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Student Number

Sydney Girls High School

2019

TRIAL
HSC
EXAMINATION

Biology

General Instructions

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

Total Marks: 100

Section I – 20 marks (pages 2 – 9)

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

Section II – 80 marks (pages 11 - 30)

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

Section I

20 marks

Attempt Questions 1 - 20

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

1. Immediately following a break in the skin, phagocytes engulf bacteria within the wound. This is an examples of an immune response which can be classified as
 - A. Adaptive, specific
 - B. Innate, specific
 - C. Innate, nonspecific
 - D. Adaptive, nonspecific

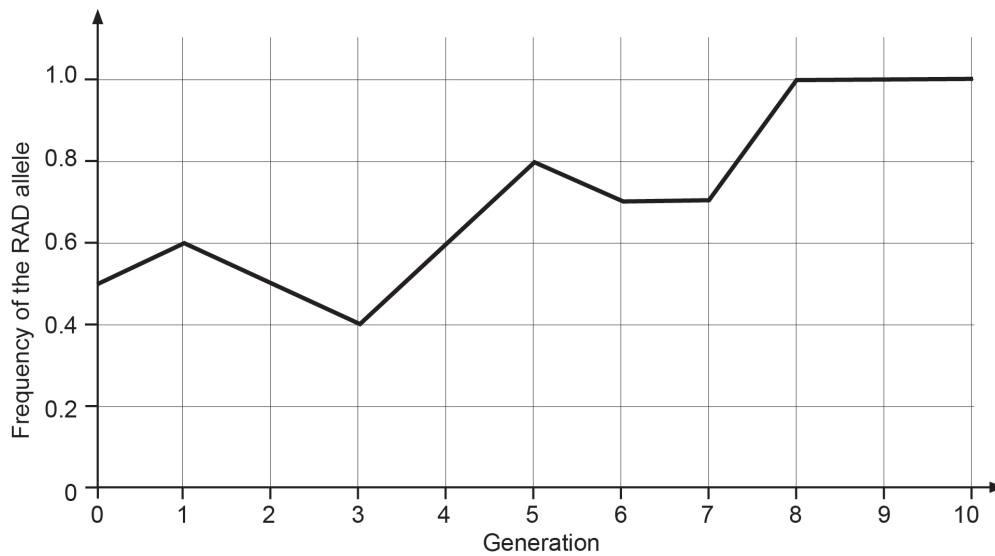
2. In order to be regarded as infectious, a disease must be
 - A. caused by a pathogen
 - B. caused by a mutation
 - C. able to infect humans
 - D. able to infect animals

3. A section of DNA has the following nucleotide sequence. AGG TCT CAG ATC .
What is the nucleotide sequence of the newly-made strand following DNA replication?
 - A. AGG TCT CAG ATC
 - B. AGG UCU CAG AUC
 - C. UCC AGA GUC UAG
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4. 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 would be expected to spread more quickly through a population than a recessive mutation.
 - C. It could give an observable phenotype in a heterozygous genotype.
 - D. It could give an observable phenotype only in a homozygous genotype.

5. A zebronkey hybrid is the result of crossing a male zebra which has a diploid ($2N$) number of 44 with a female donkey which has a haploid number (N) of 31. How many chromosomes will the zebronkey have?
- A. 53
 - B. 75
 - C. 84
 - D. 106
6. Which of the following processes occur in meiosis but do *not* occur in mitosis?
- I. Spindle formation
 - II. Separation of homologous chromosomes
 - III. Separation of sister chromatids
 - IV. Recombination
- A. I, II and III
 - B. I, II, III and IV
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7. In genetic engineering, plant viruses are sometimes used to introduce a foreign gene into a plant cell. This is because viruses are
- A. non-living and therefore easy to store in the laboratory.
 - B. non-living and therefore there are no ethical issues with using them in this way.
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 - D. able to invade the cell and merge their genetic material with that of the cell.

Questions 8 and 9 relate to the following figure which shows the frequency of an allele (RAD) for a gene in a population for 11 generations.



8. The frequency of the RAD allele in the population in Generation 3 is approximately

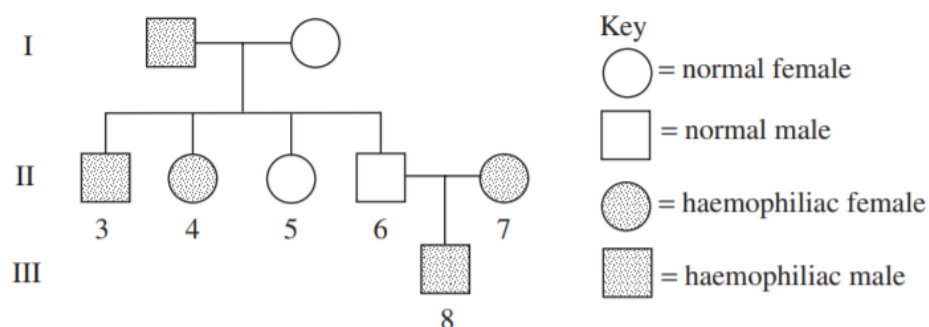
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9. By Generation 8, the frequency of the RAD allele is 1.00, which means that it is now the only allele present for this gene in this population. Which of the following needs to occur before evolution can take place at this gene after Generation 8?

- A. genetic drift
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Questions 10 and 11 refer to the following information.

Haemophilia is a human disease in which the blood of an affected individual does not clot. The disease is known to be caused by a sex-linked recessive allele. The family pedigree shows the pattern of inheritance of this disease in a family.



10. If X^h is the allele for haemophilia and X^n is the allele for normal clotting, what is the genotype of individual 5?

- A. $X^h X^h$
- B. $X^h X^n$
- C. $X^n X^n$
- D. $X^n Y$

11. If Individual 8 has a child with a female carrier of the disease, what is the probability that the child will have haemophilia?

- A. 0%
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12. A student was asked to identify a pathogen as either a bacterium or a prion after being given a number of its characteristics. She was able to identify it immediately as a prion when she was told its size. Which of the following sizes would have enabled her to be sure about this identifications?

- A. 5 nm
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- A. If the incidence rate of the disease falls.
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14. The amount of time something is quarantined depends on all of the following EXCEPT:

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15. Which of the following helps prevent the entry of pathogens into humans?

- A. Cilia
- B. Antigens
- C. B lymphocytes
- D. Inflammation response

16. The following statements describe how vaccines, antibiotics and/or antiviral medications work.

I	treat viruses and bacterial infections
II	treat only viral infections
III	can provide broad-spectrum treatment to a variety of pathogens
IV	are specific to each pathogen
V	are only effective at the time when taken
VI	can provide lasting immunity

Which of the following statements are true for antiviral medications?

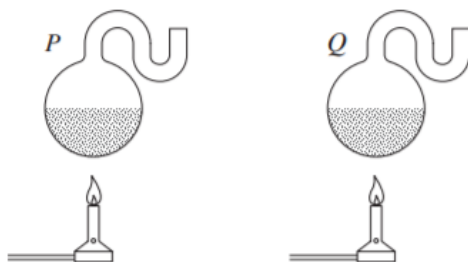
- A. I, III, V
- B. II, III, VI
- C. II, IV, V
- D. I, IV, VI

17. The following diagram summarises the steps of an experiment similar to that carried out by Louis Pasteur, which identified microbes as agents of decay.

Step 1 Two swan-neck flasks are filled partially with equal volumes of beef broth.



Step 2 The broth is boiled for at least 20 minutes.



Step 3 The neck of Flask P is left intact whereas the other is broken.



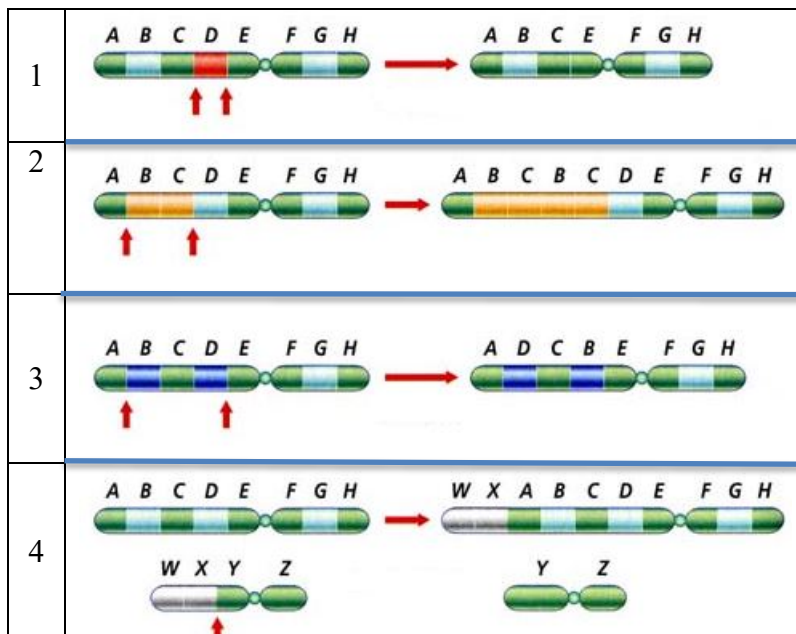
Step 4 The flasks are observed two weeks later for evidence of decay



Which of the following statements best explains the results obtained?

- A. There were no microbes in the air around Flask P at Steps 3 or 4.
- B. There were no microbes in Flask P at the beginning of the experiment.
- C. Microbes in Flask Q were not all killed by boiling, and multiplied following the cooling down of the flask.
- D. Any microbes present in both Flasks P and Q were killed by the boiling process, and only Flask Q allowed microbes to re-enter.

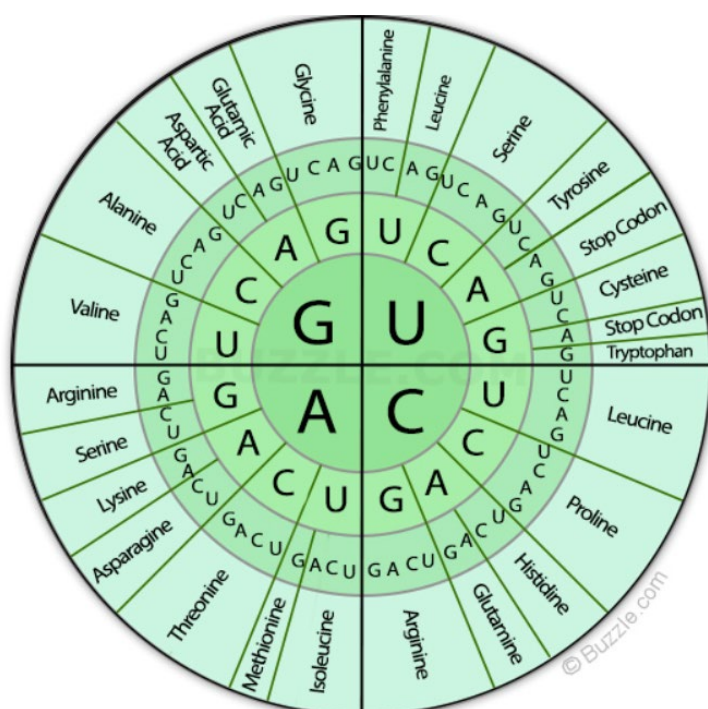
18. The following question refers to the diagram below. It shows four types of chromosomal mutations.



