



Victorian Certificate of Education

2010

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STUDENT NUMBER

Letter

Figures

Words

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BIOLOGY

Written examination 2

Friday 29 October 2010

Reading time: 3.00 pm to 3.15 pm (15 minutes)

Writing time: 3.15 pm to 4.45 pm (1 hour 30 minutes)

QUESTION AND ANSWER BOOK

Structure of book

Section	Number of questions	Number of questions to be answered	Number of marks
A	25	25	25
B	9	9	50
			Total 75

- Students are permitted to bring into the examination room: pens, pencils, highlighters, erasers, sharpeners and rulers.
- Students are NOT permitted to bring into the examination room: blank sheets of paper and/or white out liquid/tape.
- No calculator is allowed in this examination.

Materials supplied

- Question and answer book of 25 pages.
- Answer sheet for multiple-choice questions.

Instructions

- Write your **student number** in the space provided above on this page.
- Check that your **name** and **student number** as printed on your answer sheet for multiple-choice questions are correct, **and** sign your name in the space provided to verify this.
- All written responses must be in English.

At the end of the examination

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

Students are NOT permitted to bring mobile phones and/or any other unauthorised electronic devices into the examination room.

SECTION A – Multiple-choice questions**Instructions for Section A**

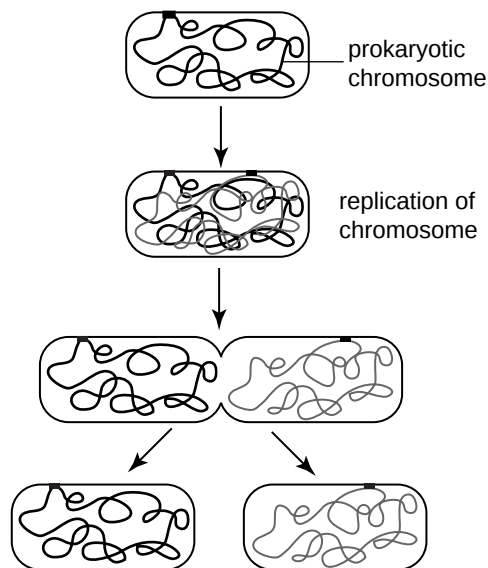
Answer **all** questions in pencil on the answer sheet provided for multiple-choice questions.

Choose the response that is **correct** for the question.

A correct answer scores 1, an incorrect answer scores 0.

Marks will **not** be deducted for incorrect answers.

No marks will be given if more than one answer is completed for any question.

Question 1

The diagram above is a representation of

- A. mitosis.
- B. apoptosis.
- C. binary fission.
- D. gamete formation.

Question 2

A gene in Hereford cattle has the alleles **H**, having horns, and **h**, being hornless. Some farmers choose to humanely remove the horns as horns can be used to injure other cattle. Stanley, a hornless bull, was mated with Iris, a cow which had had her horns removed when she was young. The mother of Iris was homozygous recessive for the trait.

All calves from a cross Iris $\times$ Stanley will

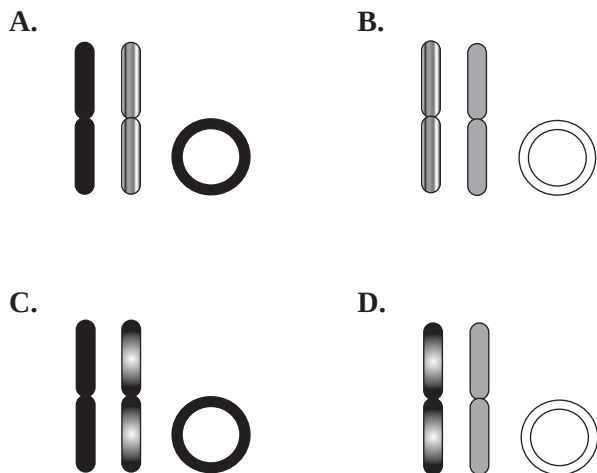
- A. be born with horns.
- B. carry at least one '**h**' allele.
- C. have a one-in-four chance of being hornless.
- D. have a one-in-two chance of being homozygous dominant for horns.

Question 3

The following diagram shows chromosome pair 3 and the mitochondrial DNA from a skin cell of a female and a male.



