SUPERVISOR TO ATTACH PROCESSING LABEL HERE

STUDENT NUMBER

										Letter
Figures										
Words										

Victorian Certificate of Education 2000

BIOLOGY

Written examination 2

Monday 30 October 2000: 3.00 pm to 4.45 pm
Reading time: 3.00 pm to 3.15 pm
Writing time: 3.15 pm to 4.45 pm
Total writing time: 1 hour 30 minutes

QUESTION AND ANSWER BOOK

Structure of book

Section	*Number of questions*	*Number of questions to be answered*
A	25	25
B	7	7

Directions to students

Materials
Question and answer book of 21 pages.
Answer sheet for multiple-choice questions.
You should have at least one pencil and an eraser. The multiple-choice questions must be answered using a pencil. The short-answer questions should be answered using a pen.

The task
Please ensure that you write your **student number** in the space provided on the cover of this book, and that your **name** and **student number**, as printed on your answer sheet for multiple-choice questions, are correct, **and** sign your name to verify this.
Answer **all** questions.
Section A multiple-choice questions should be answered on the answer sheet provided. Section A is worth 25 marks.
Section B short-answer questions should be answered in the spaces provided in this question and answer book. Section B is worth 50 marks.
There is a total of 75 marks available for this examination.
All written responses should be in English.

At the end of the task
Place the answer sheet for multiple-choice questions inside the front cover of this book.

SECTION A – Multiple-choice questions

Specific instructions for Section A

Section A consists of 25 multiple-choice questions. You should spend approximately 30 minutes on this section.

Choose the response that is **correct** or **best answers the question**, and shade the square on the multiple-choice answer sheet according to the instructions on that sheet.

A correct answer is worth 1 mark, an incorrect answer is worth no marks. No mark will be given if more than one answer is shown for any question. Marks will **not** be deducted for incorrect answers. You should attempt every question.

Use the following information to answer Questions 1 and 2.

In animals, being unable to produce pigment is called albinism. This condition occurs in humans as well as in other animals. Albinism is inherited as an autosomal recessive trait.

Question 1

A cross between two individuals, both heterozygous for albinism, could be represented by

A. AA x AA.

B. aa x aa.

C. Aa x Aa.

D. Aa x aa.

Question 2

A cross that could confirm that a prize-winning dog was a carrier for albinism is

A. AA x AA.

B. aa x aa.

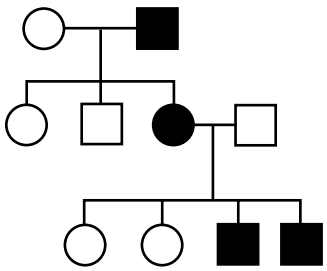
C. AA x Aa.

D. Aa x aa.

Question 3

The pedigree consistent with X-linked recessive inheritance of the trait represented by the shaded symbols is

A.



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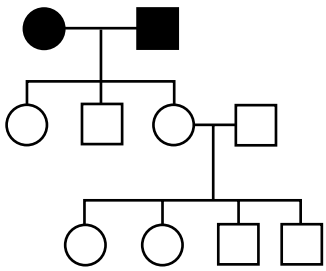

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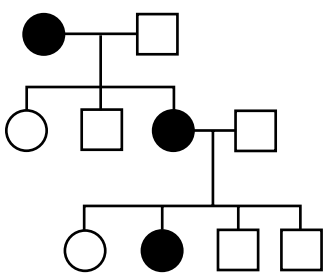
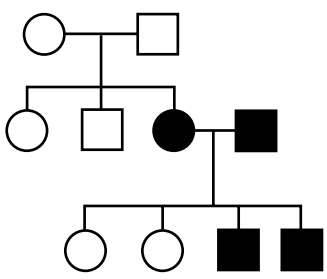


D.



