Student NESA Number

2021
HSC Trial
EX A M I N AT I O N

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 Student Number on the top of this page and on the top of the multiple question answer sheet, and both Section II option booklets.

Total Marks – 100

Section I (pages 3 – 13)

20 marks

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

Section II (pages 10 – 33)

80 marks

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

Section I

Part A – 20 marks

Attempt Questions 1 – 20

Allow about 35 minutes for this part

Use the multiple-choice answer sheet

Select the alternative A, B, C or D that best answers the question. Fill in the response oval completely.

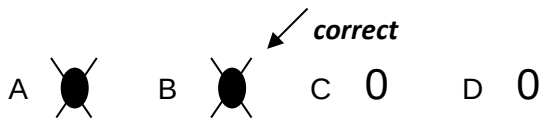
Sample 2 + 4 = (A) 2 (B) 6 (C) 8 (D) 9

A 0 B ● C 0 D 0

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

A 0 B ⊗ C 0 D 0

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:



Section I

20 marks

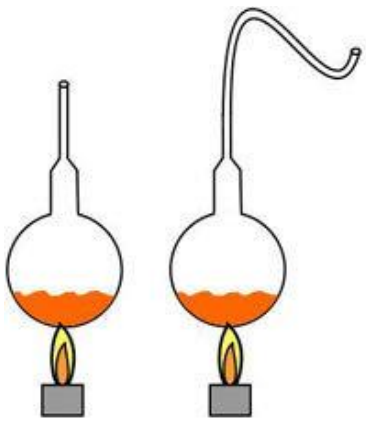
Attempt Questions 1–20

Allow about 35 minutes for this part

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

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1. Louis Pasteur designed a procedure to test whether sterile nutrient broth could spontaneously generate microbial life. In two different flasks, Pasteur added equal amounts of nutrient broth, bent the necks of the flasks into S shapes, and then boiled the broth. He broke the neck of one of the flasks and observed the microbial growth in each flask over time.



Why did Pasteur use a swan-necked flask in his investigation?

A The glass was easy to sterilise using heat ensuring better microbial growth.

B The curved neck ensured that the broth would condense in the neck therefore maximising exposure.

C A swan-necked flask allowed him to easily observe his results.

D The curved neck caught the microbes in air that entered the flask and prevented them from contaminating the broth

2. Which of the following body systems is involved in detecting and responding to environmental changes?

A Circulatory

B Digestive

C Excretory

D Nervous

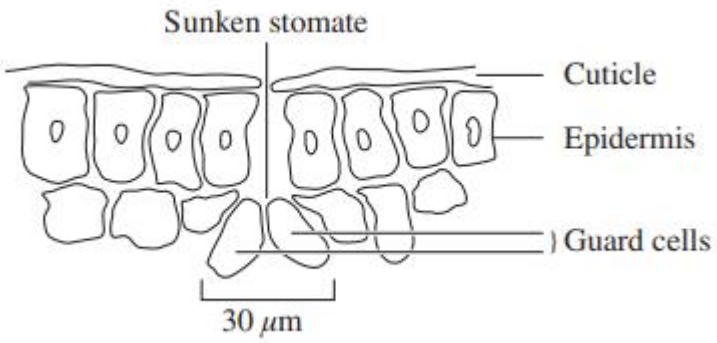
Question 3 is over the page

3. Which of the following correctly identifies the characteristics for reproduction for these organisms?

	Reptiles	Unicellular Fungi	Flowering Plant	Protists
A	external fertilisation	budding and spores	sexual and asexual	binary fission and budding
B	internal fertilisation	binary fission only	sexual only	Spores
C	internal and external fertilisation	budding and spores	asexual and sexual	binary fission only
D	external fertilisation	binary fission and budding	sexual only	binary fission only

4. Sunken stomata can be found in the leaves of some Australian plants in central Australia where they experience very dry conditions. A section of such a leaf is shown.

Sunken stomate Cuticle Epidermis



The sunken stomata assist the plant to maintain water balance by

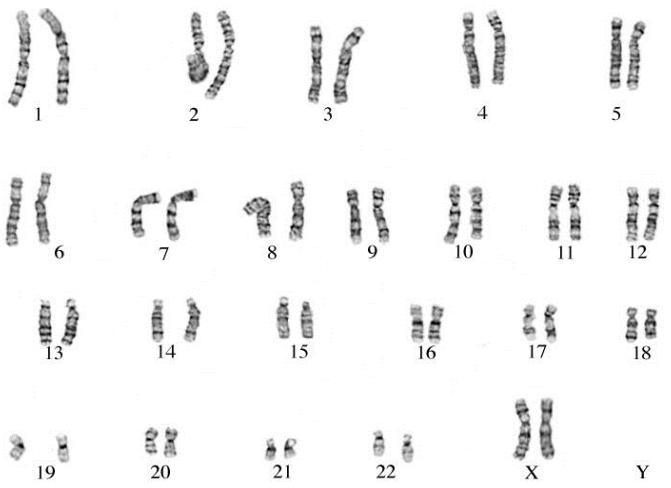
A increasing the surface area available for transpiration.

B trapping moist air, for effective gas exchange and photosynthesis.

C opening and closing based on a water feedback loop, to reduce transpiration.

D reflecting the sunlight away to reduce transpiration.

5. The karyotype below shows the chromosomes present in the nucleus of a human cell.



The cell must be a:

A Autosomal

B Diploid

C Gamete

D Homozygous

6. The table lists the types of microbes identified in a cheeseburger prepared at an outdoor market.

Type of microbe	Description of microbe
Staphyolcoccus epidermidis	Common skin organism
Lactobacillus Bulgari	Organism present in dairy products
Saccharmoyces cerevisiae	Baker's Yeast
Salmonella entercolitis	Found in raw Chicken

Why is it not safe to eat this cheeseburger?

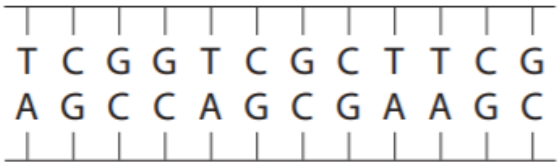
A Food should be completely free of microbes

B As this would be a vector transmission for all microbes

C As Lactobacillus and Saccharmoyces are highly pathogenic.

D As hygienic practices have not be followed while preparing the food.

7. A section of DNA from a plant is show in the diagram.



How many codons are shown in this section of DNA?

A 2

B 4

C 8

D 12

8. Eight sick animals were found to be suffering from the same symptoms. Blood tests showed that they were infected with the same type of bacterium.

Which of the following strategies would be the best to determine if this particular type of bacterium is the cause of the disease?

A Find other animals with the same symptoms. Attempt to isolate the same type of bacterium from their blood.

B Inject blood from animals with the symptoms into suitable host individuals. If they develop the same symptoms, this proves that this type of bacterium caused the disease.

C Treat all eight animals with an antibiotic known to kill their type of bacterium. They will recover if this type of bacterium is the cause of the disease.