Which if the following correctly classifies the types of chromosomal mutations shown in the diagram.

	Deletion	Translocation	Inversion	Insertion
A	1	2	3	4
B	1	4	3	2
C	1	2	3	4
D	1	4	2	3

Questions 19 and 20 refer to the diagram below.



19. Which of the following amino acids is coded for by the mRNA base triplet ACC?

- A. Glycine
- B. Proline
- C. Threonine
- D. Glutamine

20. A point mutation occurred in the mRNA base triplet UGG. The third base was substituted with adenine. The impact of this mutation would be significant

- A. depending on its location in a base
- B. depending on its location in the nucleotide
- C. depending on its location in the amino acid
- D. depending on its location in the polypeptide

2019

TRIAL
HSC
EXAMINATION

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Student Number

Biology

Section II Answer Booklet

80 marks

Attempt Questions 21- 33

Allow about 2 hours and 25 minutes for this section

Instructions

- Answer the questions in the spaces provided. These spaces provide guidance for the expected length of the response.
- Extra writing space is provided at the back of this booklet. If you use this space, clearly indicate which question you are answering.
- If you require more space than is available in the extra writing space provided, please ask a supervising teacher for extra paper. Clearly indicate which question you are answering on the extra paper.

Please turn over

Question 21 (5 marks)

5K

Sometimes, genetic material does not replicate exactly. This may cause mutations in both somatic and germ-line cells. Compare possible impacts of germ-line and somatic mutations on the continuity of species.

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Question 22 (5 marks)

Connecticut reports 3rd measles of the year, linked to Brooklyn outbreak

by NEWS DESK

April 15, 2019

The Connecticut Department of Public Health confirmed the state's third measles case of the year on Friday. The patient, 6 year old Mary Smith, who had not been vaccinated against measles, contracted the viral disease while on a visit to Brooklyn, New York which is currently experiencing a measles outbreak.

"We are monitoring and investigating this case very closely, to follow up with any individuals that may have been exposed to measles. Science tells us that the single best thing anyone can do to protect themselves from this highly contagious virus is to get vaccinated. Connecticut has very high vaccination rates, so we are at low risk for a widespread measles outbreak. " said Connecticut Department of Health (DPH) Commissioner.

- (a) Explain why Mary Smith contracted the disease while on a visit to New York rather than in her home town in Connecticut.

2K

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- (b) The Connecticut DPH Commissioner stated that "Science tells us that the single best thing anyone can do to protect themselves from this highly contagious virus is to get vaccinated". Evaluate this statement.

3K

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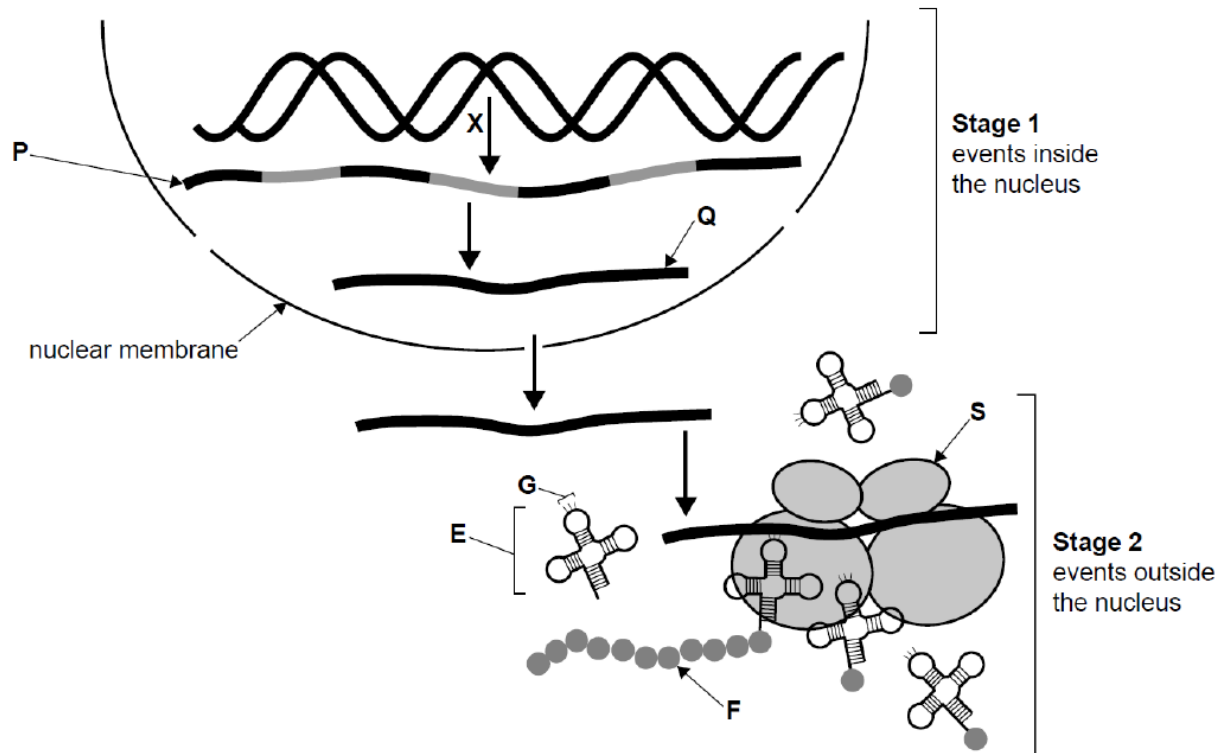
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Question 23 (8 marks)

The following diagram outlines processes that occur during the synthesis of a polypeptide.



- a) Name the main process taking place inside the nucleus at Stage 1 and using the names of structures P and Q briefly describe what is occurring in the processes inside the nucleus.

3K

Process:

Description:

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- b) Name the overall process taking place outside the nucleus at Stage 2 and using the name of structures E, F, G and S, describe what is occurring in the processes outside the nucleus.

5K

Process:

Description:

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Question 24 (8 marks)

An investigation was carried out into the effectiveness of a new antifungal cream on a skin infection caused by the fungus *Candida albicans*. Two groups of mice were exposed to the pathogen. Group 1 was treated with Antifungal Cream A and Group 2 with Antifungal Cream B. The level of fungal infection for both groups was measured as the area of skin infected with the pathogen. All mice began with a similar level of infection. After three weeks of the trial, mice in Group 1 had an average decrease of 98% in the level of infection, while Group 2 had an average decrease of 80%.

- (a) Suggest a hypothesis for the investigation. **2A**

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- (b) Name the independent and dependent variables in the investigation. **1A**

Independent variable =

Dependent variable. =

- (c) State two variables that would need to be controlled to ensure that the experiment was a fair trial. **1A**

Variable 1 =

Variable 2 =

- (d) How could you increase the reliability of the results? Justify your answer. **2A**

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- (e) Suggest one change in the method that could have increased the validity of the investigation.
Justify your answer. **2A**

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Question 25 (5 marks)

5K

Explain, using specific examples, the difference between co-dominance and incomplete dominance.

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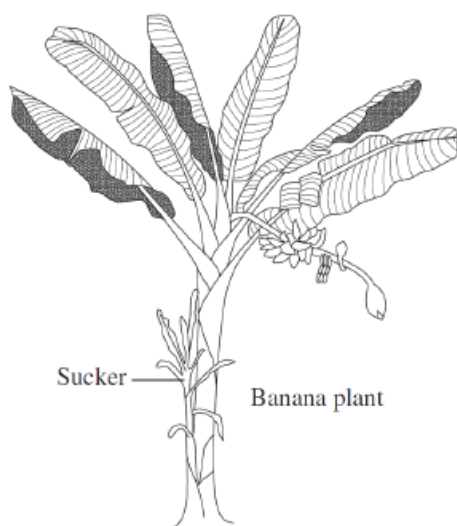
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Question 26 (3 marks)

3A

Traditionally, banana plants in Australia have been propagated asexually by cutting out and planting suckers from the adult plants being grown on the banana plantation. However, there is a growing trend to produce disease-free plants in laboratories through a process of cloning from disease-free tissues from a small selection of banana plants.

Assess the potential impact of the widespread use of such cloning processes on the genetic diversity of banana plants in Australia.



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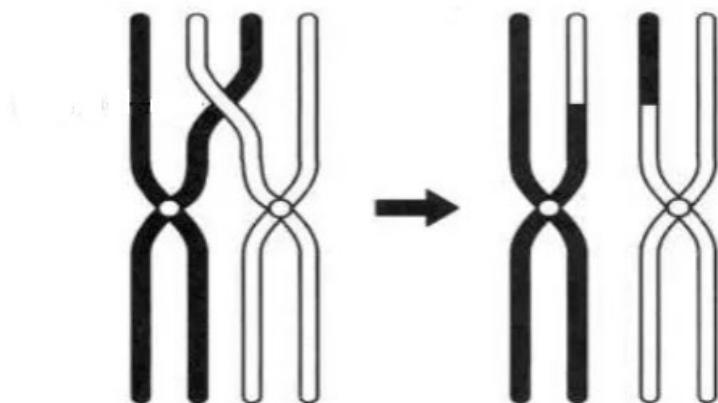
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Question 27 (6 marks)

During your Biology course you conducted practical investigations to predict variations in the genotype of offspring by modelling meiosis, including the crossing over of homologous chromosomes. The following diagram shows one possible model of crossing over.



- i) Evaluate the above model's ability to present scientific information about variation in the genotype of offspring due to crossing over. **4K**

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- ii) Name two other processes that occur during meiosis that would could be modelled in order to predict variations in the genotype of offspring. **2K**

Process 1 =

Process 2 =

Question 28 (6 marks)

In rose plants, the length of the stems is determined by a single gene. Individual plants can grow either long stems or short stems. A rose grower crossed two long-stem plants and grew the seeds to mature plants. She noticed that, of 120 plants, 33 had short stems.

- (a) Explain, using appropriate symbols, the pattern of inheritance shown in this example. Show your working.

3K

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- (b) If one of the original long-stem plants was crossed with one of the new short-stem plants, what proportion of the next generation of plants would have long stems? Show your working.

3K

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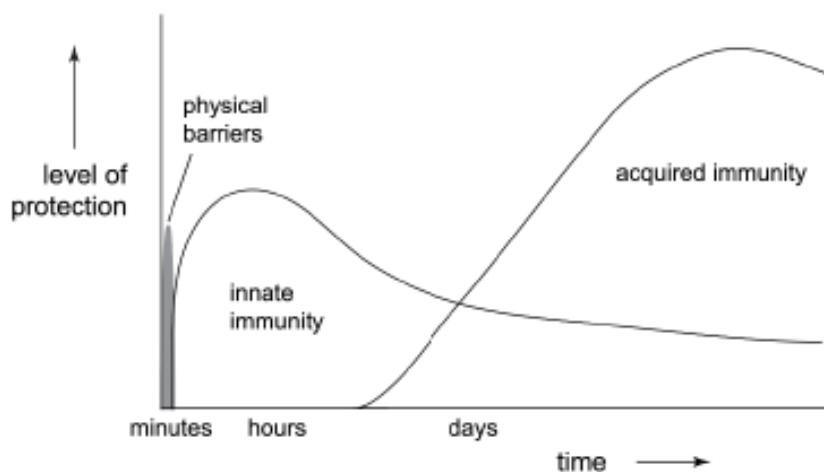
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Question 29 (5 marks)

5K

After an individual is exposed to a microbial infection the body's defence system increases its activities.