Question 4

Happle syndrome is an X-linked dominant disorder for which the phenotype includes short stature and skin abnormalities. For this X-linked dominant disorder

A. males with Happle syndrome will inherit the disorder from their fathers.

B. all sons of a heterozygous female will have Happle syndrome.

C. a homozygous female with Happle syndrome will have a father who has Happle syndrome.

D. half of the daughters of a male with Happle syndrome will have Happle syndrome.

Question 5

In cats, folded ears is dominant to straight ears. Two cats, each with folded ears, were mated and produced offspring, some with folded ears and some with straight ears. It is reasonable to conclude that

A. all the offspring with folded ears have the same genotype.

B. all the offspring with straight ears are homozygous.

C. neither of the parents is heterozygous.

D. no offspring could be homozygous dominant.

Use the following information to answer Questions 6 and 7.

In rabbits, a single autosomal gene determining coat colour has four different alleles.

Question 6

At this locus the maximum number of different alleles a rabbit can have is

A. one.

B. two.

C. three.

D. four.

Question 7

The number of different genotypes possible with respect to this gene for coat colour is

A. four.

B. six.

C. eight.

D. ten.

Question 8

A goldfish has 94 chromosomes in its somatic cells. The diploid number for a goldfish is

A. 47.

B. 94.

C. 188.

D. 376.

Question 9

An organism with more than two copies of each chromosome in its somatic cells is described as

A. polygenic.

B. polymorphic.

C. polypeptic.

D. polyploid.

Use the following information to answer Questions 10 and 11.

In the vinegar fly, *Drosophila*, grey body is dominant to black body and long wing is dominant to short wing. The allelic notations for the traits are

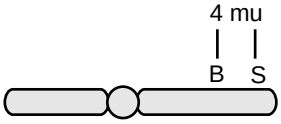
body colour locus	B	:	grey body
	b	:	black body
wing length locus	S	:	long wing
	s	:	short wing

The two gene loci are on the same autosome. In a testcross of a heterozygous female, 16 per cent recombinant type gametes are obtained.

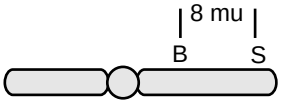
Question 10

Which of the following diagrams (**A–D**) shows the chromosomal positions of these gene loci?

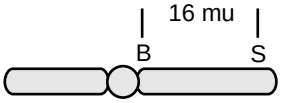
A.



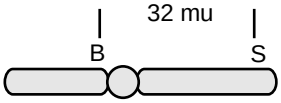
B.



C.



D.



Question 11

In the cross

$$\frac{BS}{b\ s} \times \frac{b\ s}{b\ s}$$

which one of the following offspring is possible?

A. $\frac{BS}{BS}$

B. $\frac{BB}{S\ s}$

C. $\frac{BS}{b\ s}$

D. $\frac{b\ b}{SS}$

Question 12

Compared with the amount of nuclear DNA in a nerve cell, the amount of nuclear DNA in an unfertilised egg cell will be

A. double.

B. the same.

C. half.

D. a quarter.

Question 13

The codon, CAU, codes for the amino acid histidine. It is reasonable to say that

A. the DNA sequence on the template strand coding for histidine is GUA.

B. the anticodon which matches with this codon is GTA.

C. other amino acids, apart from histidine, would be coded for by CAU.

D. other codons may code for histidine.

Question 14

In a eukaryotic organism, gene expression may involve

A. translation of the template strand of DNA.

B. processing of the primary RNA transcript during which exons are cut out.

C. complementary pairing of the codon and anticodon so that A pairs with T and G with C.

D. movement of the mRNA from the nucleus to the ribosome.

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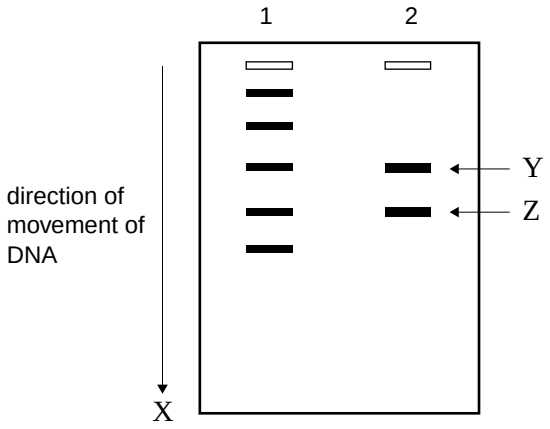
Use the following information to answer Questions 15 and 16.