D Use bacteria cultured from the blood of the animals with these symptoms to infect suitable host individuals. If they develop the disease, attempt to isolate the same type of bacterium from the blood.

9. Chickenpox, an infectious disease, appears in a small regional town with a population of 5000 people. Chickenpox infects all age groups equally. At the beginning of July, the prevalence of the disease is 50. Over the month, the incidence of the disease is 0.1%. At the end of July, 250 people who contracted the disease at the beginning of the month have fully recovered. There were no deaths. How many people in the town had the disease at the end of July?

A 100

B 450

C 500

D 600

10. Most sheep only breed in a particular time of the year. A wool farmer was looking into artificial insemination to improve his wool production. He researched the process and summarised the information in a table as below. He refers to the period during which the female animal body becomes receptive to reproduction as Estrus.

Time after Estrus (hours)	0	5	10	15	20	25
Natural Mating	too early	optimal			too late	
Artificial Insemination	too early	good	good	optimal	good	too late

Which of the following conclusions can be derived from the information in the diagram?

A There is a higher chance of conception with natural mating than with artificial insemination

B Breeders need to know when their sheep come into heat to maximise the chance of conception

C Artificial insemination produces better quality lambs than natural mating.

D Artificial insemination has a shorter time frame for conception to occur than natural mating.

11. The secretion of specific hormones is carefully regulated during the ovulation cycle to prepare the uterus for the implantation of an embryo. After ovulation the corpus luteum enlarges and starts to secrete hormones X and Y.

If fertilisation and implantation occur, the pregnancy is controlled by hormone Y, which is secreted from the corpus luteum in the first three months and later from the placenta.

Hormone Z controls birth by causing coordinated contractions of uterine muscles.

What are hormones X, Y and Z respectively?

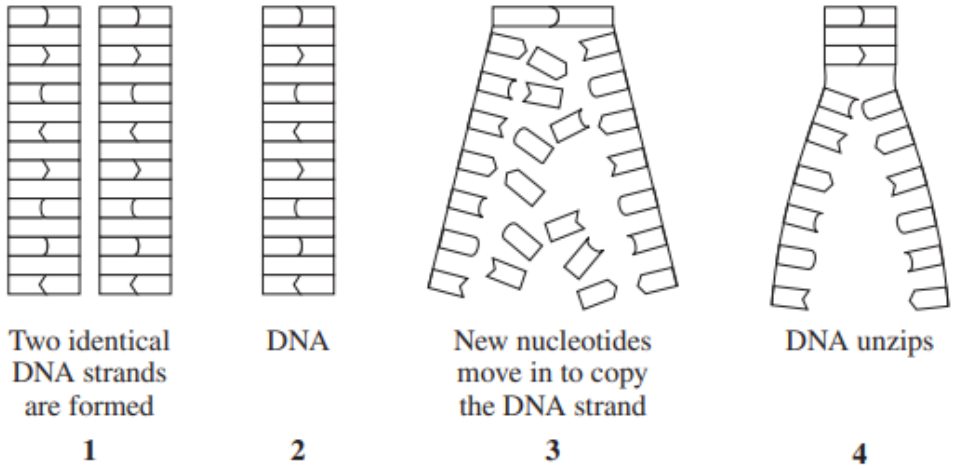
A Estrogen, oxytocin, prolactin

B Oxytocin, estrogen, progesterone

C Estrogen, progesterone, oxytocin

D Prolactin, progesterone, oxytocin

12. The diagram represents a model of DNA replication. The steps are NOT in the correct order.



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Which of the following is the correct order?

A 4, 3, 2, 1

B 2, 4, 3, 1

C 2, 3, 4, 1

D 1, 2, 3, 4

13 Select the answer that best represent the impact that radiation can have on DNA and cell activity.

A Mutation-- Change in polypeptide sequence -- Change in protein structure -- Change in cell activity

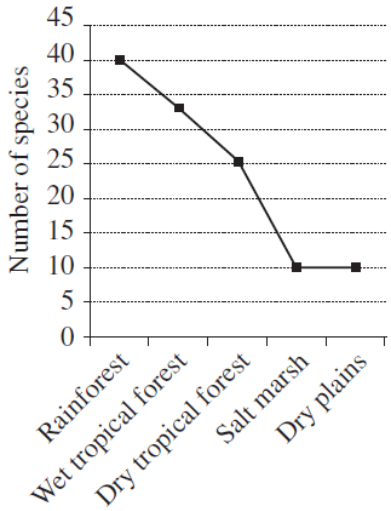
B Change in polypeptide sequence -- Change in protein structure -- Change in cell structure -- Mutation

C Change in polypeptide sequence -- Change in protein structure -- Change in cell activity – Mutation

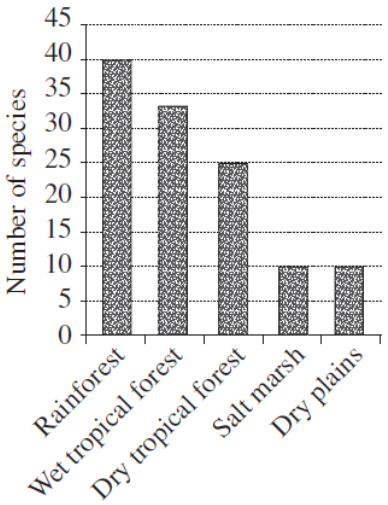
D Mutation -- Change in cell structure -- Change in protein structure -- Change in polypeptide sequence

14. A group of four students set out to determine the animal species diversity over an area of one hectare in each of five different habitats. Each student graphed their data as shown.

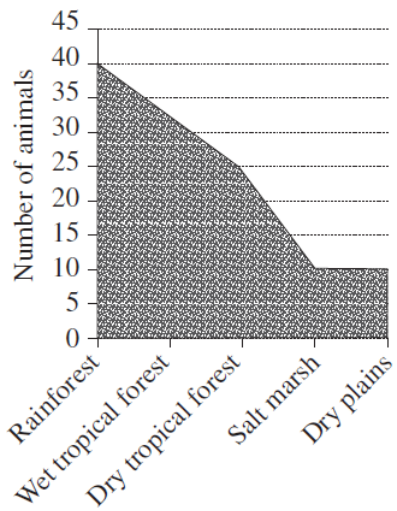
A



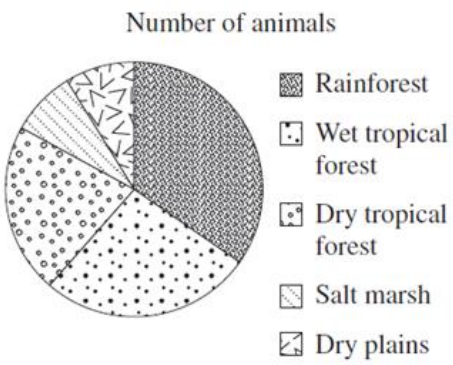
B



C



D



Which graph is the most appropriate for the data collected?

