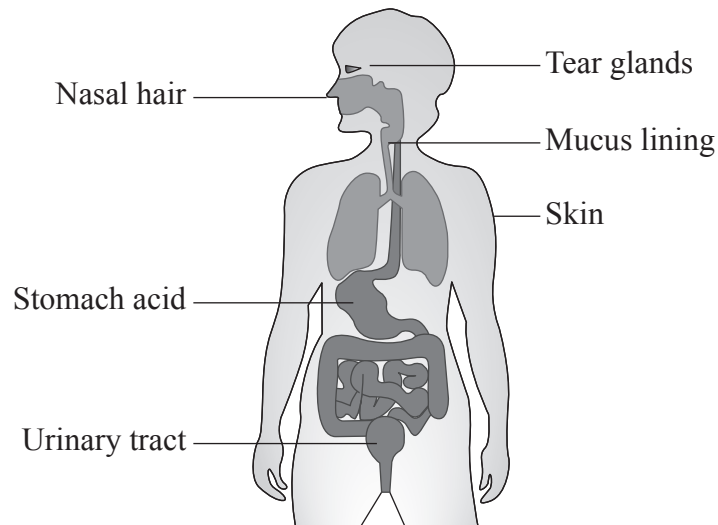
- Write your Centre Number and Student Number at the top of this page
- Answer the questions in the spaces provided. These spaces provide guidance for the expected length of response
- Show all relevant working in questions involving calculations
- Extra writing space is provided at the back of this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

Please turn over

Question 21 (2 marks)

The diagram shows components of the innate immune system in humans.

2



Courtesy of Dr. Marcus Judge & Dr. Ethan Kavanagh – SimpleMed

State the role of TWO components that protect against infection.

<i>Component</i>	<i>How it protects against infection</i>

Do NOT write in this area.

Question 22 (4 marks)

(a) Outline a process used by fungi for reproduction.

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(b) Outline an adaptation in a pathogen that facilitates transmission between hosts.

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Question 23 (3 marks)

Compare the processes of artificial insemination and artificial pollination.

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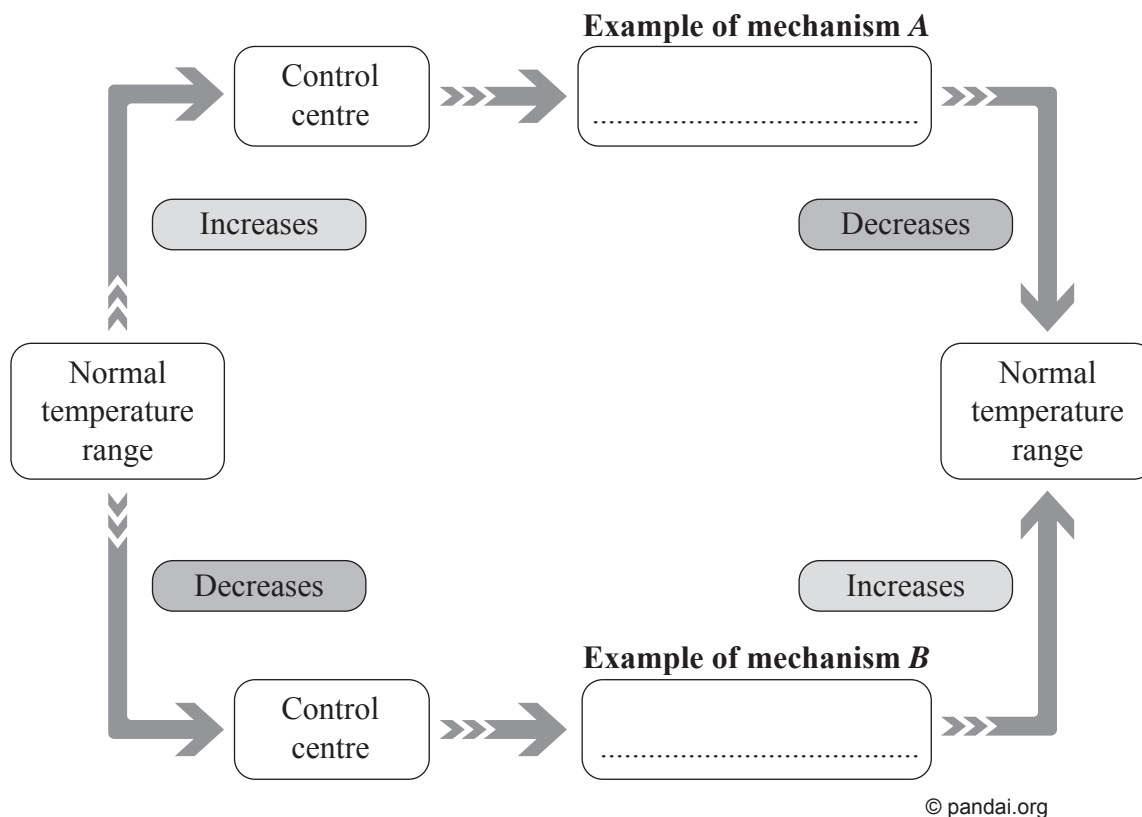
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Question 24 (4 marks)

The following flow chart represents the control of body temperature in humans.