A plasmid (a circular piece of DNA) was cut with a restriction enzyme (endonuclease) and the DNA fragments produced were separated using gel electrophoresis. A standard which consisted of 10 kb, 6 kb, 4 kb, 2 kb and 1 kb fragments was run in lane 1 of the gel.

Figure 1 shows a diagram of the gel.

Figure 1



Question 15

From the information provided in Figure 1 it is reasonable to conclude that

A. the restriction enzyme has cut the plasmid once.

B. fragment Y is smaller than fragment Z.

C. X marks the negative pole of the gel box.

D. the plasmid is approximately 6 kb.

Question 16

A restriction enzyme (endonuclease)

A. joins pieces of DNA.

B. has a recognition sequence.

C. always produces sticky ends.

D. will produce two fragments when it cuts a circular vector once.

Question 17

The flippers of a whale and the arms of a human are described as homologous structures because

A. they have a common evolutionary origin.

B. they have a similar function.

C. they contain bones.

D. both organisms are mammals.

Question 18

Random changes in allele frequencies in small populations are the result of

A. natural selection.

B. genetic drift.

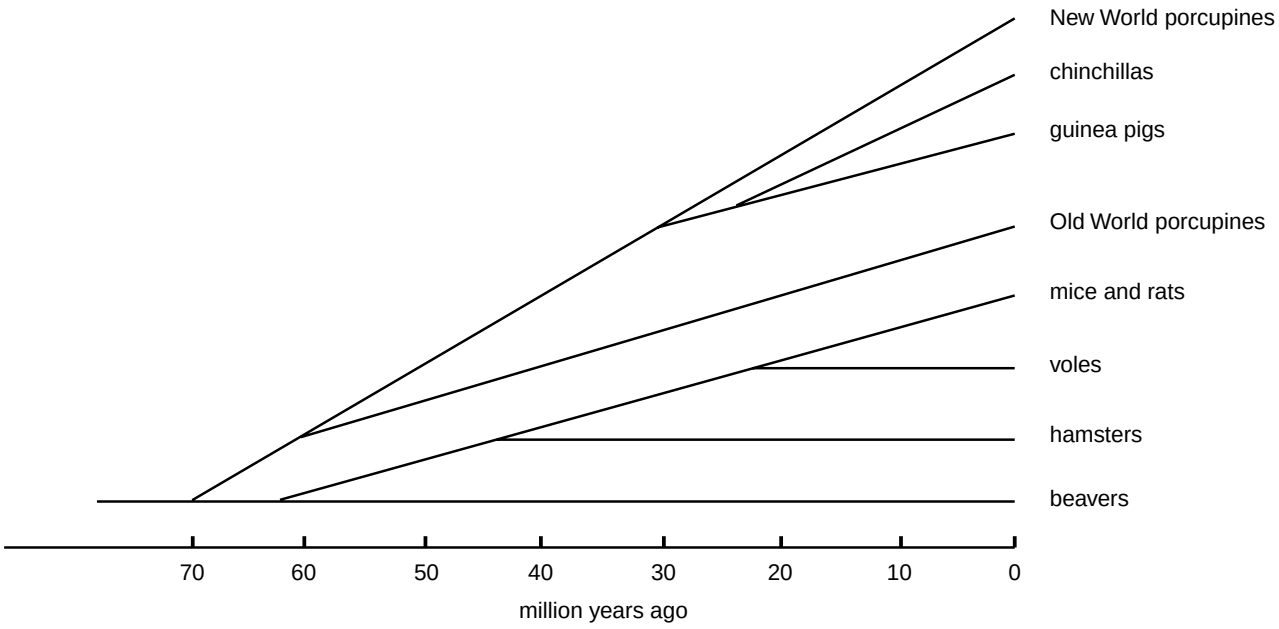
C. artificial selection.

D. parallel evolution.

Use the following information to answer Questions 19 and 20.

Figure 2 shows the evolutionary relationship between a group of animals.