A A

B B

C C

D D

Questions 15 & 16 are over the page

15. Which of the following is true of a mutation that produces an allele that is dominant?

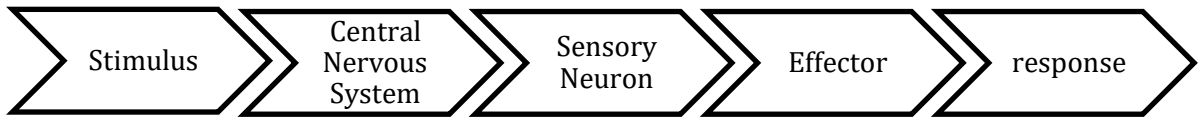
A It would be expected to cause death.

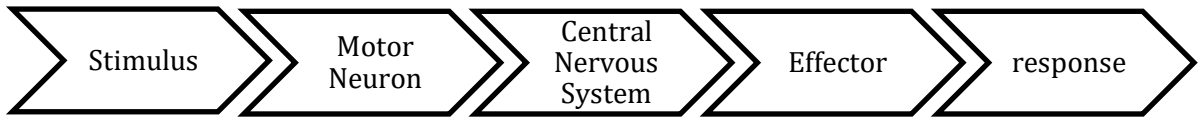
B It could give an observable phenotype in a heterozygous genotype.

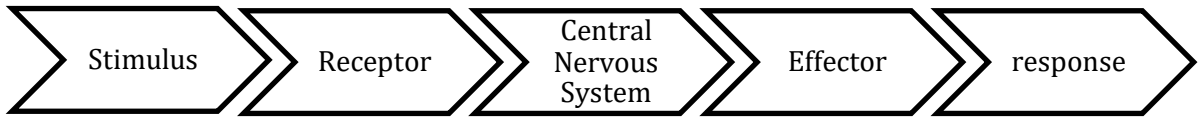
C It could give an observable phenotype only in a homozygous genotype.

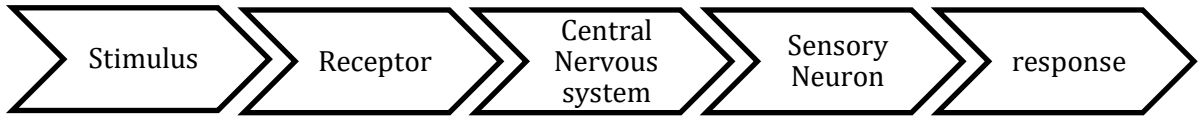
D It would be expected to spread more quickly through a population than a recessive mutation.

16. Identify the correct stimulus-response pathway.

A 

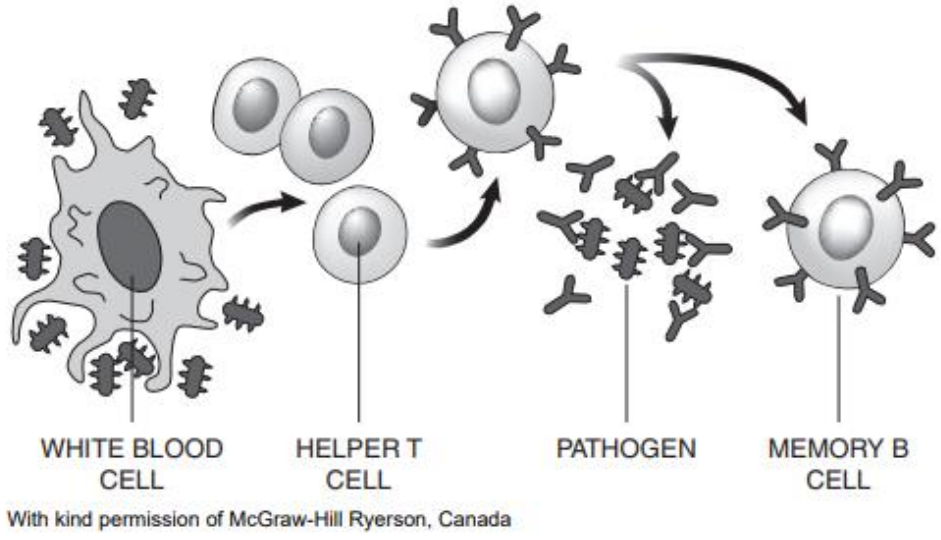
B 

C 

D 

Question 17 is over the page

17. The diagram Below is a list of statements, each describing a step in the immune response.



With kind permission of McGraw-Hill Ryerson, Canada

Below is a list of statements, each describing a step in the immune response.

1. Antibodies are produced to immobilise the pathogens.
2. B cell is activated by a helper T cell.
3. Helper T cells are activated by the white blood cell.
4. Memory B cell is ready to respond to further infections.

What is the correct sequence of events?

A 2, 3, 1, 4

B 2, 3, 4, 1

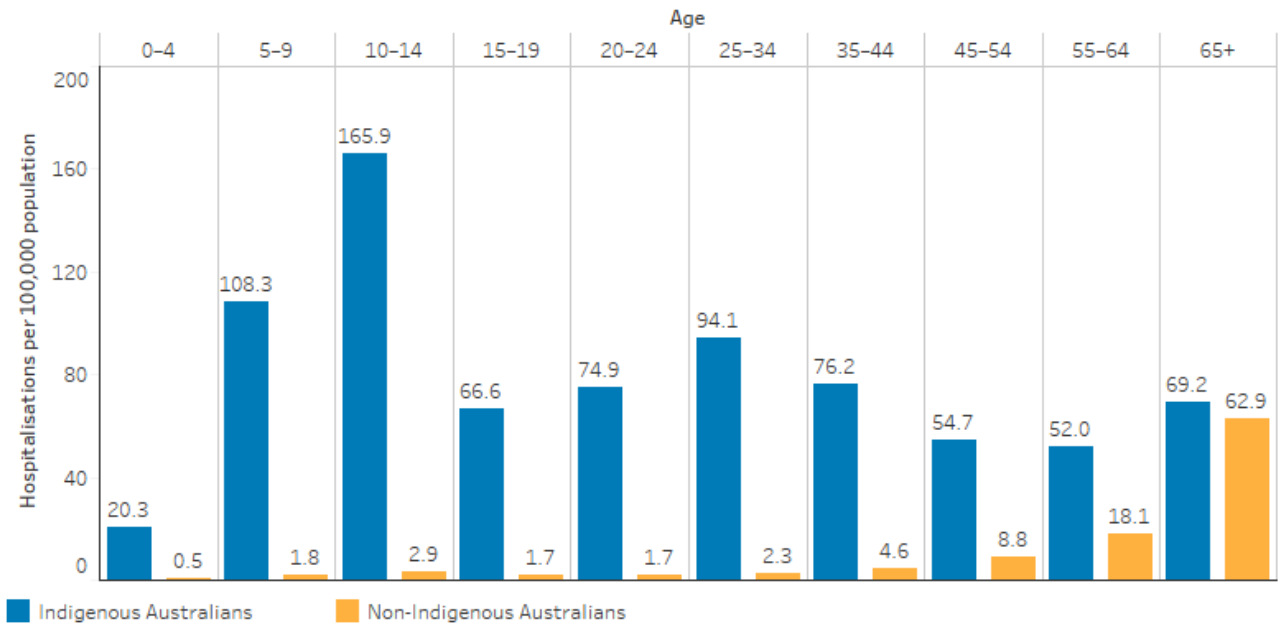
C 3, 2, 1, 4

D 3, 4, 2, 1

Question 18 is over the page

Refer to the information to answer Question 18

When a child gets a group A streptococcal infection of the throat (known as strep throat), their body's immune system, in trying to fight that infection, produces antibodies. Sometimes these antibodies, in addition to killing the strep, can damage their heart.
Acute rheumatic fever can occur following an untreated strep throat infection and can cause irreparable damage to the major cardiac valves, known as rheumatic heart disease.
Below is a graph showing the Hospitalisations with a principal diagnosis of acute rheumatic fever or chronic rheumatic heart disease, by Indigenous status and age, Australia, July 2015 to June 2017.