- (a) Complete the flow chart to give an example of mechanism *A* and an example of mechanism *B*. 2
- (b) Outline how mechanism *B* maintains homeostasis. 2

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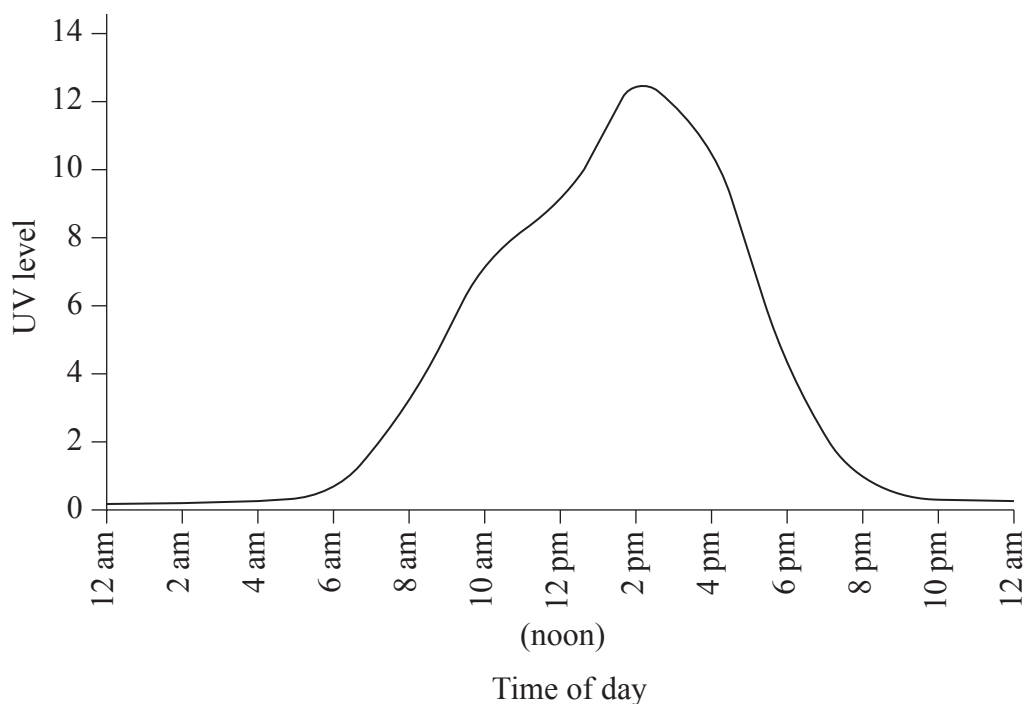
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Question 25 (3 marks)

The graph shows the changes in UV level in a single day.

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The Cancer Council suggests that sun protection is needed whenever the UV level is 3 or above. The information provided on a sunscreen product suggests that sunscreen should be used between 10 am and 4 pm.

Using the graph, evaluate the information provided on the sunscreen product with regard to the Cancer Council suggestion.

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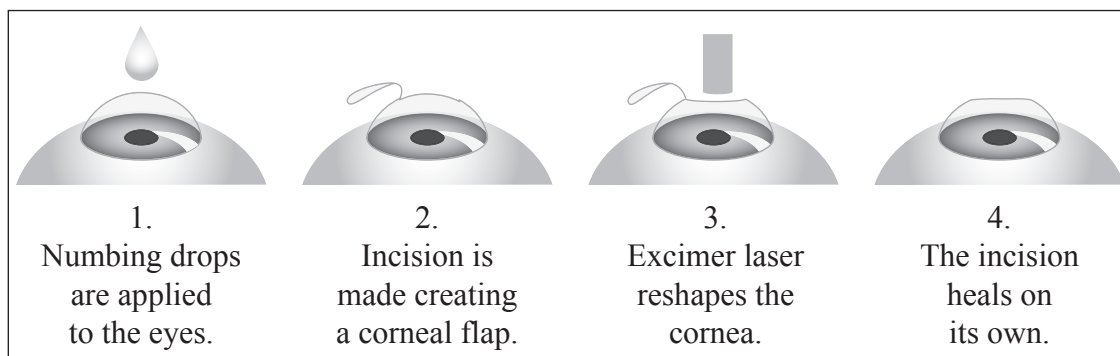
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Question 26 (4 marks)

The diagram shows the steps in LASIK (Laser-Assisted In Situ Keratomileusis) surgery.

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© Shutterstock Ireland

Compare the LASIK technology shown with ONE other technology that can be used to treat a named visual disorder.

Visual disorder:

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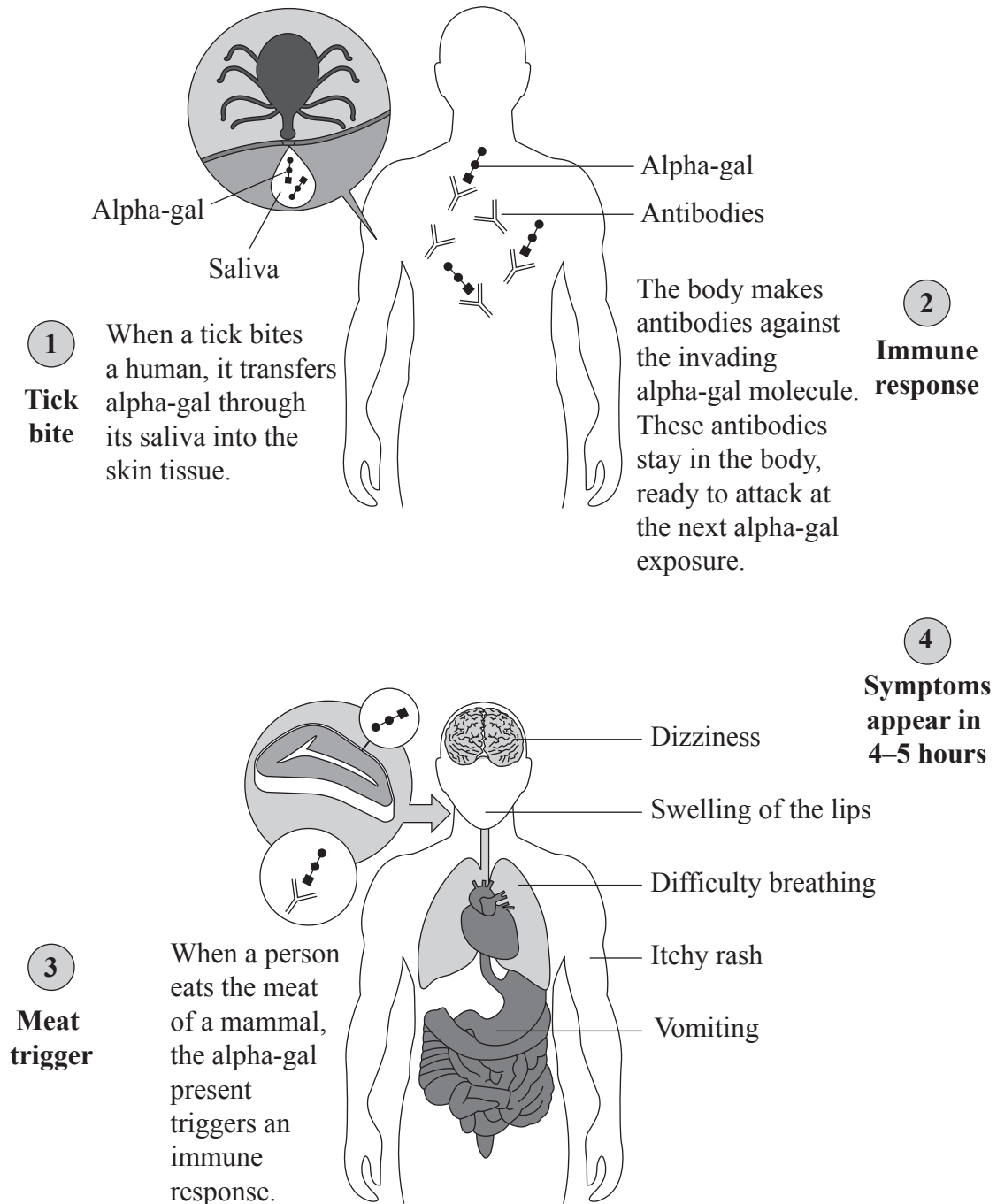
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Question 28 (9 marks)