Figure 2



Question 19

It can be concluded from Figure 2 that the group most closely related to mice and rats is

A. Old World porcupines.

B. voles.

C. hamsters.

D. guinea pigs.

Question 20

It can be concluded from Figure 2 that

A. the most recent common ancestor of guinea pigs and Old World porcupines existed approximately 60 million years ago.

B. guinea pigs are more closely related to beavers than they are to chinchillas.

C. guinea pigs and hamsters have no common ancestors.

D. New World porcupines are the most closely related group to the guinea pigs.

Question 21

Natural selection acts on

A. phenotypes.

B. alleles.

C. genotypes.

D. introns.

Question 22

An allele for a recessive disorder in mice could most likely be eliminated from a population in a single generation by

A. removing individuals who are homozygous for the disorder from the population.

B. ensuring there is interbreeding with individuals from other populations.

C. increasing the size of the population.

D. allowing only homozygous dominant individuals to breed.

Question 23

Four groups of ant-eating mammals exist today: the ant bear of South America, the pangolin of Asia, the aardvark of South Africa and the spiny anteater of Australia. These groups are an example of convergent evolution.

This means the organisms

A. have been subjected to similar selection pressures.

B. share a recent common ancestor.

C. display homologous structures.

D. are closely related.

Question 24

Fossilisation of an organism is most likely to occur if the organism

A. is soft-bodied.

B. is encased in very acid sediment.

C. has hard or bony structures.

D. is covered by a flow of lava.

Question 25

Fossil skulls of *Homo sapiens* can be identified by the presence of a large brain case and a

A. large jaw and a sloping face.

B. small jaw and a sloping face.

C. small jaw and a flat face.

D. large jaw and a flat face.

END OF SECTION A

SECTION B – Short-answer questions

Specific instructions for Section B

Section B consists of **seven** short-answer questions. You should attempt every question. You should spend approximately 60 minutes on this section.

Question 1

A number of genetic disorders are caused by abnormalities in the number of chromosomes in each cell. Some individuals have too many chromosomes in each cell, and some individuals have too few.

This can be explained in terms of non-disjunction of homologous chromosomes during meiosis.

a. What is meiosis?

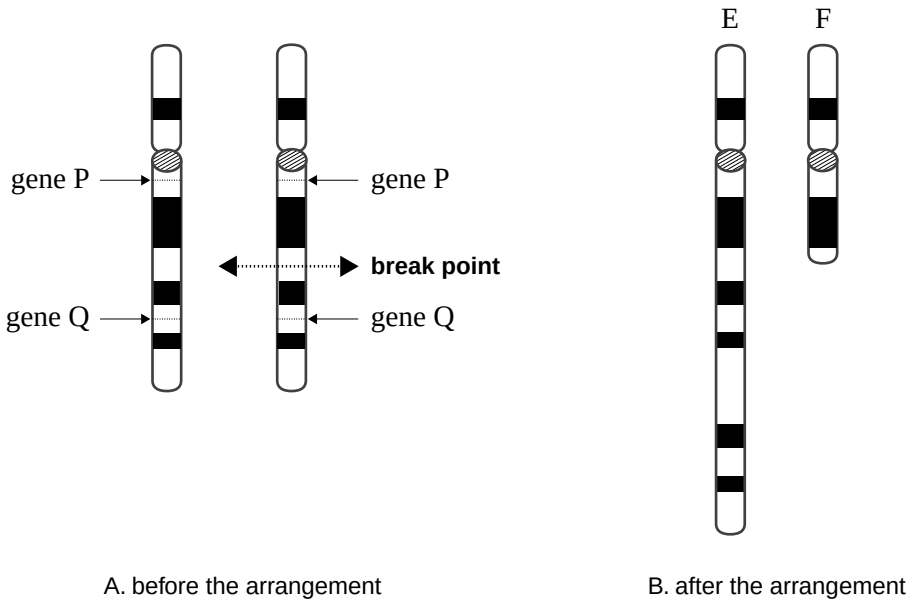
2 marks

b. With the aid of a diagram, explain what is meant by non-disjunction of homologous chromosomes during meiosis.

2 marks

Structural abnormalities in chromosomes also occur. In some cases a part of a chromosome breaks off and may become attached to the homologous chromosome. Figure 3 illustrates this. The loci of two genes found on one pair of homologous chromosomes are shown.