The following graph summarises the timeline of the level of those activities.



Interpret the information from the graph above and explain why the different measures of protection are effective over different time periods.

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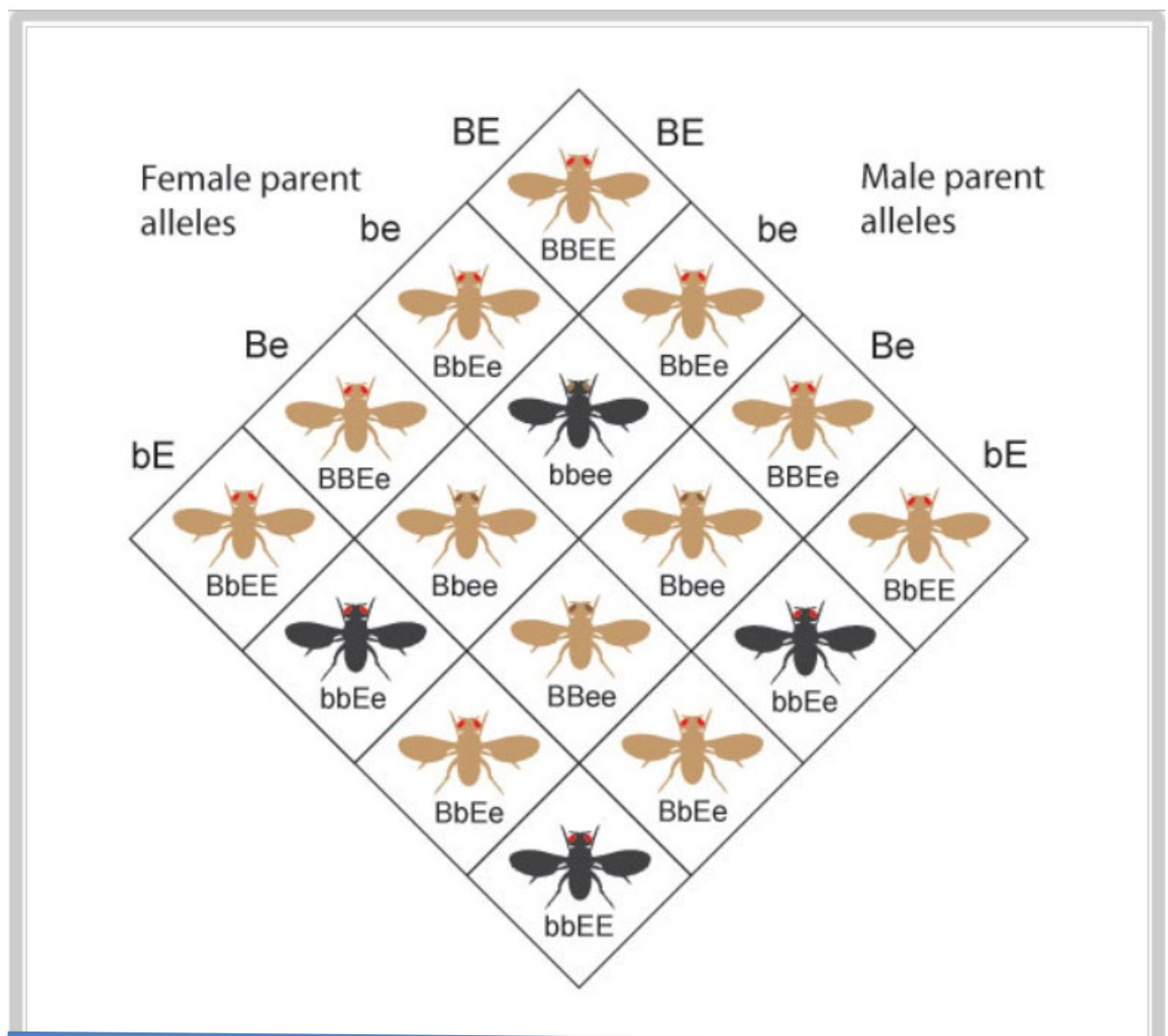
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Question 30 (6 marks)

The following figure shows all the possible genotypes that can result from crossing two parents, both of whom have the genotype BbEe. This is called a “dihybrid cross”. In this example, there are two different alleles for the eye colour gene: the E allele for red eye colour, and the e allele for brown eye colour. There are two different alleles for the body colour gene: the B allele for brown body colour and the b allele for black body colour.

Figure: Crossing two parents with genotype BbEe



- (a) Explain how the results of the dihybrid cross shown in the Figure could be used to explain Mendel's principal of independent assortment which states that "the alleles of two (or more) different genes get sorted into gametes independently of one another". **4A**

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- (b) What would be the possible genotypes that can result from crossing two parents, both of whom have the genotype BbEe, if the alleles are not sorted independently? Complete the Punnett Square below to help you answer this question. **2A**

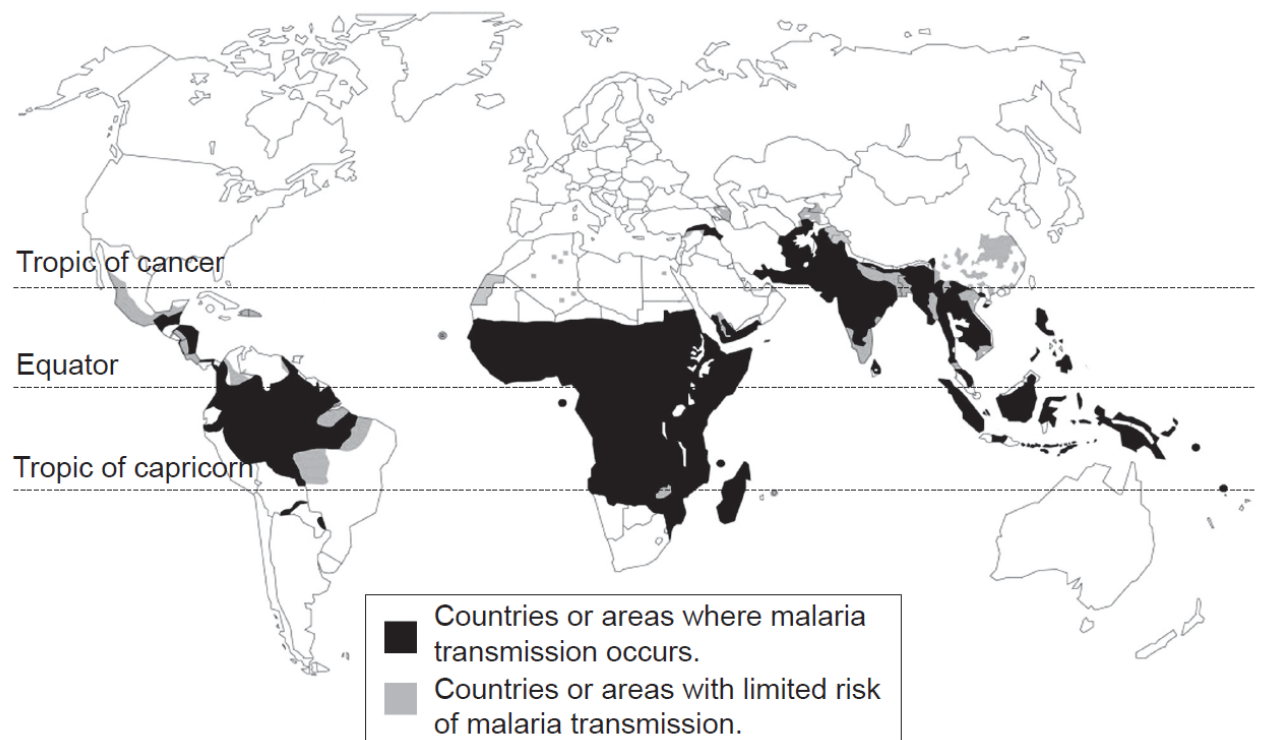
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Question 31 (8 marks)

The map below shows the worldwide distribution of malaria. Malaria is present in those areas that are shaded.



(a) Describe the distribution of malaria.

3K

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- (b) Unlike malaria, the disease tetanus, caused by a toxin made by spores of the bacterium, *Clostridium tetanibacterium*, occurs throughout the world. 5K
Explain why an infectious disease, such as tetanus, is much more widely distributed than malaria.

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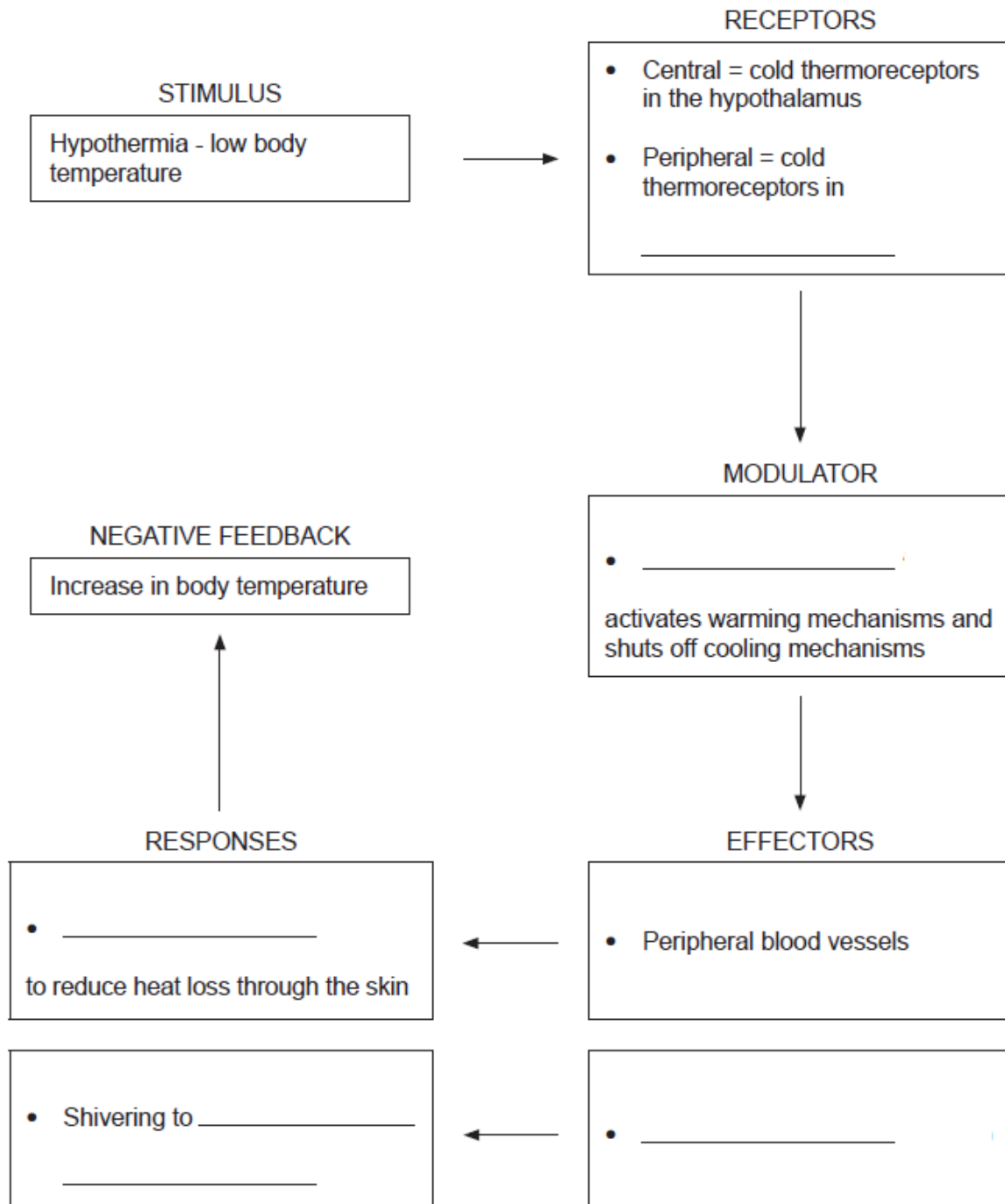
Please turn over