Alpha-gal syndrome (AGS) is a tick-borne allergy to red meat caused by tick bites. Alpha-gal is a sugar molecule found in most mammals but not humans, and can also be found in the saliva of ticks. The diagram shows how a tick bite might cause a person to develop an allergic reaction to red meat.



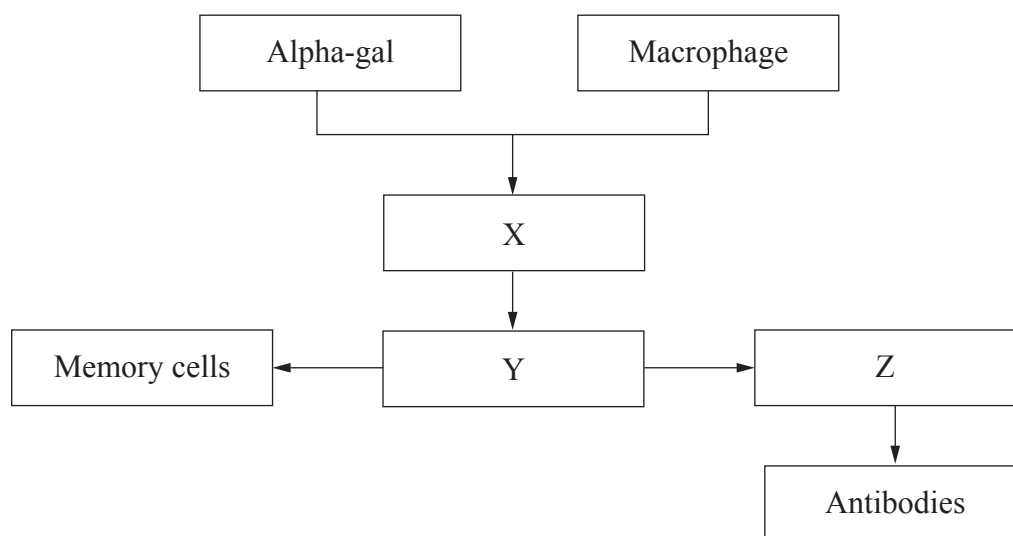
Courtesy Foothills Forum and Rappahannock News

Question 28 continues on page 21

Question 28 (continued)

- (a) The flow chart shows the process of antibody production following exposure to alpha-gal.

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Describe the role of X, Y and Z in the process of antibody production.

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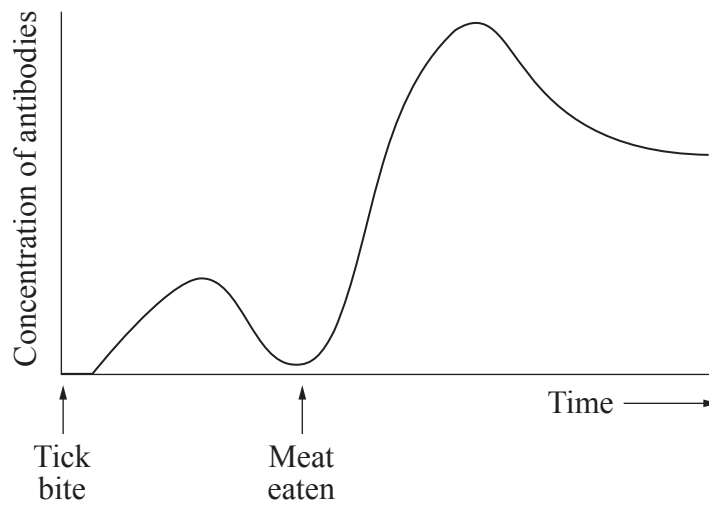
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Question 28 continues on page 22

Question 28 (continued)

- (b) An allergic reaction to alpha-gal sugar is similar to a secondary immune response.

2



Describe the features of antibody production shown in the graph.

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- (c) Explain the role of memory cells in the immune response.

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End of Question 28

Question 29 (6 marks)

The *Varroa* mite is an external parasite of European honey bees and is considered to be the most serious pest of honey bees worldwide.

- (a) Why is *Varroa* mite infection considered to be an infectious disease? 2

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- (b) In June 2022, the *Varroa* mite was detected for the first time in Australia at the Port of Newcastle. It then spread to surrounding areas. 4

Explain TWO procedures that could have been employed to prevent the spread of the *Varroa* mite in honey bees.

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Question 30 (11 marks)

PAI-1 protein is encoded by the SERPINE 1 gene in humans. *Anopheles* mosquitoes have been genetically modified to express PAI-1, which blocks the entry of the malarial *Plasmodium* into the mosquito gut. This disrupts the *Plasmodium* life cycle, resulting in reduced transmission of malaria.