Figure 3



A. before the arrangement B. after the arrangement

c. Homologous chromosomes have the same length, centromere position, and when stained, the same banding pattern. What one other significant feature do they share?

_____

_____

_____

1 mark

d. On Figure 3B (after the rearrangement) above, label the positions of gene P and gene Q on the chromosomes.

2 marks

e. A cell contains chromosomes E and F. What proportion of the daughter cells would contain chromosome E if the cell undergoes normal

i. mitosis? _____

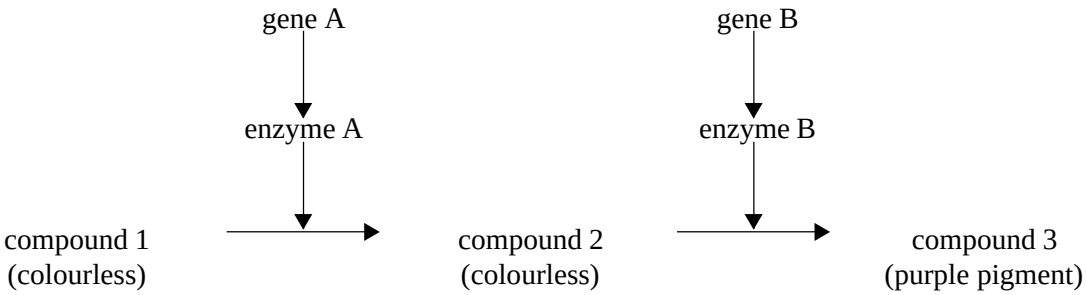
ii. meiosis? _____

1 + 1 = 2 marks

Total 9 marks

Question 2

The colour of the seed coat in some varieties of corn, *Zea mays*, is under genetic control. Two genes on different chromosomes are involved in the control of seed coat colour. The seed coat colour can be either colourless or purple. The purple coat is the result of the presence of the pigment anthocyanin. This pigment is produced in two steps from a colourless molecule. Each step is catalysed by an enzyme as shown below.



Enzyme A and enzyme B are under the control of genes A and B respectively. Each gene locus has two alleles.

Gene A	Gene B
A : enzyme A produced	B : enzyme B produced
a : enzyme A not produced	b : enzyme B not produced

a. State the seed coat colour phenotype of corn plants with each of the following genotypes.

i. aabb _____

ii. aaBb _____

1 + 1 = 2 marks

b. A cross of two corn plants, both heterozygous at the two gene loci for seed coat colour, was carried out.

i. What proportion of the offspring of this cross would you expect to have the following genotypes?

aabb _____

aaBb _____

ii. The ratio of purple seeds to colourless seeds in the large number of offspring produced from this cross is 9:7. How can this ratio be explained?

2 + 2 = 4 marks

Corn is grown on many farms. It was found that corn plants grown on one farm were always shorter than the corn plants grown on a neighbouring farm. A hypothesis that the height of the corn plants was under genetic control was put forward.

c. Describe an experiment to test this hypothesis, and the results from this experiment that would support the hypothesis.

3 marks

A geneticist investigated whether the height of a species of plant was the result of inheritance at a single gene locus or polygenic. Purebreeding tall plants were crossed to purebreeding short plants. All the F_1 plants grew to an intermediate height between that of the two parents.

d. **i.** Explain how this result in the F_1 could occur if the phenotype was due to inheritance at one gene locus.

The geneticist allowed the F_1 to interbreed to produce an F_2. The offspring from this cross allowed the geneticist to draw the conclusion that the trait was the result of polygenic inheritance.

ii. Explain what is meant by the term polygenic inheritance.

iii. Explain what you would expect to see in the F_2 of this cross if the trait was polygenic rather than the result of a single gene.

1 + 2 + 2 = 5 marks

Total 14 marks

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Question 3

In humans a locus on chromosome number 1, called the D1S80 locus, is used in forensic analysis and paternity testing.

a. How many copies of the D1S80 locus would you have in each of your cheek cells?