In relation to the chromosome pair shown and mitochondrial DNA, the genetic makeup of an offspring from this couple could be

**Question 4**

A DNA template strand codes for the amino acid serine with any of the following codons.

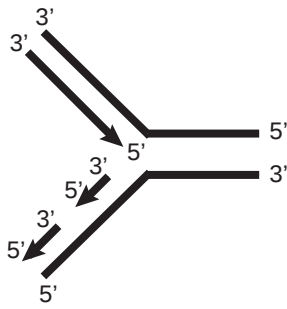
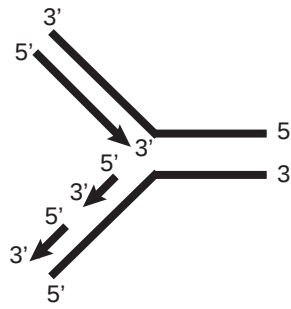
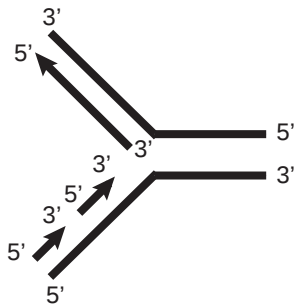
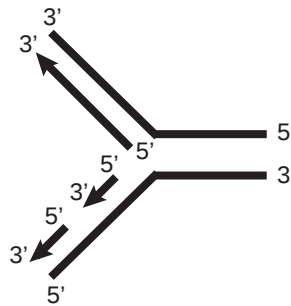
AGA AGG AGT TCA TCG AGC

A tRNA molecule that codes for the amino acid serine is

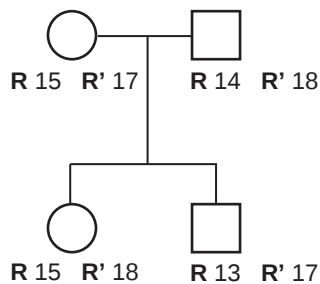
- A. AGT.
- B. UGA.
- C. TCG.
- D. UCG.

Question 5

The structure of a DNA replication fork is best represented by

A.**B.****C.****D.****Question 6**

When a gene has multiple alleles, the alleles can be represented by a series of numbers instead of letters. The following pedigree outlines the alleles for the same gene locus on a chromosome pair, **R** and **R'**, in each of the family members.



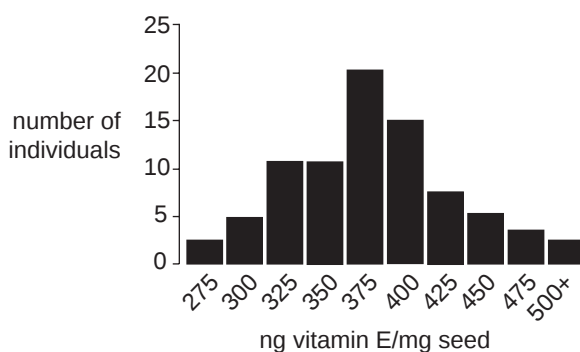
It is reasonable to assume that there has been a mutation in

- A.** chromosome **R** of the mother.
- B.** chromosome **R** of the father.
- C.** chromosome **R'** of the mother.
- D.** chromosome **R'** of the father.

Question 7

Scientists have been studying the amount of vitamin E in the corn plant *Arabidopsis thaliano*.

The amount of vitamin E in hundreds of different plant seeds that were tested is summarised in the following graph.



It is reasonable to conclude that the vitamin E phenotype of corn plants is a result of

- A. cloning.
- B. asexual reproduction.
- C. polygenic inheritance.
- D. discontinuous variation.

Question 8

In cats, coat colour and fur length are inherited characteristics. The two genes involved are on different chromosomes and have the following alleles.

Coat colour	B : black	Fur length	S : short
	b : brown		s : long

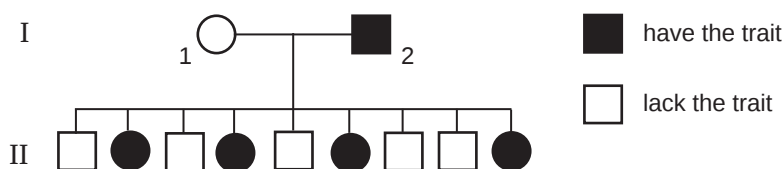
A breeder, Joyce, obtained a cat, Felix, that has short black fur.