- (a) Describe a process that could be used to produce mosquitoes which express PAI-1.

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Question 30 continues on page 25

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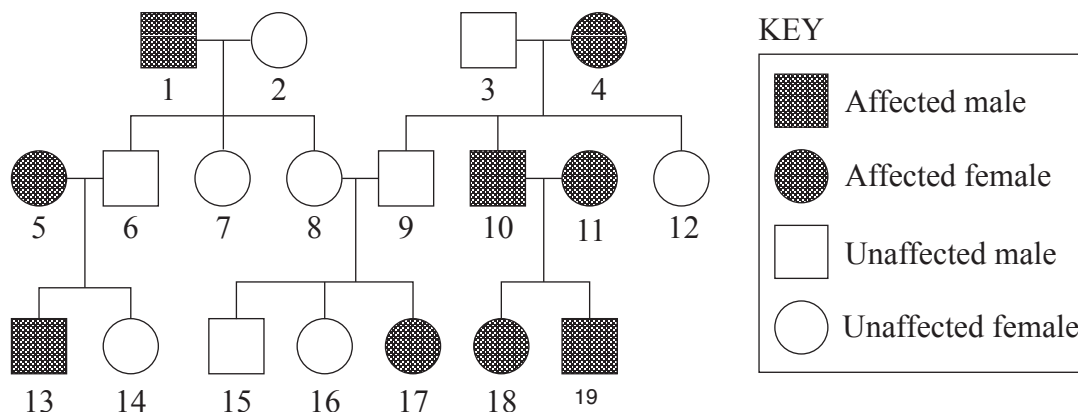
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– 25 –

Question 31 (6 marks)

Congenital amegakaryocytic thrombocytopenia (CAMT) is a rare, inherited disorder where bone marrow no longer makes platelets that are important for clotting and preventing bleeding. The pedigree below shows the inheritance of CAMT in a family.



Courtesy of Michigan Department of Health and Human Services (MDHHS)

- (a) What type of inheritance is shown in the pedigree above? Justify your answer.

3

Type of inheritance:

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Question 31 continues on page 27

Question 31 (continued)

- (b) A CAMT mutation was found to produce the following amino acid sequence.

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Glutamine – Tyrosine – Isoleucine – Aspartic acid

The same DNA fragment has been sequenced from an unaffected individual.

Template strand GTC ATA CAG CTG

The following codon chart displays all the codons and corresponding amino acids. The chart translates mRNA sequences into amino acids.

		Second base in codon					
		U	C	A	G		
First base in codon	U	UUU] Phenylalanine	UCU]	UAU] Tyrosine	UGU] Cysteine	U	Third base in codon
		UUC]	UCC] Serine	UAC]	UGC]	C	
		UUA] Leucine	UCA]	UAA] STOP	UGA – STOP	A	
		UUG]	UCG]	UAG]	UGG – Tryptophan	G	
	C	CUU]	CCU]	CAU] Histidine	CGU]	U	
		CUC] Leucine	CCC]	CAC]	CGC] Arginine	C	
		CUA]	CCA]	CAA] Glutamine	CGA]	A	
		CUG]	CCG]	CAG]	CGG]	G	
	A	AUU]	ACU]	AAU] Asparagine	AGU] Serine	U	
		AUC] Isoleucine	ACC]	AAC]	AGC]	C	
		AUA]	ACA]	AAA] Lysine	AGA] Arginine	A	
		AUG – Methionine (start)	ACG]	AAG]	AGG]	G	
	G	GUU]	GCU]	GAU] Aspartic acid	GGU]	U	
		GUC] Valine	GCC]	GAC]	GGC]	C	
		GUA]	GCA]	GAA] Glutamic acid	GGA]	A	
		GUG]	GCG]	GAG]	GGG]	G	

© Open Oregon Educational Resources

Use the codon chart shown to explain the type of mutation which causes CAMT.

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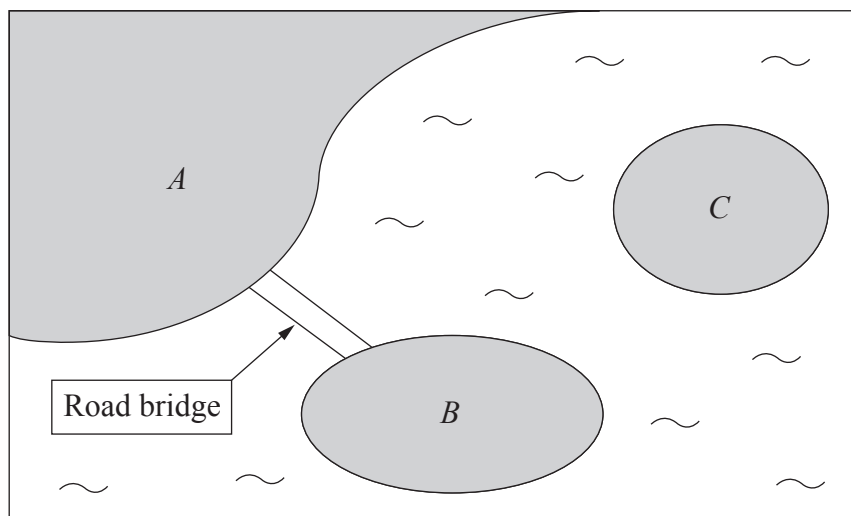
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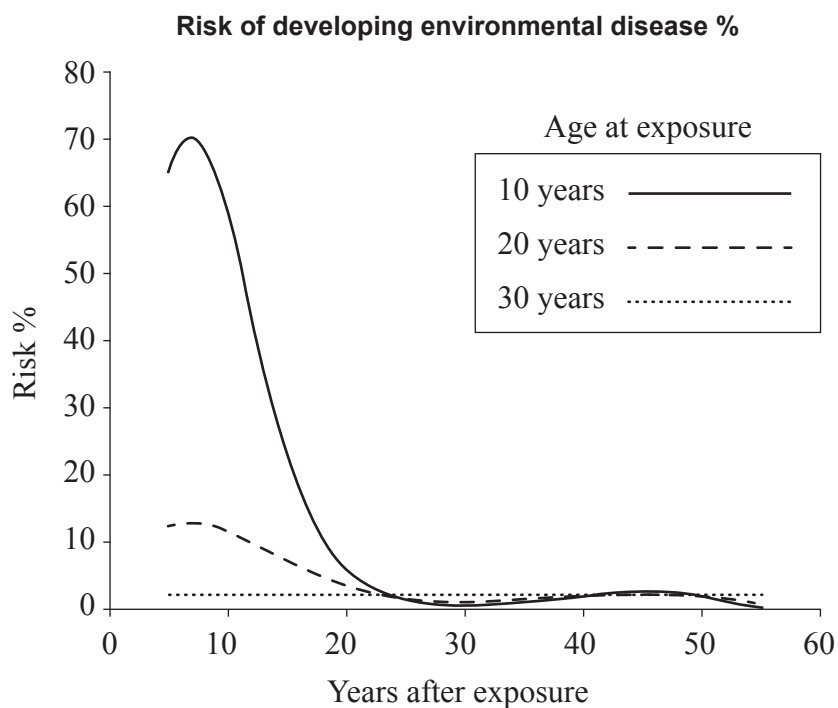
End of Question 31