_____

1 mark

In DNA testing, DNA can be extracted from human cheek cells. The polymerase chain reaction or PCR is used on the DNA sample.

b. What is the purpose of the PCR reaction?

_____

_____

1 mark

PCR can be described in a way similar to DNA replication, that is, it is **semi-conservative**.

c. What does semi-conservative replication mean?

_____

_____

1 mark

The DNA sequence of the D1S80 locus is made up of 16 bases, GAAGACCACAGGCAAG, repeated many times.

d. What are the complementary bases in DNA to the first two bases of the repeat?

G	A

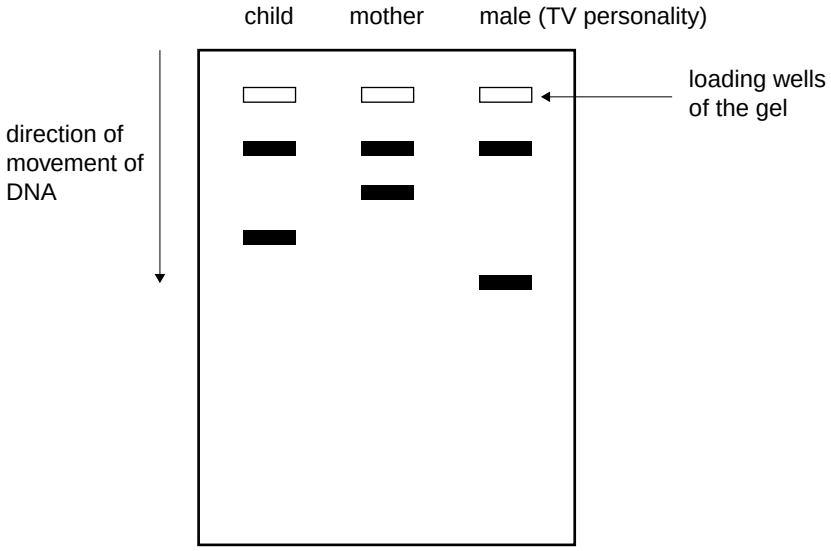
1 mark

The number of repeats at the D1S80 locus varies. The different numbers of repeats can be thought of as alleles at the D1S80 locus. The most common allele in the Australian population includes 24 repeats of the sequence.

The differing number of repeats at the D1S80 locus are passed from parent to child in the same way as any other inherited trait.

Soon after the birth of her child, a mother claimed that a well-known TV personality was the father of her child. The mother, child and TV personality underwent DNA analysis at the D1S80 locus. The result of the gel electrophoresis is shown in Figure 4.

Figure 4



e. Which person of the three mentioned above has the chromosome with the smallest number of repeats?

_____

1 mark

f. Explain, using the information provided in Figure 4, whether the claim made by the mother is supported or not.

_____

_____

_____

_____

_____

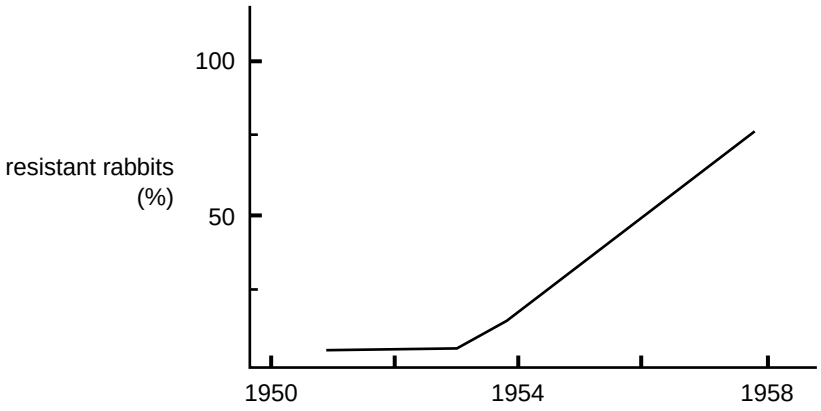
2 marks

Total 7 marks

Question 4

Myxomatosis is an often fatal disease of rabbits caused by the myxoma virus. In Australia the myxoma virus can be spread from rabbit to rabbit by mosquitoes. In the early 1950s, Australian trials began using myxomatosis as a biological control agent for reducing wild rabbit numbers. Within a few years rabbit numbers had dropped up to 80% in some areas, but in the years that followed rabbit numbers began to increase. Figure 5 shows changes in the percentage of rabbits in Australia resistant to the myxoma virus during the 1950s.