18 Identify the strategy that health authorities would prioritise when analysing this data?

A Determining which condition is infectious and developing a vaccine for it.

B Carrying out an epidemiological study to determine which Australians are most at risk.

C Developing a public campaign to raise awareness of the symptoms of Acute Rheumatic Fever and the necessary treatment.

D Reducing the number of cases of the children aged 10-14 being hospitalised.

Questions 19 and 20 are over the page

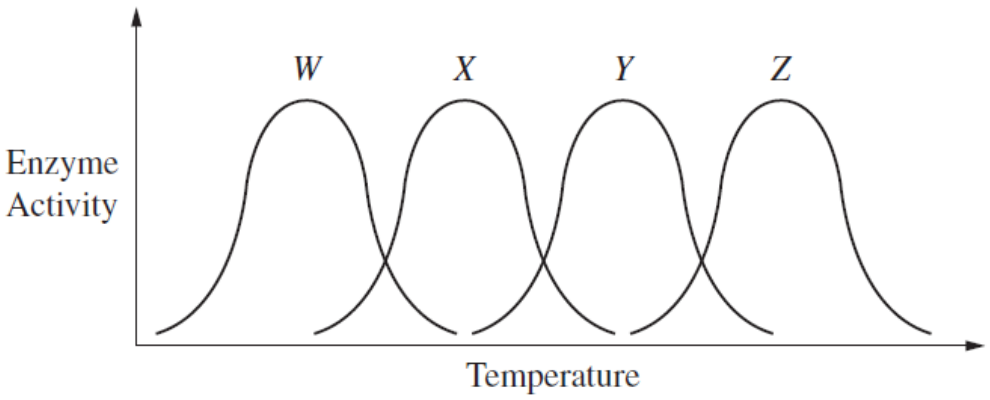
Refer to the information to answer Questions 19 and 20.

A case study of a fish species

A fish species can survive in environments with a wide range of temperature variation as long as the temperature change is gradual. The fish die if the temperature change is rapid because some metabolic reactions cannot take place.

Scientists have discovered that all the fish in this species have genes to produce four different enzymes (W, X, Y and Z) that catalyse the same reaction at different temperatures.

The graph shows the effect of increasing temperature on enzyme activity.



19. What is the best explanation for the fish surviving gradual temperature change but not rapid temperature change?

A It takes time for each gene to be expressed.

B Enzyme activity is decreased at low temperatures.

C The fish produce different enzymes at different temperatures.

D Some enzymes will not denature if the temperature change is gradual.

20 What does this case study demonstrate?

A The specificity of substrates to enzymes

B The effect of the environment on phenotype

C The narrow temperature limitations for individual species

D The maintenance of a constant body temperature for metabolic efficiency

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Section II Answer Booklet

Questions 21 - 30

(42 Marks)

80 marks
Attempt Questions 21–33
Allow about 2 hour and 25 minutes for this section

Answer the questions in the spaces provided.

Question 21 (4 marks)

Compare the processes and outcomes of artificial insemination and artificial pollination.

_____

_____

_____

_____

_____

_____

Question 22 (2 marks)

Describe the responses of a named Australian plant to a named fungal or viral pathogen.

_____

_____

_____

_____

Question 23 (4 marks)

Complete the table below, to describe a non-infectious nutritional disease OR a disease caused by environmental exposure.

Name of Disease	
Cause	
Effects on the individual	
Treatment/management	
Possible future directions for further research.	

Question 24 (4 marks)

Evaluate the effectiveness of a technology that is used to manage and assist with the effects of a disorder for one of the following;

- Hearing loss
- Visual disorder
- Loss of kidney function

Question 25 (8 marks)

(a) In the space below, draw a negative feedback loop such as temperature control or glucose balance to demonstrate the process of homeostasis. (4 marks)

Question 25 continued over the page

(b) Why are negative feedback loops important in the maintenance of homeostasis? (4 marks)

_____

_____

_____

_____

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_____

(c) Describe a behavioural, structural or physiological adaptation in endotherms. (3 marks)

_____

_____

_____

_____

_____

_____

Question 26 (5 Marks)

The following karyotype shows the number and appearance of the chromosomes of a child. This karyotype was used to help to diagnose the child with a particular genetic disorder that affects chromosomes.



(a) Name the type of mutation that causes this genetic disorder. (1 mark)

_____

(b) Explain how this type of mutation occurs and why it results in a genetic disorder. (4 marks)

_____

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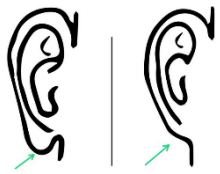
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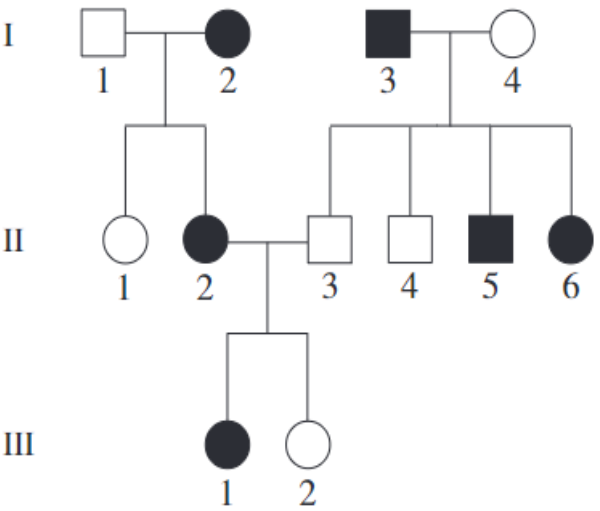
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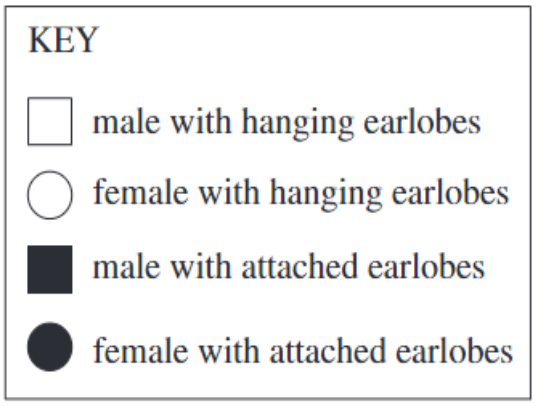
Question 27 (4 Marks)



The possession of one of two types of earlobe (hanging or attached) is sometimes used to study the inheritance of characteristics in humans.