Question 32 (7 marks)

A population lives across three regions, *A*, *B* and *C* as shown.



People in community *B* developed an environmental disease. An epidemiological study was carried out to determine the risk of developing the disease due to age at exposure. The results of this study are shown in the graph.



Question 32 continues on page 29

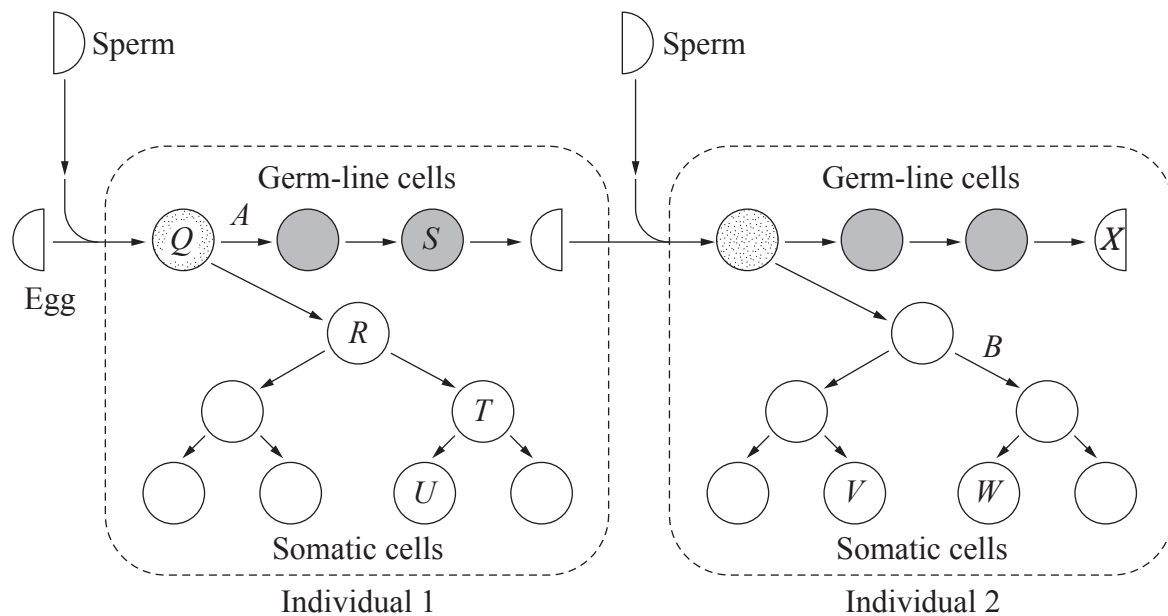
Design an epidemiological study that could be used to produce the results shown in the graph. Justify the features of your design.

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

– 29 –

Question 33 (9 marks)

The following diagram shows the cell division processes occurring in two related individuals.



KEY

 or 	Gamete		Zygote		Germ-line cell		Somatic cell
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'Figure 19-5', from *ESSENTIAL CELL BIOLOGY*, THIRD EDITION by Bruce Alberts, et al.
 © 2004, 2010 by Bruce Alberts, Dennis Bray, Karen Hopkin, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, and Peter Walter. This selection may not be reproduced, stored in a retrieval system, or transmitted in any form or by any means without the prior written permission of the publisher.

- (a) Compare the cell division processes carried out by cells *R* and *S* in Individual 1.

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Question 33 continues on page 31

Question 33 (continued)

- (b) Explain the relationship between Individuals 1 and 2. 2

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- (c) *A* and *B* are two separate mutations. Analyse how mutations *A* and *B* affect the genetic information present in cells *U*, *V*, *W* and *X*. 4

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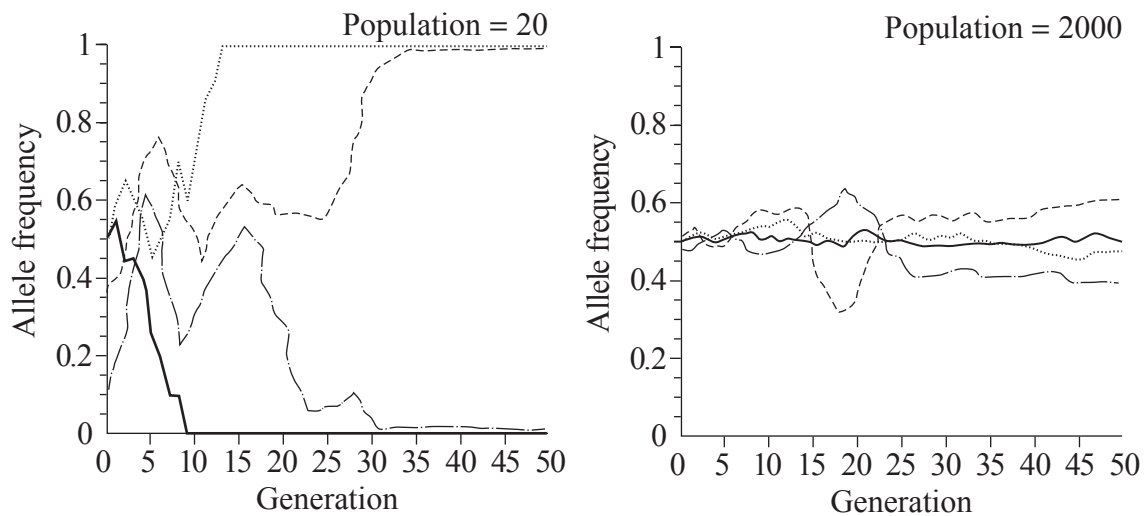
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End of Question 33

Question 34 (6 marks)

The following graphs show the changes in allele frequencies in two separate populations of the same species. Each line represents an introduced allele.