Figure 5

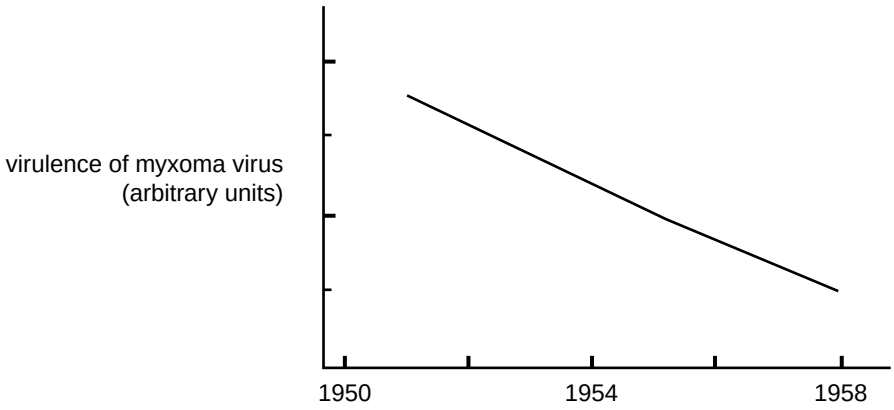


a. Resistance to the myxoma virus is a genetic trait. Explain how natural selection would bring about the changes in the percentage of myxoma resistant rabbits during the 1950s.

3 marks

Since the introduction of the myxoma virus, blood samples have been taken from wild rabbits and tested on laboratory rabbits to determine virulence (the ability of the virus to kill the rabbit more quickly). These experiments have shown that the virus itself is changing. Figure 6 shows changes in the virulence of the virus during the 1950s.

Figure 6



Virulence in the myxoma virus is a genetically determined trait. Highly virulent strains produce large numbers of virus particles in the blood of the rabbit.

b. Explain the selective advantage to the virus of the high virulence phenotype in an environment with many rabbits and mosquitoes.

1 mark

c. The drop in the virulence of the myxoma virus corresponded with a large drop in rabbit numbers. Explain the selective advantage to the virus of the low virulence phenotype in an environment with few rabbits.

2 marks

Total 6 marks

Question 5

In adult humans the blood protein, haemoglobin, consists of two forms of globin; alpha (α) globin and beta (β) globin. The DNA and amino acid sequences of human β globin have been compared to the sequences in three different species; mouse, rabbit and chimpanzee.

Species being compared	% similarity of DNA sequence of β globin	% similarity of the amino acid sequence of β globin
Human with species 1	100	100
Human with species 2	89.3	90.4
Human with species 3	82.1	80.1

a. **i.** Which of the three species (1, 2 or 3) is most likely to be the chimpanzee?

_____

1 mark

ii. Explain your choice in **a.i.**

_____

_____

_____

1 mark

b. You will note that for species 2 and humans there is a greater degree of similarity in the amino acid sequence of β globin than for the DNA sequence of β globin.

Explain why the amino acid sequence shows less variability than the DNA sequence in these two species.

_____

_____

_____

_____

2 marks

Haemoglobin C (HBC) is a variant of adult haemoglobin (HBA) that has arisen by mutation in the β globin sequence.

Table 1. The first 8 amino acids of the β globin sequence of HBA and HBC

HBA beta globin	val-his-leu-thr-pro-glu-glu-lys.....
HBC beta globin	val-his-leu-thr-pro-lys-glu-lys.....