The pedigree below shows the different types of earlobes present in three generations. In the first generation, individuals 1 and 4 are heterozygous for the alleles responsible for earlobe type and individuals 2 and 3 are homozygous for these alleles.

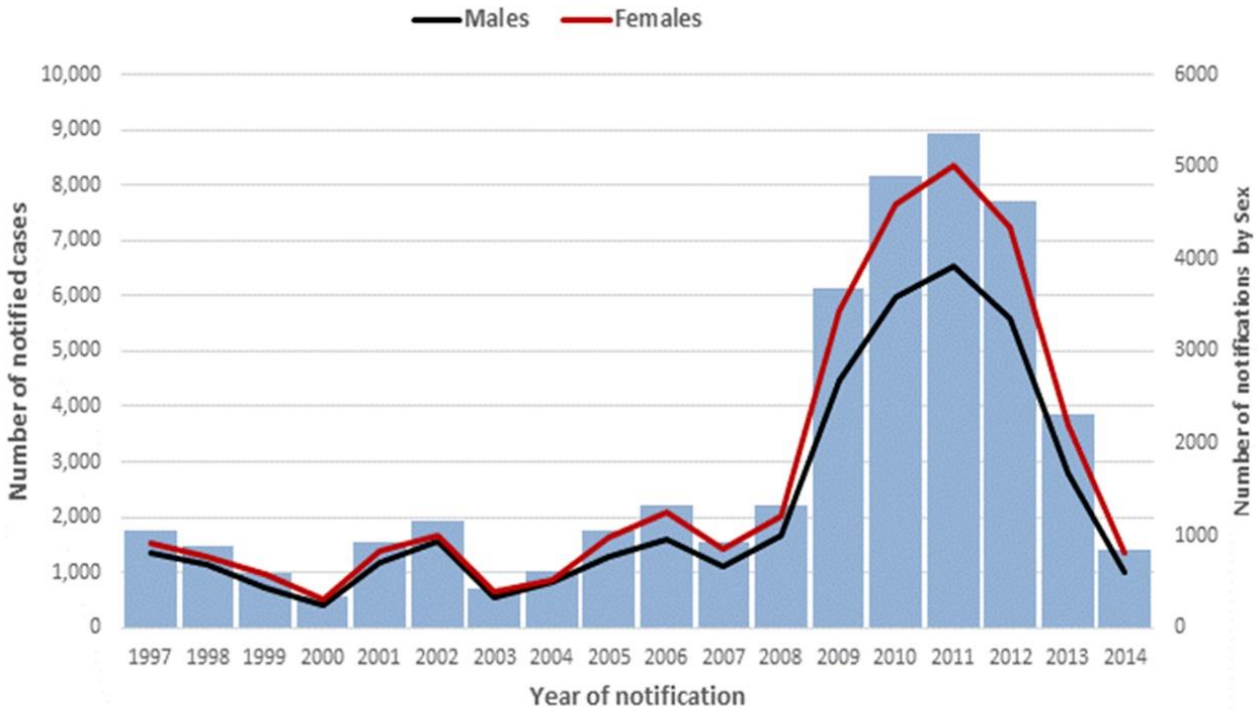




Discuss the type of inheritance shown in the pedigree. In your answer, justify with reference to specific alleles. (4 marks)

Question 28 (4 marks)

(a) Pertussis (commonly known as Whooping Cough) is a disease that when diagnosed must be reported to the government for monitoring. Morbidity is highest in infants too young to be fully protected by routine vaccination schedules. Pertussis is commonly transmitted to infants from exposure to parents, siblings – responsible for up to 80% of infections – and to a lesser extent grandparents and exposure to other children in child care and other health care settings. The Government introduced a program for free vaccination program for Pregnant women, carers and Grandparents.



https://www.cambridge.org/core/journals/epidemiology-and-infection/article/pertussis-epidemiology-prior-to-the-introduction-of-a-maternal-vaccination-program-queensland-australia/9F76A1AAD25EF59797D8A425262C8505

(i) Use the graph below to determine what year this program was introduced. (1 mark)

_____

(ii) With reference to this data, explain the trend and why there was a need to modify the existing vaccination program with the introduction a booster vaccination for adults. (3 marks)

_____

_____

_____

_____

_____

Question 29 (5 marks)

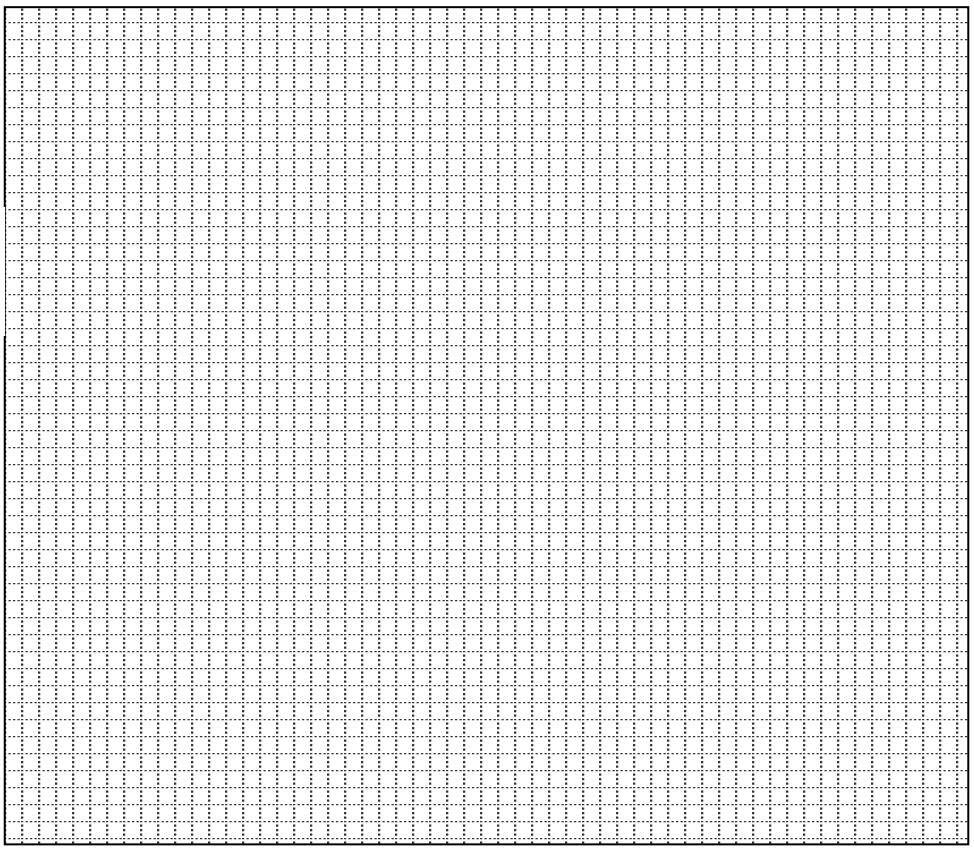
Both genes and the environment determine the phenotype of an individual. An understanding of the extent to which the environment is responsible for the acquisition of various non-infectious diseases is an extremely useful tool in helping to prevent these diseases.