- (a) Explain why the fluctuations of the allele frequencies are more pronounced in the small population, compared to the larger population.

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Question 34 continues on page 33

Question 34 (continued)

- (b) Evaluate the effects of gene flow on the gene pools of the two populations.

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2025 HSC Biology Marking Guidelines

Section I

Multiple-choice Answer Key

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

Section II

Question 21

Criteria	Marks
• Identifies the role of two components of the innate immune system	2
• Provides some relevant information	1

Sample answer:

Component	How it protects against infection
Stomach acid	The acid inhibits the growth of or kills bacteria/pathogens
Skin	Acts as a physical barrier to pathogen entry into the body

Answer could include:

Nasal hair, tear glands, mucus lining, urinary tract

Question 22 (a)

Criteria	Marks
• Outlines a process used by fungi for reproduction	2
• Provides some relevant information	1

Sample answer:

Fungi can reproduce asexually by producing spores which are released and when carried into a favourable environment they germinate and grow into a new fungal organism.

Answer could include:

Budding

Question 22 (b)

Criteria	Marks
• Outlines how a pathogen adaptation facilitates transmission between hosts	2
• Provides some relevant information	1

Sample answer:

After colonising a host, fungi can produce spores which can be released to infect a new host.

Question 23

Criteria	Marks
• Compares artificial insemination and artificial pollination	3
• Provides an incomplete comparison of artificial insemination and artificial pollination	2
• Provides some relevant information	1

Sample answer:

A similarity is that both processes involve gametes of an organism. A difference is that artificial insemination occurs only in animals while artificial pollination occurs only in (flowering) plants.

Question 24 (a)

Criteria	Marks
• Provides correct example for both mechanism <i>A</i> and mechanism <i>B</i>	2
• Provides some relevant information	1

Sample answer:

Mechanism *A* – sweating
Mechanism *B* – shivering

Question 24 (b)

Criteria	Marks
• Outlines how mechanism <i>B</i> maintains homeostasis	2
• Provides some relevant information	1

Sample answer:

When the body temperature drops, skeletal muscles start shivering. This generates body heat and raises the temperature. This helps maintain homeostasis.

Question 25

Criteria	Marks
- Provides an accurate evaluation of the product statement - Demonstrates a sound understanding of the data provided	3
Demonstrates some understanding of the product statement and the data provided	2
Provides some relevant information	1

Sample answer:

The product statement is incorrect because a person is not fully protected from UV. UV levels greater than 3 occur between approximately 8 am and 6 pm and so for the given day there is about 2 hours before and after recommended times, a person would have no protection from UV.

Question 26

Criteria	Marks
Provides a thorough comparison between LASIK and one other technology	4
Provides a sound comparison between LASIK and one other technology	3
- Provides some comparison between LASIK and one other technology OR - Demonstrates some understanding of LASIK OR another relevant technology	2
Provides some relevant information	1

Sample answer:

Named visual disorder – Myopia

Myopia can be corrected by wearing glasses with concave lenses which refracts the light so that the image falls on the retina rather than before it. This is similar to LASIK surgery where the cornea is reshaped to precisely refract the light to reach the retina at the back of the eye. LASIK is an intrusive and more expensive procedure whereas prescription glasses are less expensive and non-intrusive.

Question 27

Criteria	Marks
• Correctly identifies the type of fertilisation in each group • Provides an extensive comparison of internal and external fertilisation • Incorporates references to the data provided	6
• Correctly identifies the type of fertilisation in each group • Provides a thorough comparison of internal and external fertilisation • Makes some reference to the data provided	5
• Correctly identifies the type of fertilisation in each group • Demonstrates a sound understanding of internal and external fertilisation • Makes limited reference to the data provided	4
• Outlines feature(s) of fertilisation	2–3
• Provides some relevant information	1

Sample answer:

The animals in Group A are all terrestrial animals with internal fertilisation. The animals in Group B are all aquatic animals with external fertilisation.

In both groups, fertilisation involves fusion of male and female gametes.

In Group A this occurs inside the female body. Fewer gametes are needed as there is a higher probability of fertilisation in the internal space. Thus the animals in Group A produce far fewer eggs (eg 1 to 100 in snakes) than in Group B (100 000 to 2 million in sea urchins) and they are able to reproduce in terrestrial environments as internal fertilisation protects the gametes.

In Group B, fertilisation must occur in an aquatic environment so that the gametes do not dry out. Fertilisation in Group B has a much lower probability of success as the gametes are spread over a larger volume. Internal fertilisation ensure higher rates of survival of the fewer offspring produced.

Question 28 (a)

Criteria	Marks
• Correctly describes the process of antibody production with correct reference to the role of X, Y and Z	4
• Outlines the process of antibody production with some reference to the flow chart	3
• Outlines a process of antibody production	2
• Provides some relevant information	1

Sample answer:

The tick bite transfers antigenic alpha-gal sugar molecules into the skin. Macrophages, together with Helper T cells (X), activate B-lymphocytes (Y). These cells grow and differentiate into either memory cells, when exposure occurs, or plasma cells (Z) which produce antibodies against the antigen.

Question 28 (b)

Criteria	Marks
• Describes features of antibody production shown in the graph	2
• Provides some relevant information	1

Sample answer:

On first exposure to the alpha-gal sugar by the tick bite, antibody production takes longer and only a lower concentration of antibodies is produced. On re-exposure, antibodies are produced more quickly and a higher concentration is produced.