Question 32 (8 marks)

Jai was snowboarding in Japan when he was caught in an avalanche. He was partially buried in the snow and it took several hours to find him. Luckily he was relatively unhurt but, when found, was suffering from the early stages of hypothermia. Below is a negative feedback model showing the physiological responses to hypothermia.

- (a) Complete the feedback loop below by writing the appropriate word/s in the spaces provided.

3K



(b) Several days after Jai was caught in the avalanche, he developed a cold, with a runny nose and sore throat. His friends said Jai had become sick because he was in a cold environment. Using your knowledge of infectious diseases and the immune response, explain how being in a cold environment would not have been the cause of Jai’s infection, runny nose and sore throat. **5K**

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Please turn over

Question 33 (7 marks)

Figure 1 shows a single nucleotide polymorphism (SNP). SNPs are DNA sequence variations that occur when a single nucleotide differs from a reference DNA sequence. For example, a SNP may replace the nucleotide cytosine (C) with the nucleotide thymine (T) in a certain stretch of DNA. SNPs are the most common type of genetic variation in humans.

Figure 2 shows that SNPs can be analysed in large groups of humans.

Genome-wide association studies (GWASs) search the human genome for SNPs that occur more frequently in people with a particular disease (cases) than in people without the disease (controls). Each person gives a sample of DNA. If a SNP is more frequent in people with the disease, the SNP is said to be *associated* with the disease. The associated SNPs are then considered to mark a region of the human genome that may influence the risk of disease.

Figure 3 shows a “Manhattan plot”. The plot depicts several strongly associated risk loci (locus = location of a gene on a chromosome) for small blood vessels in the eye. Each dot on the plot represents a SNP, with the X-axis showing the SNP’s location in the genome and the Y-axis showing the SNP’s association level for small blood vessels in the eye. The strongest associations have the smallest probability value (P- values) and their negative logarithms will be the greatest e.g. P-value 10^{-15} has a negative logarithm of 15.

Figure 1: A SNP replaces the nucleotide cytosine (C) with the nucleotide thymine (T) in a certain stretch of DNA

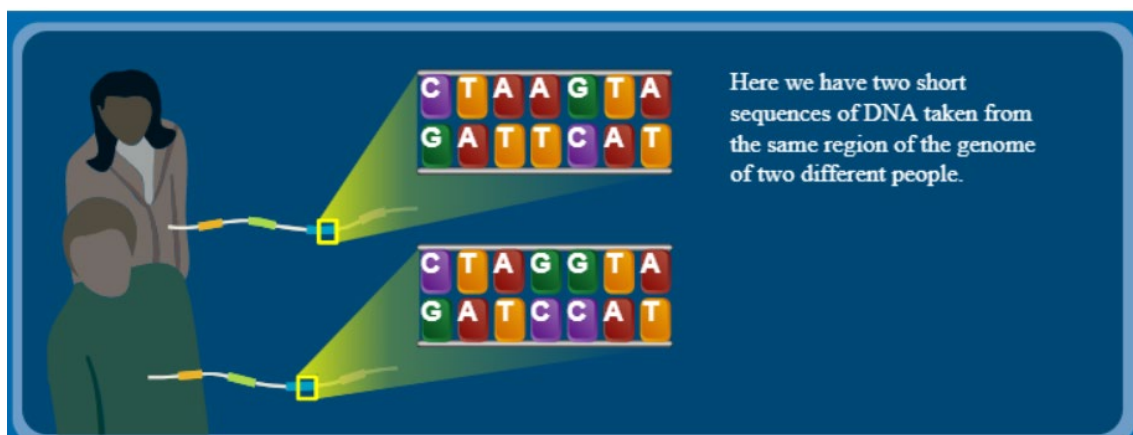


Figure 2: SNPs can be analysed in large groups of humans

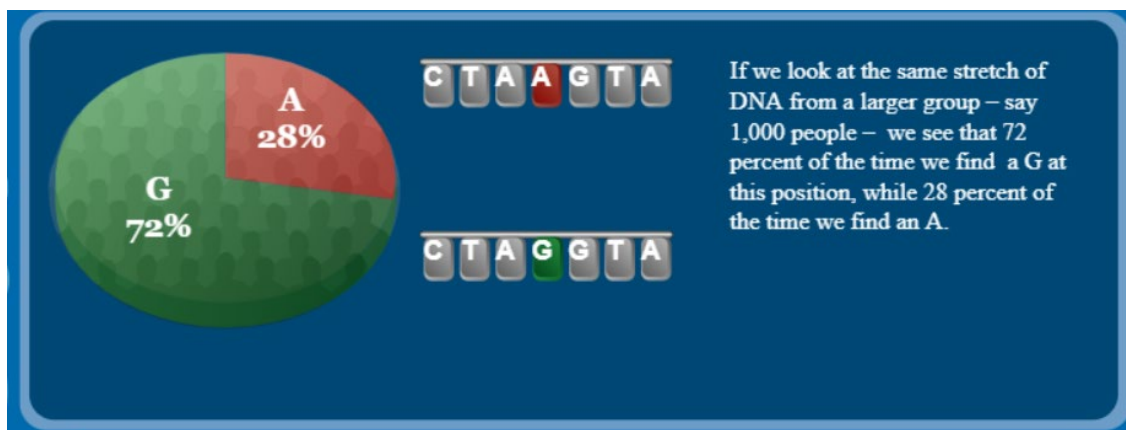
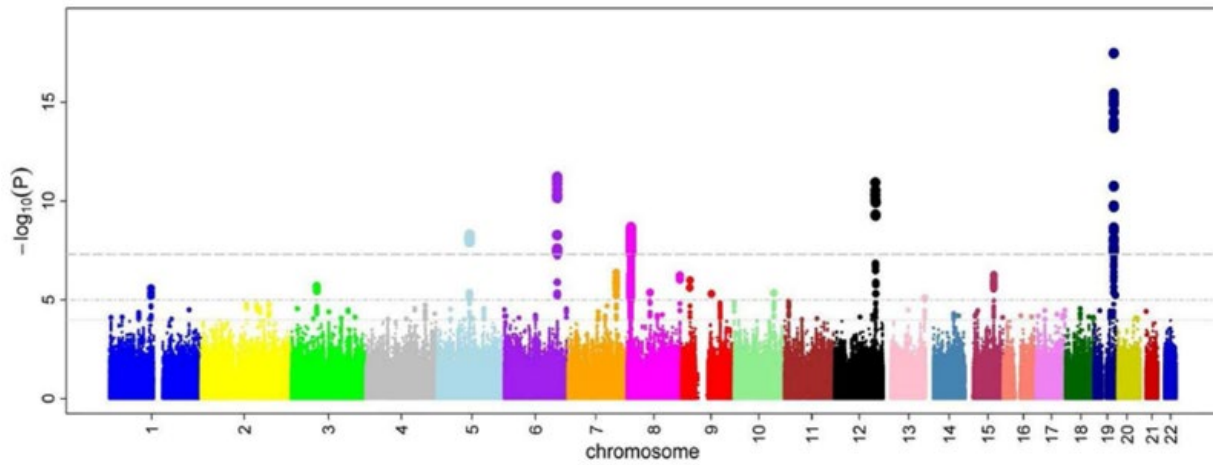


Figure 3: A “Manhattan plot” depicting several strongly associated risk loci for small blood vessels in the eye.



a) Construct a graph of the data shown in Figure 2.

3A

- b) Use the information in Figure 3 to justify the statement “The use of SNPs was able to show that particular components of the human genome show larger risk associations for small blood vessels in the eye.” 4A

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END OF PAPER

Section II extra writing space

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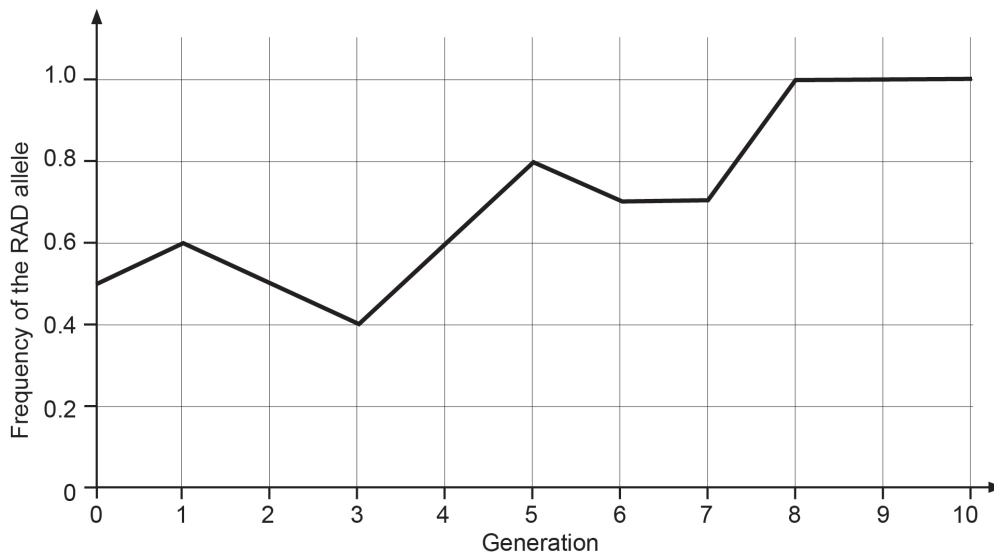
- A. I, II and III
- B. I, II, III and IV
- C. II only

D. II and IV

7. In genetic engineering, plant viruses are sometimes used to introduce a foreign gene into a plant cell. This is because viruses are

- A. non-living and therefore easy to store in the laboratory.
- B. non-living and therefore there are no ethical issues with using them in this way.
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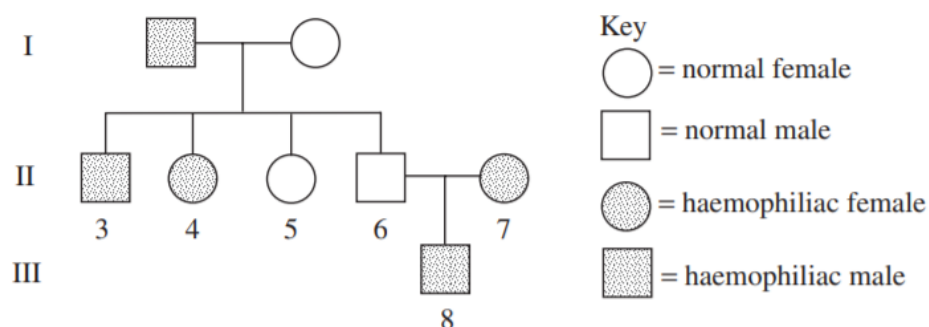
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- A. $X^h X^h$
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- C. $X^n X^n$
- D. $X^n Y$

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- A. The place from which something is being imported from
- B. The organisations determining the rules of quarantine
- C. The plant or animal in question
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15. Which of the following helps prevent the entry of pathogens into humans?