The table below shows the results of a study in which the degree of contribution of genetics and the environment towards five different forms of cancer were determined.

Type of Cancer	Contribution on environmental factors (%)	Contribution of Genetic factors (%)
Breast	75	25
Bowel	64	36
Prostate	60	40
Lung	73	27
Stomach	75	25

(a) On the grid below, draw an appropriate graph to show the relationship (if any) between the environmental and genetic factors for certain cancers (3 marks).

Percentage contribution



Type of cancer studied

(b) From your graph, what inference can be made about the relationship between the environment and the genetic predisposition to certain cancers. (2 marks)

_____

_____

_____

_____

QUESTION 31 is continued in BOOKLET TWO

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Section II Answer Booklet

Questions 31 - 34

(38 marks)

Question 31 (7 marks)

"Life continues through the processes of reproduction and heredity."

Assess this statement by analysing the causes of genetic variation relating to the processes of fertilisation, crossing over, meiosis and mutation. (7 Marks)

Question 32 is over the page.

Question 32 (7 marks)

Barry J. Marshall and Robin Warren, two Australian researchers, were awarded a Nobel Prize in Physiology or Medicine for their discovery of the bacterium *Helicobacter pylori* and its role in gastritis and peptic ulcer disease (a stomach condition).

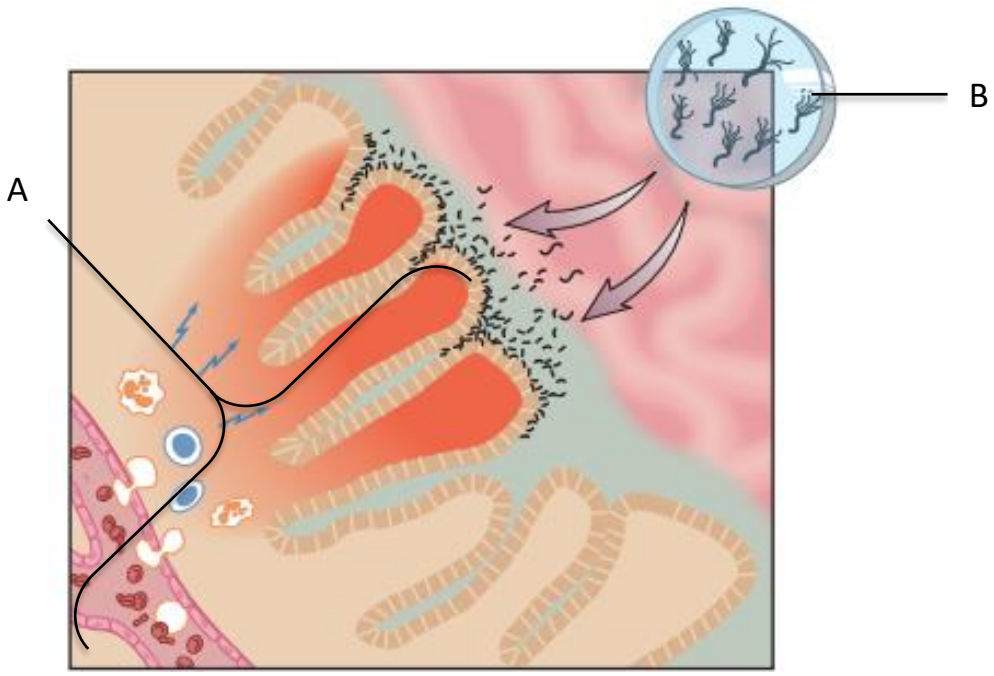
Warren and Marshall's investigations included:

- using a microscope to look at prepared slides of ulcerated stomach tissue;
- using a flexible endoscope with a camera to view the inside of the stomach of patients with stomach ulcers and gastritis for localised or general inflammation of the stomach
- using staining techniques to determine the possible presence of bacteria in stomach tissue.

In addition, Warren checked that Marshall's stomach contained no Helicobacter pylori. Marshall then swallowed a dose of the bacteria, triggering symptoms of gastric ulcer disease.

Below is a diagram of a cross section of a stomach with a peptic ulcer.

(a) Complete the table below to identify what A and B represents and your observations from the diagram to justify your answer. (2 marks)

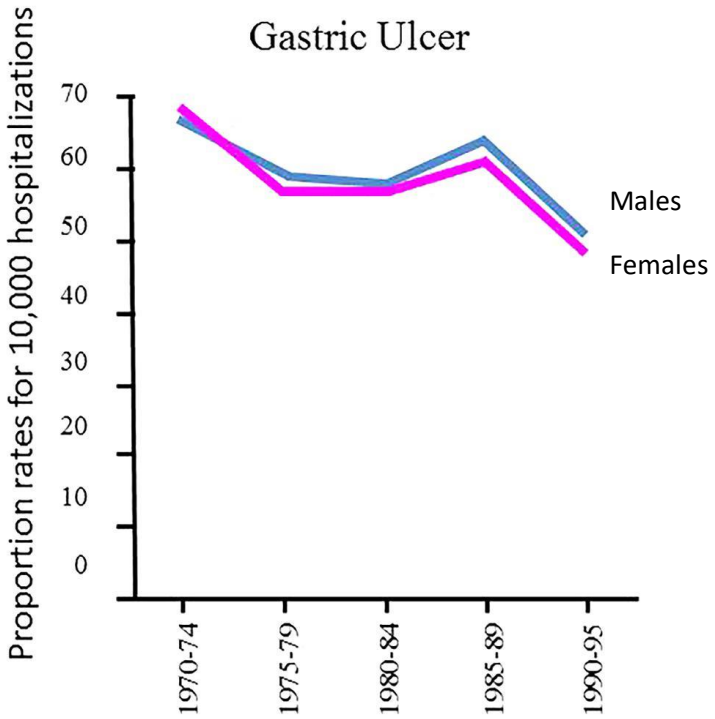


Label	Name	Observations used for justification of answer
A		
B		

Question 32 is continued over the page

Question 32 continued

The graph below represents the number of people per 10 000 that have been hospitalised due to Peptic Ulcers (Gastric Ulcer) over a twenty-year period.