Question 28 (c)

Criteria	Marks
• Explains the role of memory cells in the immune response	3
• Outlines the role of memory cells	2
• Provides some relevant information	1

Sample answer:

Memory cells are created by B-cells in response to a specific antigen. Memory cells remain in the lymph nodes after the infection. On re-exposure to the antigen, these memory cells quickly differentiate into plasma cells or cytotoxic T-cells, which neutralise the pathogen more rapidly to prevent disease.

Question 29 (a)

Criteria	Marks
• Provides justification for <i>Varroa</i> mite infection being an infectious disease	2
• Provides some relevant information	1

Sample answer:

Varroa mite is an infectious disease because the mite is a parasitic pathogen that is spread between bees and hives that come into direct contact with the pest.

Question 29 (b)

Criteria	Marks
• Explains TWO procedures used to prevent the spread of <i>Varroa</i> mite	4
• Explains ONE procedure OR • Describes procedures used to prevent the spread of <i>Varroa</i> mite	3
• Describes ONE procedure OR • Outlines TWO procedures	2
• Provides some relevant information	1

Sample answer:

Measures used to prevent the spread of *Varroa* mite include:

- Early identification of *Varroa* mite infestation ensures early detection and isolation of infected bee populations. This will stop them from spreading to healthy bees
- Destroy infected hives. This will kill the mites and infected bees, preventing the spread of the mite to healthy hives.

Answers could include:

- Regular monitoring of bee colonies
- Minimising exposure by washing equipment and disinfection

Question 30 (a)

Criteria	Marks
• Describes an appropriate process used to produce genetically modified mosquitoes	4
• Outlines an appropriate process used to produce genetically modified mosquitoes	3
• Shows some understanding of how genetically modified mosquitoes are produced	2
• Provides some relevant information	1

Sample answer:

To produce the genetically modified (GM) mosquitoes, it is necessary to transfer the SERPINE 1 gene from a human to the mosquito using recombinant DNA technology. Restriction enzymes are used to cut the SERPINE 1 gene from a human cell chromosome. A bacterial plasmid (circular DNA) is opened using the same restriction enzymes and the SERPINE 1 gene is inserted and attached using DNA ligase. The bacteria then reproduce, producing multiple copies of the SERPINE 1 gene. The gene can then be delivered into the mosquitos. This can be done by micro-injection into mosquito egg cells, so that the mosquito which develop from the egg will contain the SERPINE 1 gene, which will allow the mosquito to express PAI-1.

Question 30 (b)

Criteria	Marks
• Demonstrates an extensive understanding of the impacts of genetic technologies for society • Provides a relevant judgement	7
• Demonstrates a thorough understanding of the impacts of genetic technologies for society • Provides a judgement	5–6
• Demonstrates a sound understanding of the impacts of genetic technologie/s for society	3–4
• Demonstrates some understanding of the impact of a genetic technology	2
• Provides some relevant information	1

Sample answer:

In recombinant DNA technology, selected genes can be cut and pasted from one organism into another using, for example, ligase enzymes. The human insulin producing gene has been transferred into bacteria, allowing for increased production of insulin, benefitting sufferers of diabetes, who can access insulin more readily and cheaply. This means that diabetes patients have a greater life span.

Genetic technologies such as CRISPR can be used for controlling pest populations including insects that cause diseases in both humans and other animals. By controlling the number of disease causing insects eg mosquitoes that cause dengue fever, we can significantly reduce the incidence of the vector-borne diseases. This would result in healthier populations and reduced stress on the health care system.

These technologies have largely been beneficial to society, improving access to drugs, the life expectancy and quality of life for many people.

Answers could include:

Benefits of the following genetic technologies

- Artificial insemination
- Artificial pollination
- Cloning.

Argument against genetic technologies

- Unintended health effects
- Environmental risks
- Ethical concerns.

Question 31 (a)

Criteria	Marks
- Identifies the type of inheritance from the pedigree - Provides an appropriate justification	3
Demonstrates some understanding of the type of inheritance from the pedigree	2
Provides some relevant information	1

Sample answer:

Type of inheritance: autosomal recessive

	b	b
B	Bb	Bb
b	bb	bb

BB – unaffected

bb – affected

Bb – unaffected

Individuals 3 and 4 have affected and unaffected children. Since 9 is an unaffected male, 3 would have to be heterozygous with genotype Bb and 4 would be homozygous recessive. For 10 to be affected, they would have inherited the recessive allele from the father and the mother.

Answers could include:

Individuals 8 and 9 are unaffected but have an affected child (17) thus the disease is recessive and was inherited from both parents making it autosomal. Individual 15 would be affected if it was sex-linked.

Question 31 (b)

Criteria	Marks
- Explains the type of mutation - Makes reference to the data provided	3
Outlines the mutation with reference to the data provided	2
Provides some relevant information	1

Sample answer:

The amino acid sequence in the unaffected individual is Glutamine-Tyrosine-Valine-Aspartic acid. The codon GUC coding for Valine is replaced with AUC, producing Isoleucine. As a single nucleotide is changed, CAMT is a point mutation.

Answers could include:

Missense, substitution

Question 32

Criteria	Marks
• Designs an appropriate epidemiological study that could produce most features of the graphed results • Justifies the features/steps with reference to the information provided	7
• Designs an appropriate epidemiological study that could produce some features of the graphed results • Justifies feature(s)/step(s) with reference to the information provided	5–6
• Provides some features of an epidemiological study • Makes some reference to the information provided	3–4
• Demonstrates some understanding of epidemiological studies	2
• Provides some relevant information	1

Sample answer:

Individuals from age groups 10, 20 and 30 in areas A, B and C should be surveyed over 55 years as shown in the graph. Areas A and B are connected via a road bridge so the communities can easily mix but area C is isolated so would serve as a control group.

The study should include equal numbers of males and females to ensure validity. To determine the risk of developing the disease due to age at exposure, data must be collected on other relevant features including diet, exercise, exposure to disease causing agents, general lifestyle and daily activities, and health of individuals.