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16. The following statements describe how vaccines, antibiotics and/or antiviral medications work.

I	treat viruses and bacterial infections
II	treat only viral infections
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IV	are specific to each pathogen
V	are only effective at the time when taken
VI	can provide lasting immunity

Which of the following statements are true for antiviral medications?

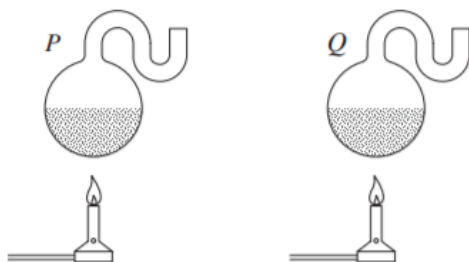
- A. I, III, V
- B. II, III, VI
- C. II, IV, V
- D. I, IV, VI

17. The following diagram summarises the steps of an experiment similar to that carried out by Louis Pasteur, which identified microbes as agents of decay.

Step 1 Two swan-neck flasks are filled partially with equal volumes of beef broth.



Step 2 The broth is boiled for at least 20 minutes.



Step 3 The neck of Flask P is left intact whereas the other is broken.



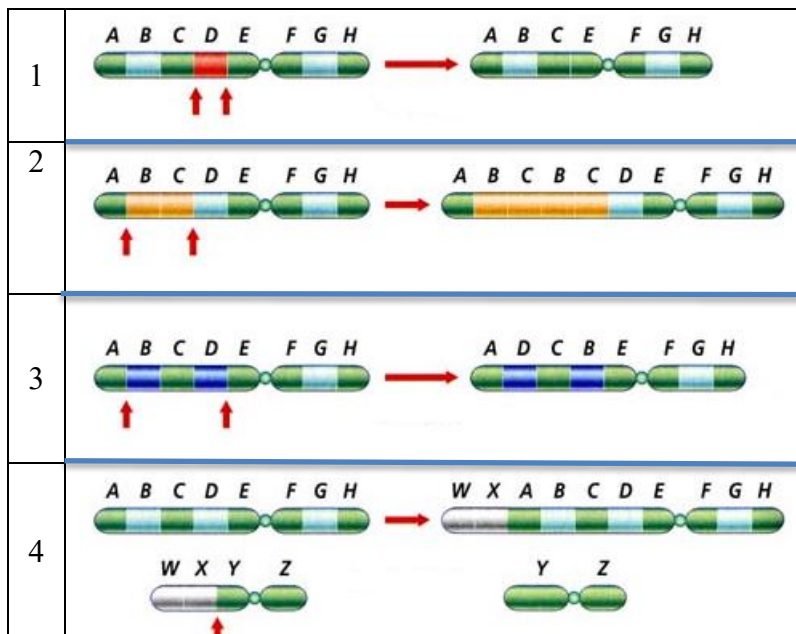
Step 4 The flasks are observed two weeks later for evidence of decay



Which of the following statements best explains the results obtained?

- A. There were no microbes in the air around Flask P at Steps 3 or 4.
- B. There were no microbes in Flask P at the beginning of the experiment.
- C. Microbes in Flask Q were not all killed by boiling, and multiplied following the cooling down of the flask.
- D. Any microbes present in both Flasks P and Q were killed by the boiling process, and only Flask Q allowed microbes to re-enter.

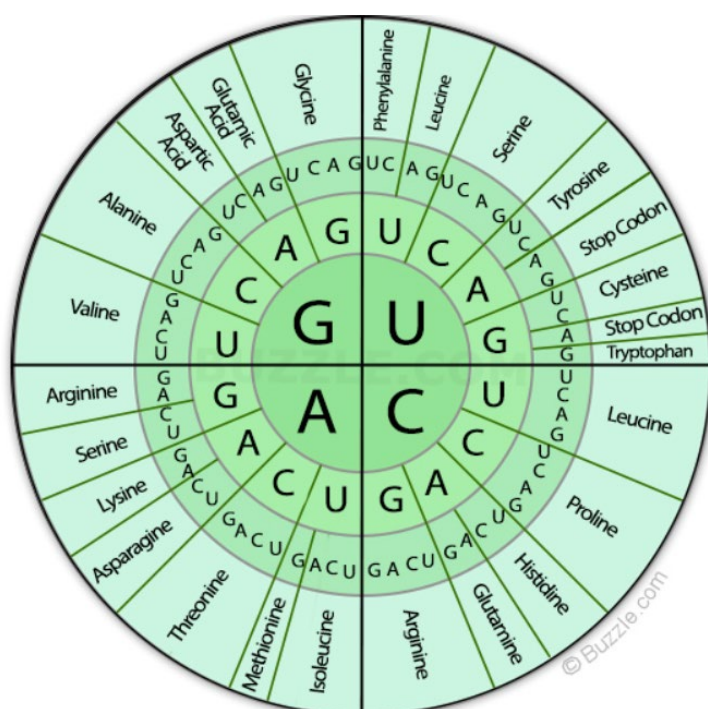
18. The following question refers to the diagram below. It shows four types of chromosomal mutations.



Which if the following correctly classifies the types of chromosomal mutations shown in the diagram.

	Deletion	Translocation	Inversion	Insertion
A	1	2	3	4
B	1	4	3	2
C	1	2	3	4
D	1	4	2	3

Questions 19 and 20 refer to the diagram below.



19. Which of the following amino acids is coded for by the mRNA base triplet ACC?

- A. Glycine
- B. Proline
- C. Threonine
- D. Glutamine

20. A point mutation occurred in the mRNA base triplet UGG. The third base was substituted with adenine. The impact of this mutation would be significant

- A. depending on its location in a base
- B. depending on its location in the nucleotide
- C. depending on its location in the amino acid
- D. depending on its location in the polypeptide

2019

TRIAL
HSC
EXAMINATION

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Student Number

Biology

Section II Answer Booklet

80 marks

Attempt Questions 21- 33

Allow about 2 hours and 25 minutes for this section

Instructions

- Answer the questions in the spaces provided. These spaces provide guidance for the expected length of the response.
- Extra writing space is provided at the back of this booklet. If you use this space, clearly indicate which question you are answering.
- If you require more space than is available in the extra writing space provided, please ask a supervising teacher for extra paper. Clearly indicate which question you are answering on the extra paper.

Please turn over

Question 21 (5 marks)



Sometimes, genetic material does not replicate exactly. This may cause mutations in both somatic and germ-line cells. Compare possible impacts of germ-line and somatic mutations on the continuity of species.

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Some students did not define the two types cells
Nearly all students did not state the main causes of mutation
Need to clearly describe impact of BOTH on continuity of species, and possible scenarios for neutral, positive and negative mutations

Many students confused that somatic cell mutations contribute to genetic diversity even though they say they are NOT inherited.

Question 22 (5 marks)

Connecticut reports 3rd measles of the year, linked to Brooklyn outbreak

by NEWS DESK

April 15, 2019

The Connecticut Department of Public Health confirmed the state's third measles case of the year on Friday. The patient, 6 year old Mary Smith, who had not been vaccinated against measles, contracted the viral disease while on a visit to Brooklyn, New York which is currently experiencing a measles outbreak.

"We are monitoring and investigating this case very closely, to follow up with any individuals that may have been exposed to measles. Science tells us that the single best thing anyone can do to protect themselves from this highly contagious virus is to get vaccinated. Connecticut has very high vaccination rates, so we are at low risk for a widespread measles outbreak. " said Connecticut Department of Health (DPH) Commissioner.

- (a) Explain why Mary Smith contracted the disease while on a visit to New York rather than in her home town in Connecticut.

2K

In Connecticut – most people are vaccinated against measles. Therefore it is unlikely that an individual who has not been vaccinated (Mary Smith) will come into contact with a person with the virus and she is unlikely to be infected with the virus

In New York there was a measles outbreak. Therefore an unvaccinated person (Mary Smith) is more likely to encounter people with the virus and she will therefore be more likely to be infected with the virus

Did not compare probability of being infected for BOTH cities

- (b) The Connecticut DPH Commissioner stated that "Science tells us that the single best thing anyone can do to protect themselves from this highly contagious virus is to get vaccinated". Evaluate this statement.

3K

I agree with this statement.