(b)

(i) Use the graph to identify the year range that Warren and Marshall made their discovery. (1 mark)

_____

(ii) Name the type of pharmaceutical that would be best used to treat the bacterial infection. (1 mark)

_____

(iii) Describe the possible long-term effectiveness of the identified pharmaceutical in part (ii) and how this may affect the trend of the graph above. (3 marks)

_____

_____

_____

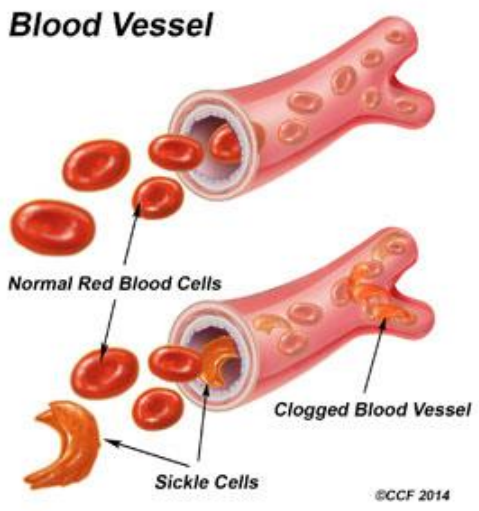
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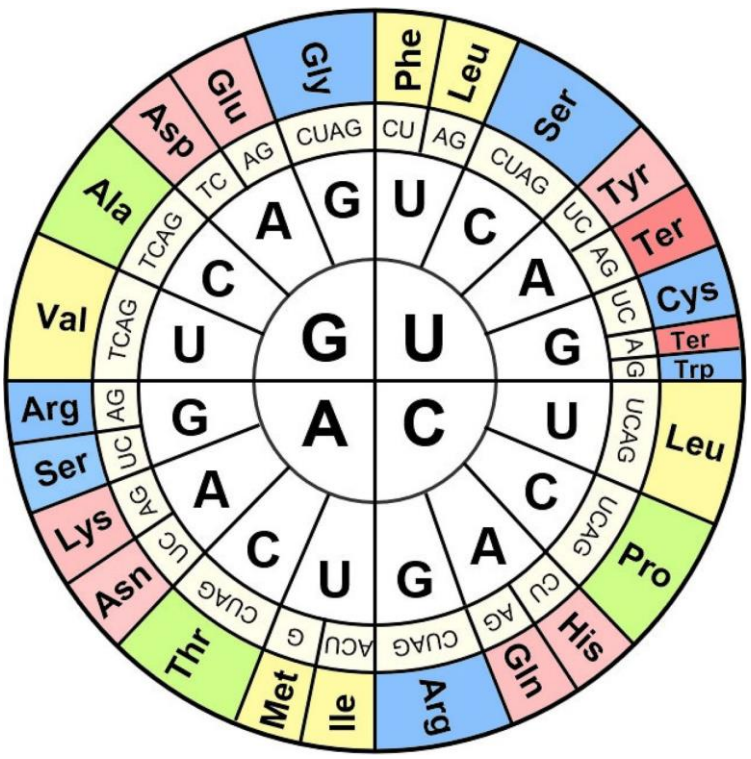
_____

Question 33 (16 marks)

Sickle cell disease is an inherited red blood cell disorder that affects haemoglobin, the protein that carries oxygen through the body. Normally, red blood cells are disc shaped and flexible to making it easy for them to move through the blood vessels. If you have sickle cell disease, your red blood cells are crescent or "sickle" shaped. These cells do not bend or move easily and can consequentially block blood flow to the rest of the body.



https://my.clevelandclinic.org/health/diseases/4579-sickle-cell-anemia



This disorder is caused by a mutation in the beta goblin gene that codes for one of the protein chains that make up the haemoglobin molecule. The RNA Codon Chart below can be used to determine the section of the amino acid sequence that forms this protein in people with and without Sickle Anaemia and can be used to assist with answering part (a).

(a) Complete the table below (4 marks)

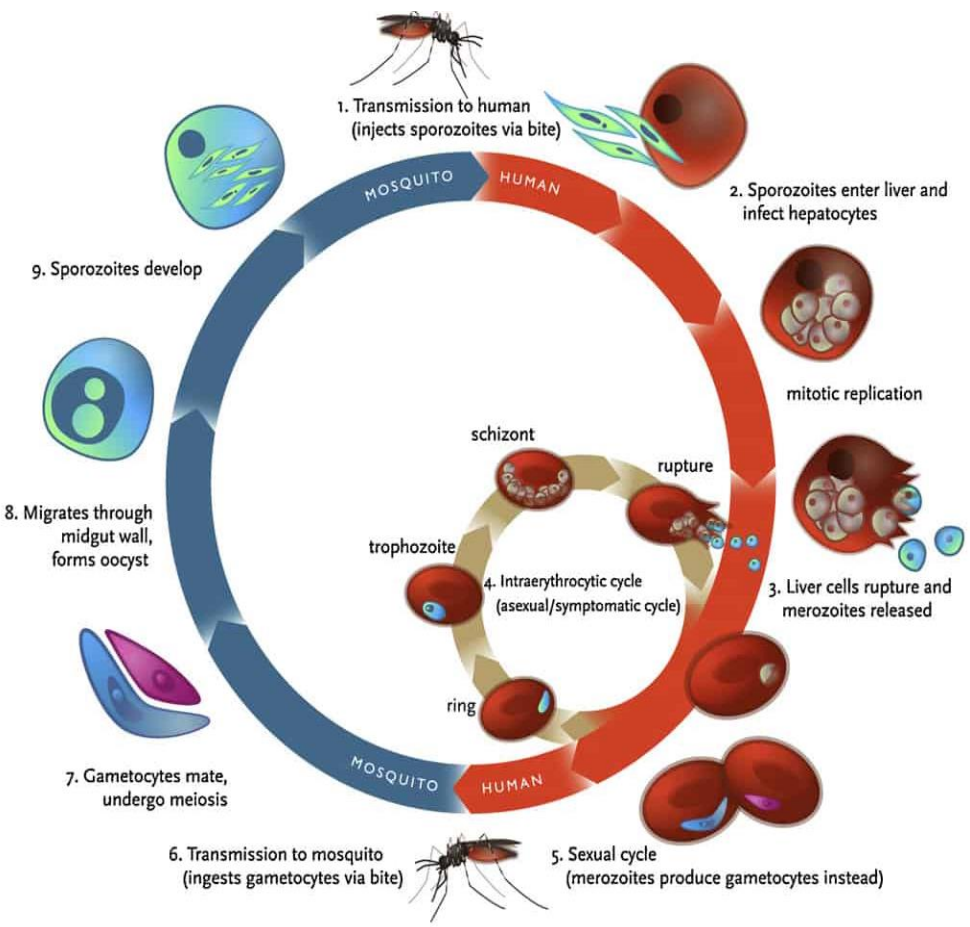
	NORMAL RED BLOOD CELLS	SICKLE RED BLOOD CELLS
DNA sequence	CAC CTG ACT CCT GAG GAG	CAC CTG ACT CCT GTG GAG
Translation		
Amino Acid sequence		
Name of mutation		

Question 33 is continued over the page

(a) Sickle Cell Anaemia is a Codominant autosomal disease. The heterozygous individuals have both normal and sickle shaped red blood cells but generally are symptom free. These individuals are referred to as carriers and have the Sickle Cell **Trait** as compared to a homozygous recessive who has the Sickle Cell Anaemia **Disease**. What are the chances of two individuals both with the Sickle Cell trait having a child with Sickle Cell Anaemia? Show your working in the space below. (4 marks)

(b) The Sickle Cell Anaemia allele has a higher frequency in areas where the infectious disease Malaria is high. The parasite Plasmodium causes malaria. It is transmitted to humans through the bite of an infected Anopheles mosquito.