Joyce wanted to determine if Felix was heterozygous or homozygous at the two gene loci. To do this it is best that Joyce carries out a test cross between Felix and a female cat with the genotype

- A. **Bb Ss**
- B. **Bb ss**
- C. **bb ss**
- D. **bb Ss**

Question 9

The following pedigree shows the inheritance of an X-linked dominant trait in a family.

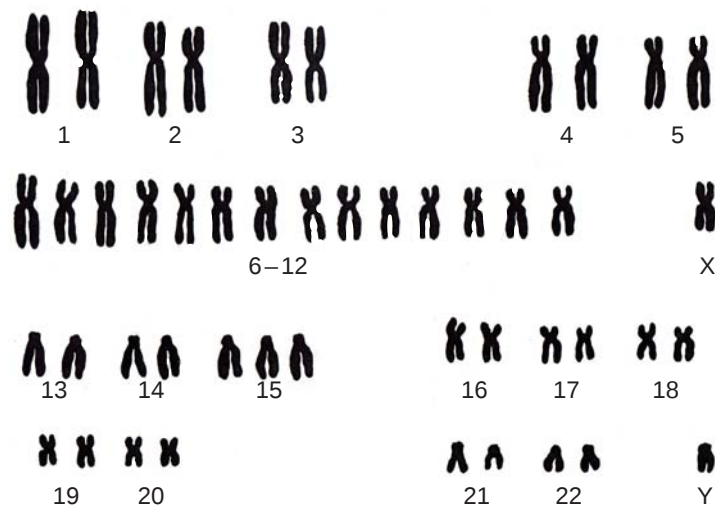


It is reasonable to assume that the

- A. mother of I 1 had the trait.
- B. father of I 1 had the trait.
- C. mother of I 2 had the trait.
- D. father of I 2 had the trait.

Question 10

The following karyotype is from a human baby with a genetic defect.



The condition indicated by the karyotype is an example of

- A. monosomy.
- B. polyploidy.
- C. inversions.
- D. trisomy.

Question 11

Two gene loci that control red seed colour in wheat have the following alleles.

Gene locus 1:	R_1^+	:	red colour	Gene locus 2:	R_2^+	:	red colour
	R_1^-	:	no colour		R_2^-	:	no colour

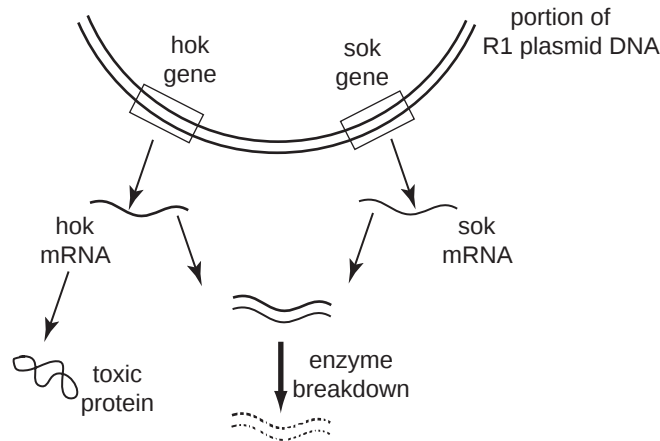
The number of R_1^+ or R_2^+ alleles present in a wheat seed determines the darkness of red in the seed.

It would be reasonable to expect that with regard to wheat

- A. a plant with the genotype $R_1^- R_1^- R_2^- R_2^-$ could be a parent of a seed with the darkest red colour.
- B. seeds with genotypes $R_1^+ R_1^+ R_2^- R_2^-$ and $R_1^- R_1^- R_2^+ R_2^+$ would have the same red colour.
- C. parents $R_1^+ R_1^+ R_2^- R_2^- \times R_1^- R_1^- R_2^+ R_2^+$ could produce seeds with the darkest red colour.
- D. seeds with the genotype $R_1^+ R_1^+ R_2^+ R_2^-$ would have a lighter red colour than seeds $R_1^- R_1^- R_2^+ R_2^+$.