Reasons

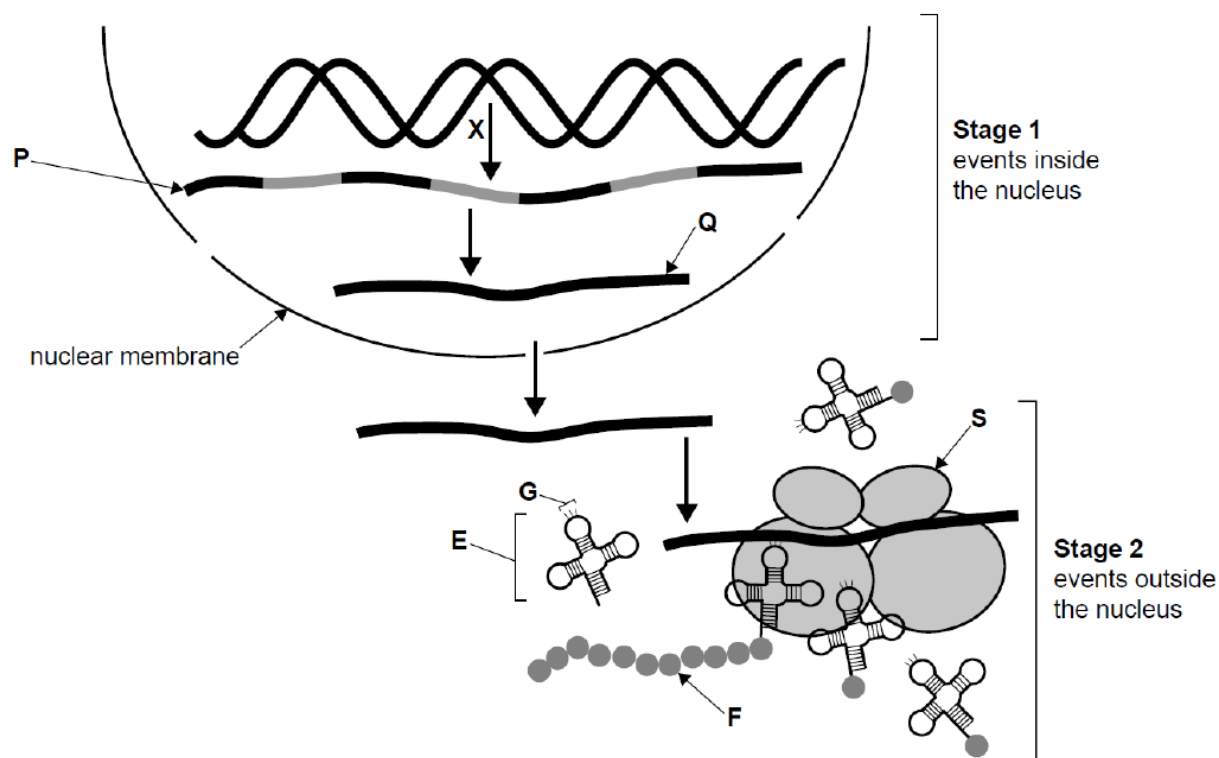
Transmission measles is "highly infectious" therefore an individual is likely to be infected with the virus if they encounter a person infected with the virus

Vaccination vaccination will protect individuals from infection with the virus

Many students did not explain concept of transmission

Question 23 (8 marks)

The following diagram outlines processes that occur during the synthesis of a polypeptide.



- a) Name the main process taking place inside the nucleus at Stage 1 and using the names of structures P and Q briefly describe what is occurring in the processes inside the nucleus.

3K

Process: Transcription

Description: The DNA template strand codes for initial/ pre mRNA strand (**P**). Non-coding parts of the pre-mRNA (introns) are removed and the remaining pieces (exons) are joined together forming mRNA (**Q**).

- b) Name the overall process taking place outside the nucleus at Stage 2 and using the name of structures E, F, G and S, describe what is occurring in the processes outside the nucleus.



Process = Translation

Transfer RNA (E) carries a specific amino acid (F) dependent on the tRNA anticodon (G). The anticodon complements the codon (unlabelled) on the mRNA between the small subunits of the ribosomes (S). tRNA binds to its complementary codon. The amino acid the tRNA carries adds to the lengthening polypeptide chain.

Question 24 (8 marks)

An investigation was carried out into the effectiveness of a new antifungal cream on a skin infection caused by the fungus *Candida albicans*. Two groups of mice were exposed to the pathogen. Group 1 was treated with Antifungal Cream A and Group 2 with Antifungal Cream B. The level of fungal infection for both groups was measured as the area of skin infected with the pathogen. All mice began with a similar level of infection. After three weeks of the trial, mice in Group 1 had an average decrease of 98% in the level of infection of fungal infection caused by on, while Group 2 had an average decrease of 80%.

- (a) Suggest a hypothesis for the investigation.

2A

The new antifungal cream is effective in reducing the level of infection caused by the fungus *Candida albicans*

- (b) Name the independent and dependent variables in the investigation.

1A

Independent variable = **antifungal cream**

Dependent variable. = **area of skin infected with the fungus**

- (c) State two variables that would need to be controlled to ensure that the experiment was a fair trial.

1A

Variable 1 = **mass/ amount of cream applied**

Variable 2 = **age of mice**

- (d) How could you increase the reliability of the results? Justify your answer.

2A

Perform the experiment again or increase the number of mice, initially, used. This increases the sample size.

More trials or an increased number of mice, will lead to an increased number of results showing whether or not the fungal cream was effective in reducing level of fungal infection. These results can be compared in order to determine their consistency. If they are consistent, they are more reliable.

- (e) Suggest one change in the method that could have increased the validity of the investigation. Justify your answer.

2A

The experiment was designed to test whether an antifungal cream was effective in reducing the level of infection caused by the fungus *Candida albicans*. It compared the effectiveness of a new cream (assume Cream A/ Group A) with a pre-existing cream (assume Cream B/ Group B). The use of a control group (Group C) would have increased the validity of the investigation. The mice in the control group would begin the experiment with a similar level of infection to the experimental groups. The control group would not be treated with any antifungal cream. The level of infection of the experimental groups (A and B) could then be compared with the level of infection in Group C. This would allow a more accurate measure of the impact of the cream in reducing the level of infection.

Question 25 (5 marks)

5K

Explain, using specific examples, the difference between co-dominance and incomplete dominance.

Codominance is a form of dominance where the alleles of a gene pair in a heterozygote are fully expressed. E.g. codominance is the ABO blood group system. The alleles A and B are codominant. Genotype AB / $I^A I^B$ results in the phenotype blood group AB.

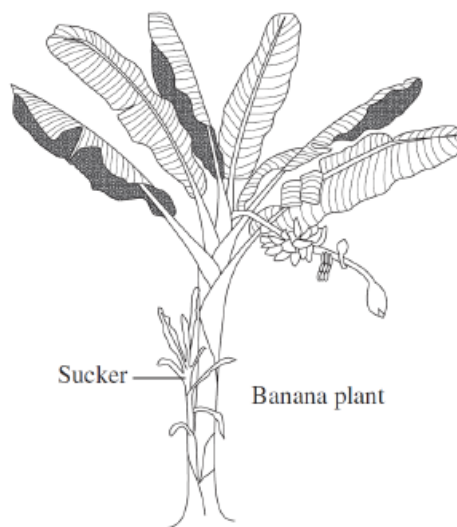
Incomplete dominance is a form of dominance occurring in heterozygotes in which the dominant allele is only partially expressed, and usually resulting in an offspring with an intermediate phenotype e.g. flower colour in Snapdragons. The alleles R (for red flower colour) and r (for white flower colour) show incomplete dominance. Genotype Rr results in phenotype flower colour pink.

Question 26 (3 marks)

3A

Traditionally, banana plants in Australia have been propagated asexually by cutting out and planting suckers from the adult plants being grown on the banana plantation. However, there is a growing trend to produce disease-free plants in laboratories through a process of cloning from disease-free tissues from a small selection of banana plants.

Assess the potential impact of the widespread use of such cloning processes on the genetic diversity of banana plants in Australia.

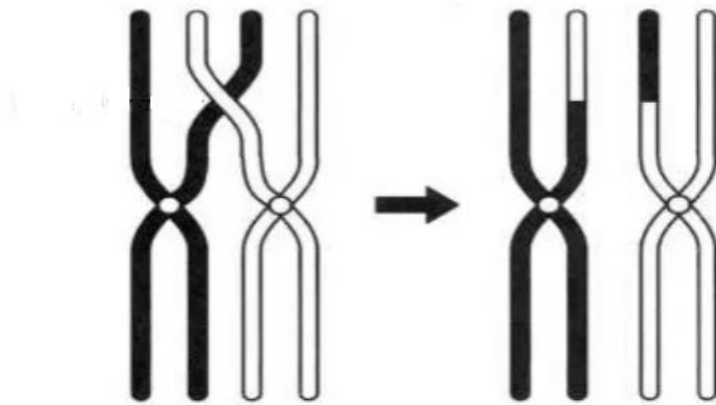


Cloning is an example of asexual reproduction and means that the banana plants produced will be genetically identical. Will reduce genetic diversity of banana plants in Australia

Many students did not state that cloning is a form of asexual reproduction

Question 27 (6 marks)

During your Biology course you conducted practical investigations to predict variations in the genotype of offspring by modelling meiosis, including the crossing over of homologous chromosomes. The following diagram shows one possible model of crossing over.



- i) Evaluate the above model's ability to present scientific information about variation in the genotype of offspring due to crossing over. 4K

Evaluation = The model shows some ability to present the scientific information required.

Does show sister chromatids of homologous chromosomes crossing over; exchange of genetic material

Does not show alleles present on the chromosomes nor the meiotic processes that occur after crossing-over. Therefore cannot determine genotype of the gametes produced and their contribution to the genotype of offspring.

Name two other processes that occur during meiosis that would could be modelled in order to predict variations in the genotype of offspring. 2K

Process 1 = **random segregation of homologous chromosomes**

Process 2 = **independent assortment of alleles**

Question 28 (6 marks)

In rose plants, the length of the stems is determined by a single gene. Individual plants can grow either long stems or short stems. A rose grower crossed two long-stem plants and grew the seeds to mature plants. She noticed that, of 120 plants, 33 had short stems.

- (a) Explain, using appropriate symbols, the pattern of inheritance shown in this example. Show your working.



Inheritance pattern = autosomal dominant

Let allele for long stem = L

Let allele for short stem = l

	L	l
L	LL	Ll
l	lL	ll

Parents = Ll X Ll

Genotypic ratio = LL : Ll : ll = 1:2:1

Phenotypic ratio = long: short = 3: 1

Therefore this approximates the 3:1 (120:33) ratio in the example

With a larger sample size the ratio would be closer to 3:1

Conventions for assigning letters done poorly

Some students did pedigree chart, others did Punnett square using sex linked genotypes

Need to identify alleles and parental genotypes

- (b) If one of the original long-stem plants was crossed with one of the new short-stem plants, what proportion of the next generation of plants would have long stems? Show your working.



Let allele for long stem = L

Let allele for short stem = l

Parents = Ll X ll

	L	l
l	Ll	ll
l	Ll	ll

Genotypic ratio = LL : ll = 1:1

Phenotypic ratio = long: short = 1: 1

Therefore 50% of the next generation should have long stems.

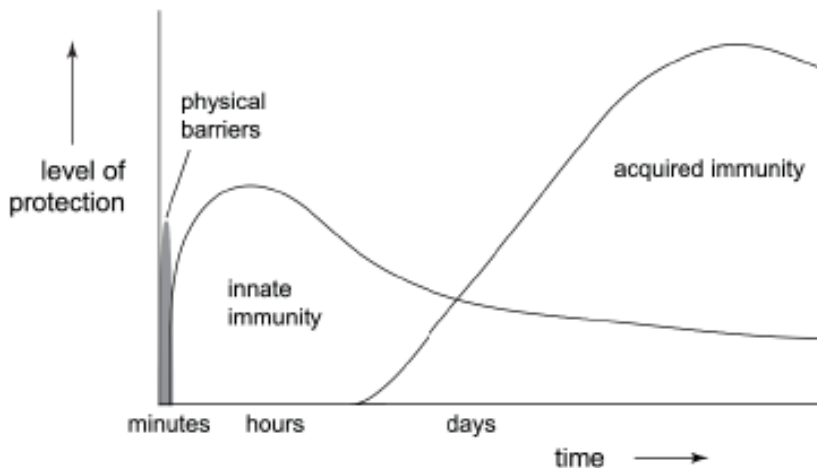
Need to identify alleles and parental genotypes

Question 29 (5 marks)

5K

After an individual is exposed to a microbial infection the body's defence system increases its activities.