Life Cycle of the Malaria Parasite



Question 33 is continued over the page

Question 33 Continued

Use the information provided to identify TWO features of the Malaria infection that facilitate transmission of the pathogen to a new host. (2 marks)

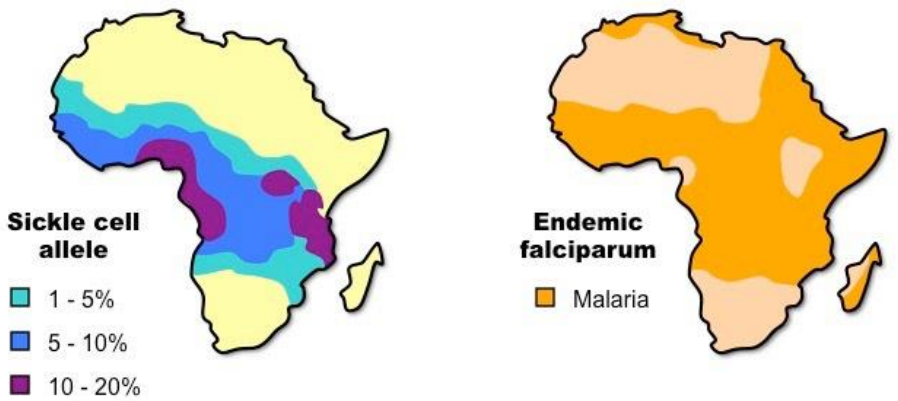
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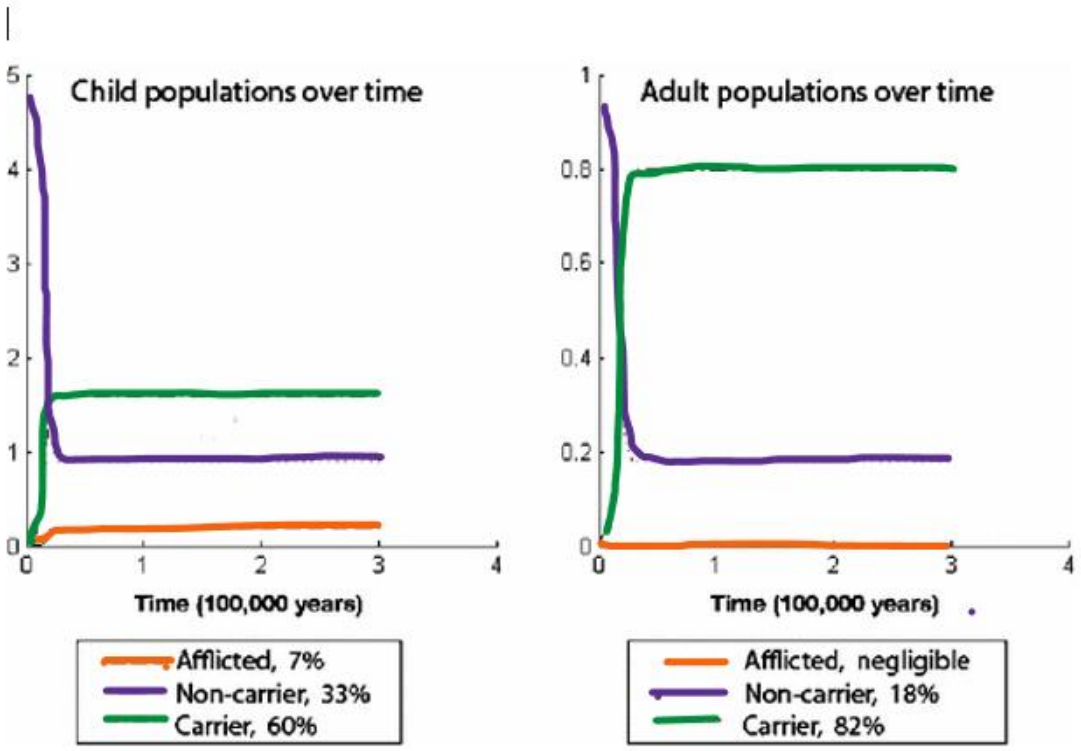
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Scientists are researching the hypothesis that the sickle cell allele frequency is higher in heterozygous individuals often referred to as Carriers. They have mapped the gene frequencies to areas with Malaria in Africa.



They have also developed a mathematical model (below) that proposed the frequencies of the gene over time.



Note:

Afflicted = Sickle Cell Anaemia Disease

Question 33 is continued over the page

Question 33 Continued

Describe the methodology that epidemiologists would carry out to investigate the cause and effect relationship shown in the model. Evaluate the effectiveness of this model to investigate the hypothesis. (6 marks)

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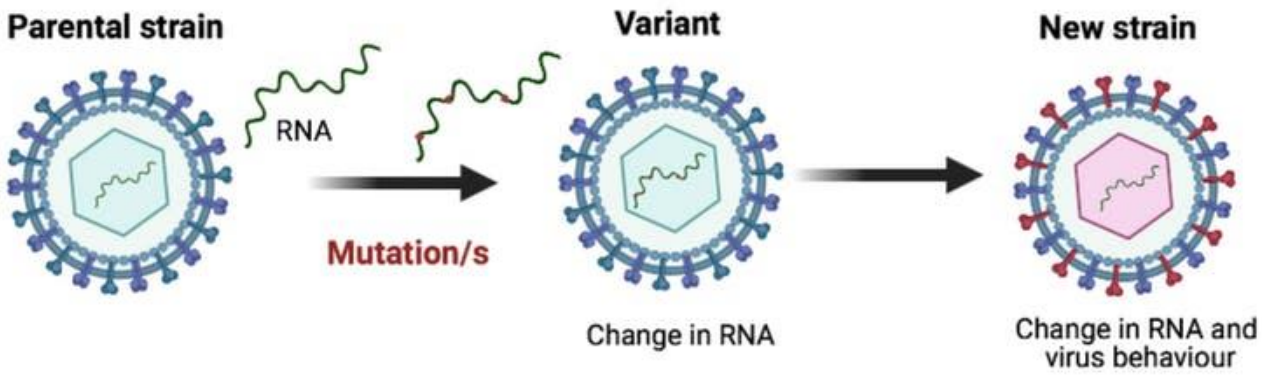
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Question 34 is over the page

Question 34 (8 marks)

The Avian Influenza virus has a high rate of mutation which lead to changes in the surface antigens.



Analyse the impact of high mutation rates for this virus and the implications for human health.

End of the Examination