Question 12

The *hok* gene in the R1 plasmid of the bacterium *E. Coli* codes for a toxic protein that causes cell death. The *sok* gene in the same plasmid codes for an antisense regulator that binds to the *hok* mRNA. When the two mRNA strands come together, they are broken down by an enzyme and so cell death is prevented. The following diagram summarises these events.



It would be reasonable to expect that

- A. *hok* mRNA would be translated if *sok* mRNA was absent.
- B. *hok* DNA would be unable to be transcribed if *sok* mRNA is present.
- C. *sok* mRNA would have the same nucleotide sequence as *hok* mRNA.
- D. an *E. Coli* cell without any plasmids would be killed by the toxic protein.

Question 13

In populations

- A. genetic drift will have less effect in a large population compared to a small population.
- B. bottlenecks enable a population to become better equipped for future changes in the environment.
- C. some organisms develop mutations in order to better suit them to their environment compared to other members of the population.
- D. allele frequencies remain constant if the number of individuals leaving the population equals the number of individuals entering it.

Question 14

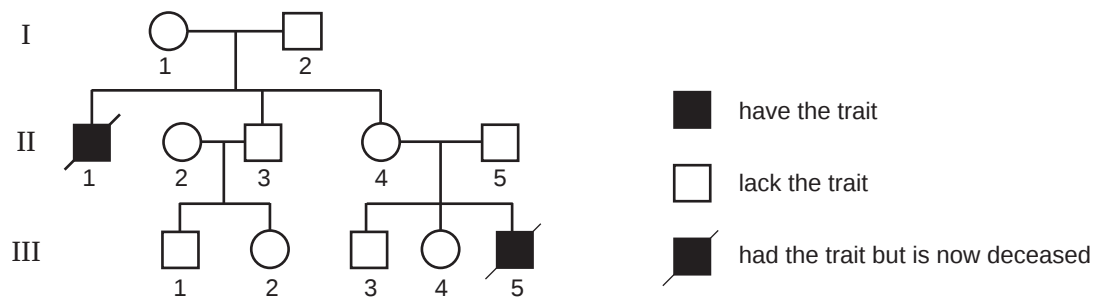
The out-of-Africa hypothesis

- A. is also called the multiregional hypothesis.
- B. proposes that mitochondrial DNA sequences are the same worldwide.
- C. proposes that *Homo sapiens* first appeared in Africa and other continents at the same time.
- D. proposes that *Homo erectus* evolved into *Homo sapiens* in Africa before migrating to other continents.

Use the following information to answer Questions 15 and 16.

Duchenne Muscular Dystrophy (DMD) is inherited as an X-linked recessive condition in which cells fail to produce normal dystrophin protein.

The following pedigree shows a family in which some members have DMD.



Question 15

From the pedigree it is reasonable to conclude that

- A. II 4 is homozygous normal at the DMD locus.
- B. I 1 is heterozygous with respect to the DMD allele.
- C. I 1 and I 2 have a one-in-four chance of producing a daughter with DMD.
- D. II 4 and II 5 have a one-in-three chance of producing a daughter who is a carrier of DMD.

Question 16

It has been suggested that gene therapy is a possible treatment for muscular dystrophy.

Expected benefits if this technique is successfully used include the

- A. inability of the introduced allele being passed on to offspring.
- B. introduced DNA remaining functional for a short time in cells.
- C. integration of the introduced allele into many different gene loci.
- D. production of normal dystrophin protein in genetically affected individuals.

Question 17

A patient with HIV (human immunodeficiency virus) subtype **O** was treated with drug **QT**. After a few weeks of treatment, all of the HIV in the patient was resistant to drug **QT**.

This result is most likely due to

- A. a drug-induced change in the RNA of the HIV.
- B. a reinfection of HIV subtype **O** in the patient after treatment with the drug.
- C. survival of drug-resistant viruses already in the patient at the time of treatment.
- D. the ability of surface proteins on HIV to change on contact with the introduced drug.

Question 18

An index fossil may be used for identifying

- A. the oldest rocks in a series of strata.
- B. the age of rocks from the Jurassic period only.
- C. the absolute age of a sedimentary rock stratum.
- D. sedimentary rocks of the same age in different locations.