The following graph summarises the timeline of the level of those activities.



Interpret the information from the graph above and explain why the different measures of protection are effective over different time periods.

- a) **Physical barriers**: initially such barriers as the skin, mucus, tears, stomach acid etc. prevent the bacteria from entry into body tissue. However, once breached (the site of infection), these barriers are non-specific have no further role in defence. Therefore time period over which it acts is very short. Very effective at providing protection from pathogens continuously until barrier is breached.
- b) **Innate (non-specific) Immunity**: Involves the inflammatory response where (macrophages/mast) cells that are disrupted caused chemicals/histamines to be released which leads to dilation of blood vessels, increase in capillary permeability and influx of phagocytes responding to destroy the microbe. This is non-specific occurring close to site of initial infection and an immediate/fast response hence the sharp gradient in the graph. If this response is not enough to destroy all pathogens (which may then invade other tissue/blood/lymph) then bacterial antigens can then be presented by phagocytes (macrophages and dendritic cells) to helper T cells.
- c) **Acquired (adaptive/specific) Immunity**: Helper T-cells become active to seek B cells (or B/T memory cells) with an antibody match to the antigen cloning of these cells to facilitate a response. It takes at least 5 to 7 days to produce enough plasma B cells to produce enough antibodies to fight the pathogen so response is initially slow

compared to the innate response Production of killer T-cells is also initially slow but proliferate to kill already infected cells. Any B/T cells that recognise antigens will be further cloned to fight infection increasing the response rapidly, but also leaving behind a memory to fight the pathogen should it be encountered again. Specific immunity provides a much greater level of protection than the innate system as it identifies a specific antigen and produces an abundance of cells that work together to fight the specific pathogen

Many students confused and did not realise physical barriers was part of the first line of defence

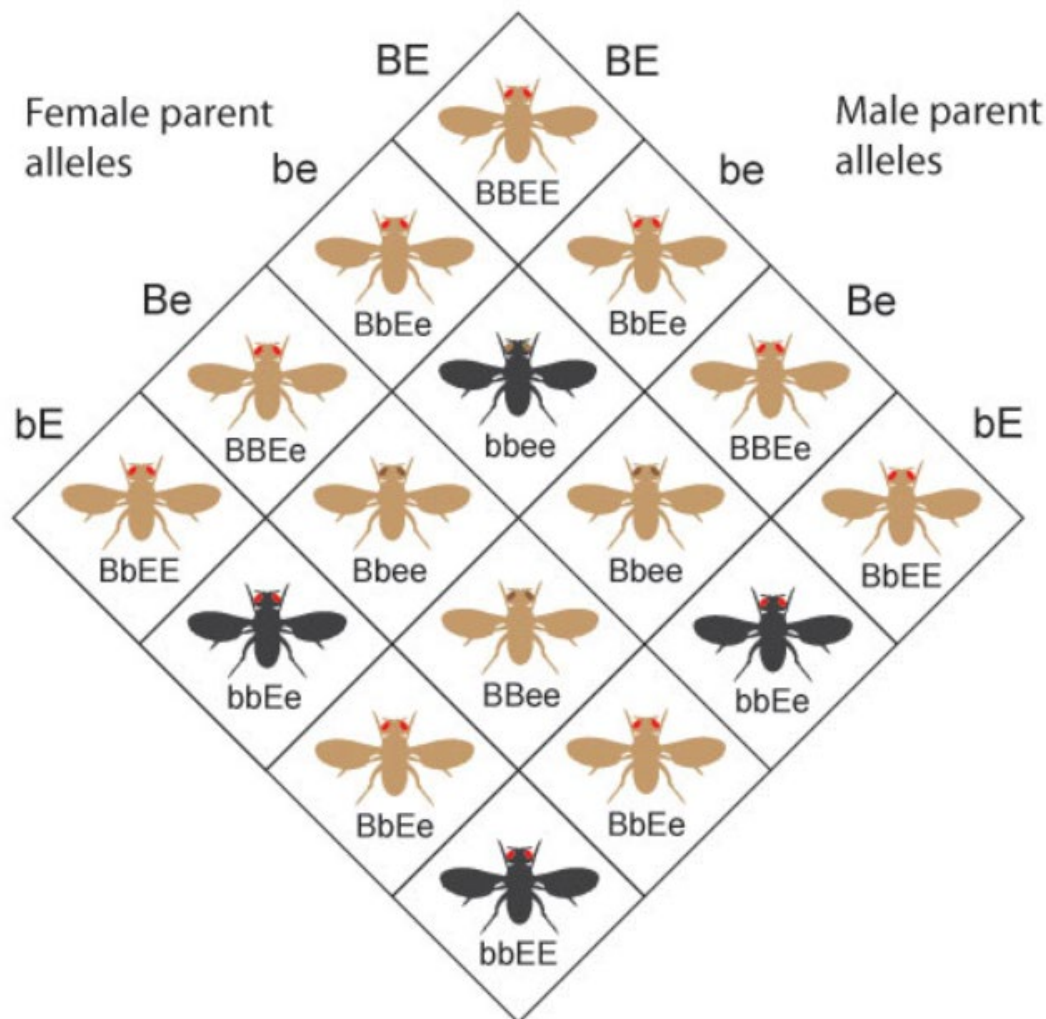
Did not discuss clearly all three lines of defence in terms of

- **Specificity**
- **Processes involved**

Question 30 (6 marks)

The following figure shows all the possible genotypes that can result from crossing two parents, both of whom have the genotype BbEe. This is called a “dihybrid cross”. In this example, there are two different alleles for the eye colour gene: the E allele for red eye colour, and the e allele for brown eye colour. There are two different alleles for the body colour gene: the B allele for brown body colour and the b allele for black body colour.

Figure: Crossing two parents with genotype BbEe



Explain how the results of the dihybrid cross shown in the Figure could be used to explain Mendel's principal of independent assortment which states that "the alleles of two (or more) different genes get sorted into gametes independently of one another".

4A

Parental alleles for body colour sort independently from the alleles for eye colour. There are four possible ways the alleles can combine in the gamete. These allelic combinations are BE, be, Be, bE. This produces 16 possible genotypes when the gametes fuse during fertilisation e.g. BBEE, BB~~E~~e, BB~~e~~E, bbEE, bb~~E~~e, bb~~e~~E etc.

(a)

- (b) What would be the possible genotypes that can result from crossing two parents, both of whom have the genotype BbEe, if the alleles are not sorted independently?
Complete the Punnett Square below to help you answer this question.

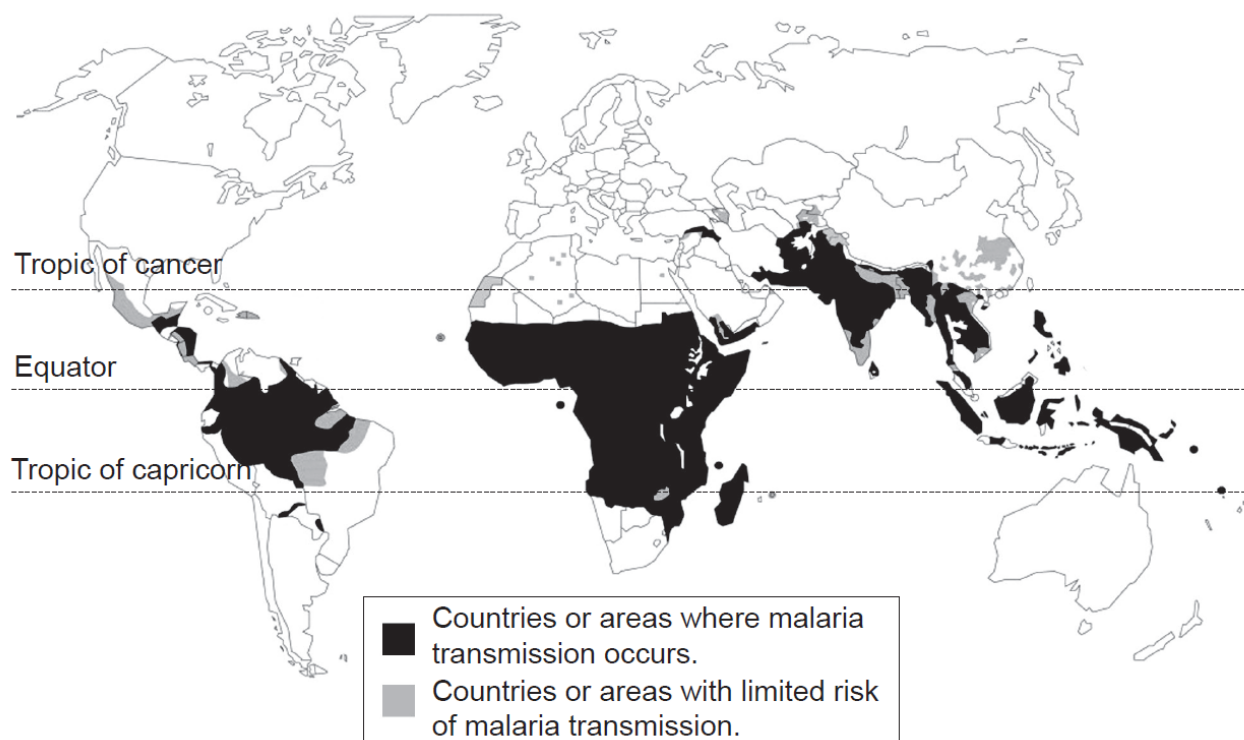
2A

	BE	be
BE	BBEE	BbEe
be	BbEe	bebe

BBEE, BbEe, BbEe, bebe

Question 31 (8 marks)

The map below shows the worldwide distribution of malaria. Malaria is present in those areas that are shaded.



- (a) Describe the distribution of malaria.

3K

Done well

- (b) Unlike malaria, the disease tetanus, caused by a toxin made by spores of the bacterium, *Clostridium tetanibacterium*, occurs throughout the world. Explain why an infectious disease, such as tetanus, is much more widely distributed than malaria.