Table 2. The genetic code

First letter	Second letter: U	Second letter: C	Second letter: A	Second letter: G	Third letter
U	UUU phe UUC phe UUA leu UUG leu	UCU ser UCC ser UCA ser UCG ser	UAU tyr UAC tyr UAA stop UAG stop	UGU cys UGC cys UGA stop UGG trp	U C A G
C	CUU leu CUC leu CUA leu CUG leu	CCU pro CCC pro CCA pro CCG pro	CAU his CAC his CAA gln CAG gln	CGU arg CGC arg CGA arg CGG arg	U C A G
A	AUU ile AUC ile AUA ile AUG met	ACU thr ACC thr ACA thr ACG thr	AAU asn AAC asn AAA lys AAG lys	AGU ser AGC ser AGA arg AGG arg	U C A G
G	GUU val GUC val GUA val GUG val	GCU ala GCC ala GCA ala GCG ala	GAU asp GAC asp GAA glu GAG glu	GGU gly GGC gly GGA gly GGG gly	U C A G

Use the information in Tables 1 and 2 to answer the following questions.

Identify the difference in the amino acid sequence of HBA and HBC and compare the RNA sequence for HBA and HBC.

c. What change has occurred in the RNA sequence of HBA β globin that resulted in the changed amino acid sequence in HBC β globin?

1 mark

In another mutation in HBA, a single base substitution in the codon for the seventh amino acid (glu) occurred where the first G of the codon was replaced by U.

d. Explain what effect this base substitution would have on β globin synthesis.

2 marks

Total 7 marks

Question 6

The Pedra Branca Skink, *Niveoscincus palfreymani*, is a small lizard found only on Pedra Branca Rock, a small craggy island located 26 km off the southeastern coast of Tasmania. Pedra Branca Rock was connected to Tasmania during the ice age, 20 000–15 000 years ago, but has been isolated since as a result of higher sea levels. No living or fossil record of this lizard has been found anywhere else; neither in Tasmania nor on the Australian mainland.

a. The existence of *Niveoscincus palfreymani* on Pedra Branca Rock is a result of speciation. Explain how this speciation would have occurred.

3 marks

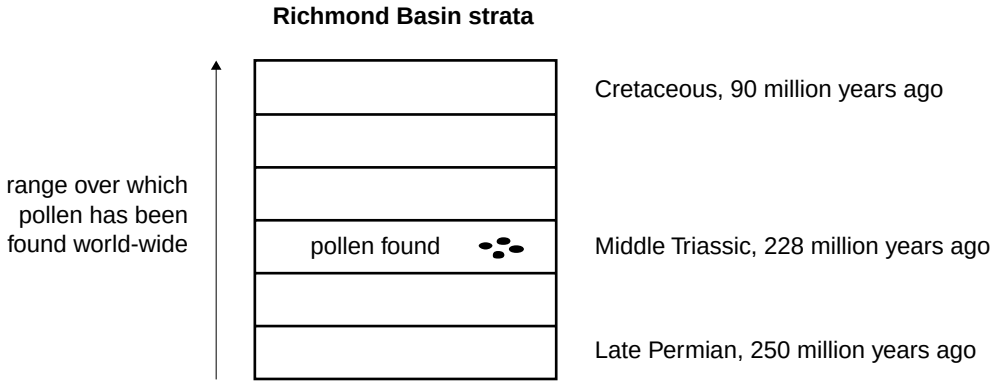
b. This species is regarded as endangered because of its limited distribution and small population size (about 250 individuals). Suggest what could be done to reduce the chances of extinction of this species.

1 mark

Total 4 marks

Question 7

Evidence of the existence of plants in the past is often inferred by the presence of fossilised pollen. Pollen of one group of plants known as *Steevesipollenites* has been recorded in strata from a variety of places throughout the world from the late Permian (250 mya) to the middle Cretaceous (90 mya). In one particular deposit (Richmond Basin in the USA), it does not appear until the Middle Triassic (228 mya) and disappears after only a few million years. In the Richmond Basin strata, where it is found, *Steevesipollenites* pollen is scarce, making up less than 2% of most samples.



a. Give two possible reasons why *Steevesipollenites* pollen has not been recorded from the Richmond Basin strata older than 228 million years.

i. _____

ii. _____

2 marks

b. What radioisotopic technique could be used to date the pollen sample from the Richmond Basin?

_____

_____

1 mark

Total 3 marks

END OF QUESTION AND ANSWER BOOK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