Question 19

Genetic transformation

- A. requires stem cells.
- B. occurs between cloned cells.
- C. is necessary for gene sequencing.
- D. involves plasmid uptake in bacteria.

Question 20

The wild sunflower plant has been cultivated by humans over several generations. During that time, selection for or against particular sunflower traits has been carried out.

A comparison of some of the traits in wild and cultivated sunflowers is given below.

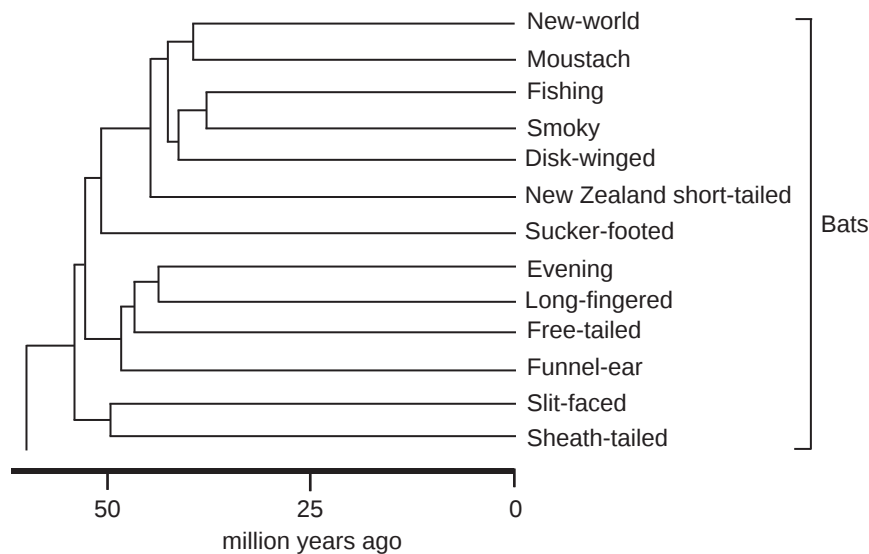
		Wild sunflower	Cultivated sunflower
fruit weight	9–10 mg		 55–65 mg
plant height	153–170 cm		 120–136 cm
flower diameter	3–5 cm		 9–11 cm
number of branches	12–16		0
leaf area	180–270 cm ²		 300–315 cm ²

From the information above, we can assume that humans have selected against large

- A. leaf area.
- B. plant height.
- C. fruit weight.
- D. flower diameter.

Question 21

Part of the phylogenetic tree for bats is shown below.



The most recent divergence of two bat species is the

- A. smoky and fishing bats.
- B. evening and long-fingered bats.
- C. slit-faced and sheath-tailed bats.
- D. sucker-footed and New Zealand short-tailed bats.

Question 22

The following statements are about ideas, discoveries and techniques.

- Idea 1.** The molecular structure of DNA was revealed to be a double helix.
- Idea 2.** Individuals best suited to the environment have the best chance of surviving and reproducing.
- Idea 3.** Comparing the similarities of nucleotide sequences in different organisms helps determine how closely related the organisms are to each other.
- Idea 4.** Organisms can alter their structure to suit their environment and then they are able to pass this favourable alteration onto their offspring.