5K

Did not – identify that each disease caused by different pathogen

- Each have different life cycles, transmission methods and environmental needs for pathogen transmission

Not answered well

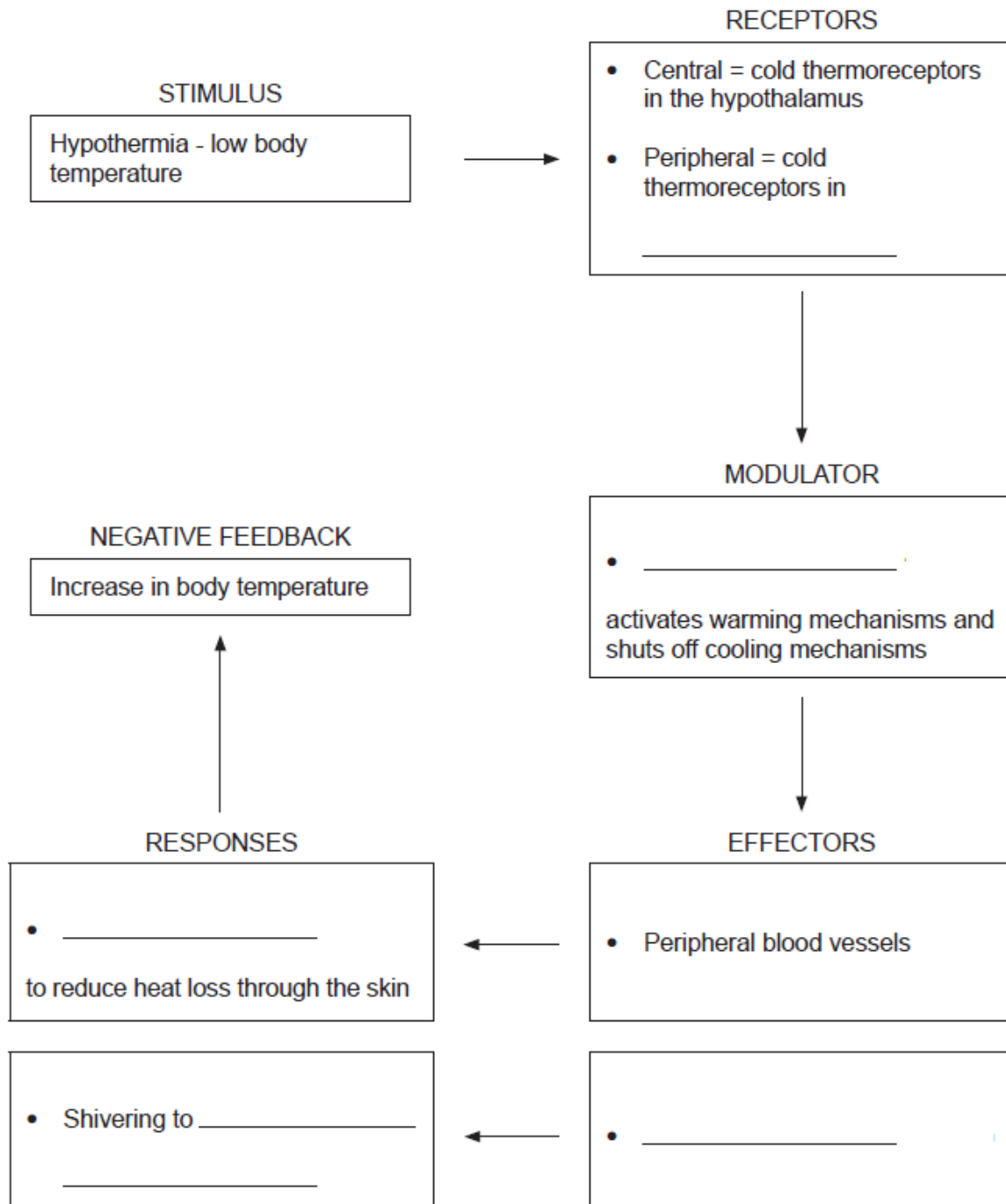
Please turn over

Question 32 (8 marks)

Jai was snowboarding in Japan when he was caught in an avalanche. He was partially buried in the snow and it took several hours to find him. Luckily he was relatively unhurt but, when found, was suffering from the early stages of hypothermia. Below is a negative feedback model showing the physiological responses to hypothermia.

- (a) Complete the feedback loop below by writing the appropriate word/s in the spaces provided.

3K



- (b) Several days after Jai was caught in the avalanche, he developed a cold, with a runny nose and sore throat. His friends said Jai had become sick because he was in a cold environment. Using our knowledge of infectious diseases and the immune response, explain how being in a cold environment would not have been the cause of Jai's infection, runny nose and sore throat. 

Please turn over

Question 33 (7 marks)

Figure 1 shows a single nucleotide polymorphism (SNP). SNPs are DNA sequence variations that occur when a single nucleotide differs from a reference DNA sequence. For example, a SNP may replace the nucleotide cytosine (C) with the nucleotide thymine (T) in a certain stretch of DNA. SNPs are the most common type of genetic variation in humans.

Figure 2 shows that SNPs can be analysed in large groups of humans.

Genome-wide association studies (GWASs) search the human genome for SNPs that occur more frequently in people with a particular disease (cases) than in people without the disease (controls). Each person gives a sample of DNA. If a SNP is more frequent in people with the disease, the SNP is said to be *associated* with the disease. The associated SNPs are then considered to mark a region of the human genome that may influence the risk of disease.

Figure 3 shows a “Manhattan plot”. The plot depicts several strongly associated risk loci (locus = location of a gene on a chromosome) for small blood vessels in the eye. Each dot on the plot represents a SNP, with the X-axis showing the SNP’s location in the genome and the Y-axis showing the SNP’s association level for small blood vessels in the eye. The strongest associations have the smallest probability value (P- values) and their negative logarithms will be the greatest e.g. P-value 10^{-15} has a negative logarithm of 15.

Figure 1: A SNP replaces the nucleotide cytosine (C) with the nucleotide thymine (T) in a certain stretch of DNA

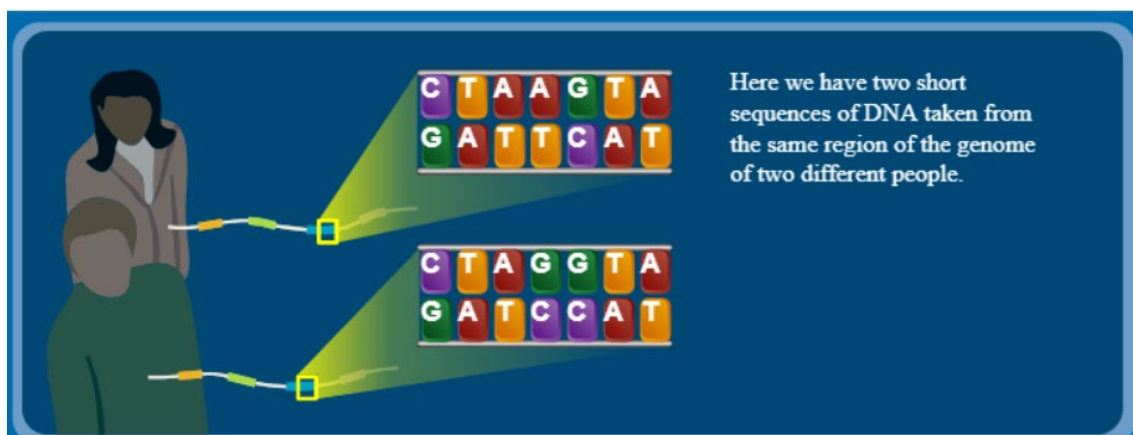


Figure 2: SNPs can be analysed in large groups of humans

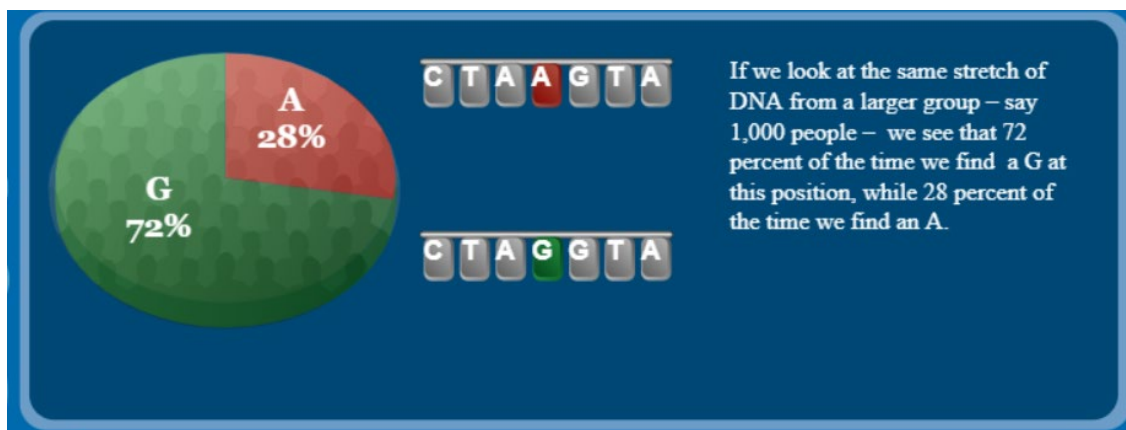
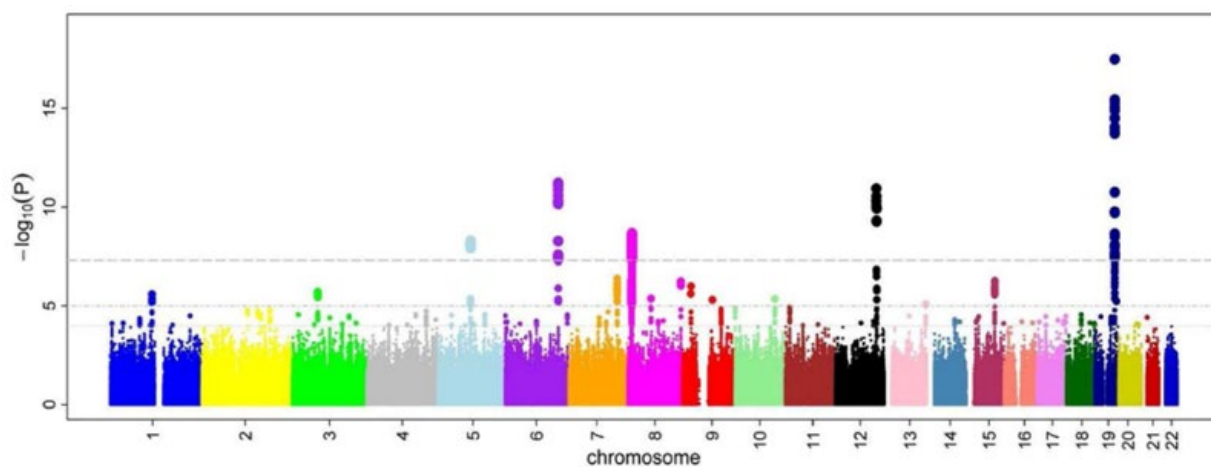


Figure 3: A “Manhattan plot” depicting several strongly associated risk loci for small blood vessels in the eye.



- a) Construct a graph of the data shown in Figure 2.

3A

Some students did not realise it is a column graph

- b) Use the information in Figure 3 to justify the statement “The use of SNPs was able to show that particular components of the human genome show larger risk associations for  small blood vessels in the eye.” 4A

Not answered well because many students did not use the data in the

- **plot shows data relating to 22 chromosomes/ autosomes of the human genome**
- **gene loci on each chromosome/ all chromosomes have different risk associations for the trait (small blood vessels in the eye)**
- **Provides quantitative data P value(s)**

END OF PAPER

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