Correlating the data to find common features or activities would help determine the risk of disease due to age at exposure. Surveying large numbers of individuals would improve the validity of the study.

Question 33 (a)

Criteria	Marks
• Compares the cell division processes in cell <i>R</i> and cell <i>S</i>	3
• Describes a cell division process	2
• Provides some relevant information	1

Sample answer:

Cell *R* undergoes mitosis which results in two genetically identical daughter cells. Cell *S* undergoes meiosis with half the chromosome number producing gametes. Both mitosis and meiosis will require DNA replication where the genetic content doubles.

Question 33 (b)

Criteria	Marks
• Correctly explains the relationship between the two individuals	2
• Provides some relevant information	1

Sample answer:

Individual 1 is the parent of Individual 2 because they provide a gamete to produce the offspring which is Individual 2.

Question 33 (c)

Criteria	Marks
• Provides a thorough analysis of how the separate mutations account for genetic differences in the cells	4
• Provides a sound analysis of how the separate mutations account for genetic differences in the cells	3
• Demonstrates some understanding of how the separate mutations account for genetic differences in the cells OR • Provides a sound analysis of a mutation	2
• Provides some relevant information	1

Sample answer:

Mutation *A* is a germline mutation and will not be present in Individual 1, but could be present in its offspring, including individual 2. Mutation *B* is a somatic cell mutation and will only be present in some cells of Individual 2 but not their offspring. As a result, cell *U* will not have mutations *A* or *B*. Cell *V* could have mutation *A* but not *B* and cell *W* could have both mutations. Cell *X* could carry mutation *A*.

Question 34 (a)

Criteria	Marks
Explains why the small population allele frequency fluctuations are more pronounced compared to that of a larger population	2
Makes a comparison between the two groups	1

Sample answer:

The smaller the population size, the smaller the gene pool. Small gene pools have a decreased genetic diversity, so any fluctuations in allele frequency will have a greater effect on the gene pool.

Question 34 (b)

Criteria	Marks
Evaluates the effects of gene flow on a gene pool for both small and large populations	4
Describes the effects of gene flow on a gene pool for both small and large populations	3
Describes an effect of gene flow on a gene pool for either small or large populations	2
Provides some relevant information	1

Sample answer:

Small populations have limited genetic diversity. Gene flow can benefit the gene pool by introducing genetic variation into a population. If the environmental conditions are favourable, the gene can easily spread to increase the population's ability to adapt to a changing environment. Where the environmental conditions are unfavourable, the gene will quickly be removed due to natural selection, as shown in the graph of the small population where the frequency of the introduced allele is shown to dramatically change in frequency.

The impact of the introduced gene is less pronounced in larger populations, due to the higher level of genetic variation already present. Gene flow generally has a positive effect by further increasing genetic diversity. The graph shows that the allele frequencies of a larger population fluctuate little over time as the introduced allele is of a lower proportion in the gene pool.

The impact of gene flow can be positive or negative depending on population size and environmental conditions.

2025 HSC Biology Mapping Grid

Section I

Question	Marks	Content	Syllabus outcomes
1	1	Mod 5 Reproduction	12-12
2	1	Mod 6 Mutation	12-13
3	1	Mod 7 Immunity	12-14
4	1	Mod 6 Mutation	12-13
5	1	Mod 7 Causes of Infectious Disease	12-14
6	1	Mod 7 Prevention, Treatment and Control	12-14
7	1	Mod 8 Homeostasis	12-5, 12-15
8	1	Mod 5 Genetic Variation	12-12
9	1	Mod 8 Technologies and Disorders	12-6, 12-15
10	1	Mod 7 Prevention, Treatment and Control	12-5, 12-14
11	1	Mod 7 Prevention, Treatment and Control	12-14
12	1	Mod 6 Mutation	12-13
13	1	Mod 8 Epidemiology	12-6, 12-15
14	1	Mod 7 Immunity	12-14
15	1	Mod 8 Technologies and Disorders	12-6, 12-15
16	1	Mod 6 Genetic Technologies	12-13
17	1	Mod 5 Cell Replication	12-6, 12-12
18	1	Mod 5 Genetic Variation	12-6, 12-12
19	1	Mod 5 Cell Replication	12-6, 12-12
20	1	Mod 8 Causes and Effects	12-5, 12-13, 12-15

Section II

Question	Marks	Content	Syllabus outcomes
21	2	Mod 7 Immunity	12-14
22 (a)	2	Mod 5 Reproduction	12-12
22 (b)	2	Mod 7 Causes of Infectious Disease	12-14
23	3	Mod 6 Genetic Technologies	12-13
24 (a)	2	Mod 8 Homeostasis	12-15
24 (b)	2	Mod 8 Homeostasis	12-6, 12-15
25	3	Mod 8 Prevention	12-5, 12-15
26	4	Mod 8 Technologies and Disorders	12-15
27	6	Mod 5 Reproduction	12-5, 12-12
28 (a)	4	Mod 7 Immunity	12-5, 12-14
28 (b)	2	Mod 7 Immunity	12-5, 12-14
28 (c)	3	Mod 7 Immunity	12-5, 12-14

Question	Marks	Content	Syllabus outcomes
29 (a)	2	Mod 7 Causes of Infectious Disease	12-14
29 (b)	4	Mod 7 Prevention, Treatment and Control	12-14
30 (a)	4	Mod 6 Genetic Technologies	12-13
30 (b)	7	Mod 6 Genetic Technologies	12-6, 12-13
31 (a)	3	Mod 5 Genetic Variation	12-6, 12-12
31 (b)	3	Mod 5 DNA and Polypeptide Synthesis	12-6, 12-12
32	7	Mod 8 Epidemiology	12-2, 12-5, 12-15
33(a)	3	Mod 5 Cell Replication	12-5, 12-12
33 (b)	2	Mod 5 Reproduction	12-12
33 (c)	4	Mod 6 Mutation	12-5, 12-13
34 (a)	2	Mod 5 Inheritance Patterns in a Population	12-5, 12-12
34 (b)	4	Mod 6 Mutation	12-13