The correct sequence of timing from oldest to youngest would be

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

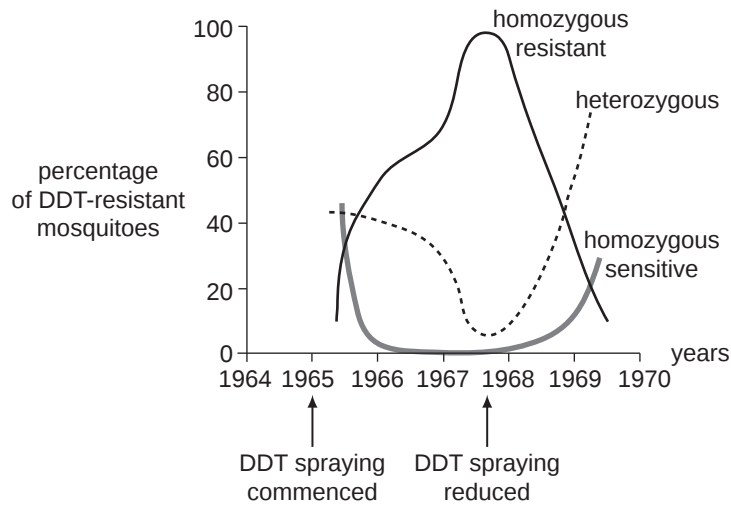
Question 23

In the mid-1960s, DDT was widely used as an insecticide against mosquitoes. The sensitivity to insecticide in mosquitoes is determined by a single gene that has two alleles.

allele 1 : resistant to DDT

allele 2 : sensitive to DDT

Over several years genotypic frequencies were measured in a population of mosquito larvae. The graph below shows the results.

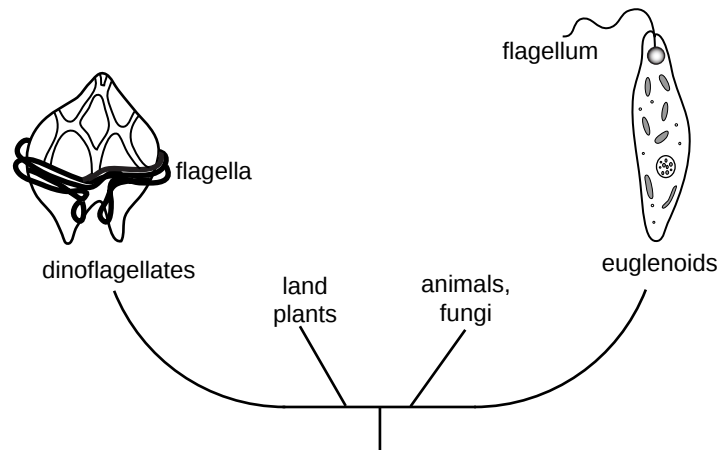


Analysis of the graph reveals that in the population

- A. when spraying levels declined, heterozygous advantage occurred.
- B. there were no alleles for sensitivity present in the population in 1967.
- C. the number of alleles for resistance was equal to the number for sensitivity in 1966.
- D. the homozygous resistant genotype was unable to produce offspring at low spraying levels.

Use the following information to answer Questions 24 and 25.

The phylogenetic tree below is based on molecular analysis and shows one view of the relationships between the kingdoms of living things.



The following table outlines some of the comparative features of two unicellular eukaryotes, dinoflagellates and euglenoids.

Feature	Dinoflagellates	Euglenoids
habitat	• marine environment	• freshwater environment
wall structure	• cellulose wall often encrusted with sand	• cellulose wall absent
locomotion	• spiralling motion of two flagella	• whip-like action of one flagellum

The role of flagella is to cause forward locomotion in both groups; however, the flagellum structure is quite different and unique in each group.

Question 24

The development of the flagellum in the two groups can best be described by the term

- A. homology.
- B. reduction division.
- C. convergent evolution.
- D. phylogenetic classification.

Question 25

Dinoflagellate fossils are more common than euglenoid fossils because

- A. dinoflagellate walls are tougher than those of euglenoids.
- B. dinoflagellate fossil deposits have been subjected to salt water.
- C. euglenoids were more likely to be covered by sediment when they died.
- D. dinoflagellate fossil deposits are more accessible than those of euglenoids.

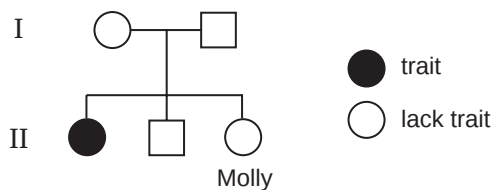
SECTION B – Short answer questions**Instructions for Section B**

Answer this section in pen.

Answer **all** questions in the spaces provided.

Question 1

Consider the following pedigree.



- a. What is the mode of inheritance of the trait?

1 mark

- b. What is the chance that Molly is heterozygous for the trait? Show your working out including the genotype of Molly's parents.

chance

2 marks

Eukaryotic chromosomes, prokaryotic chromosomes and plasmids all contain DNA and vary in size.

- c. What is one other key difference between a
- eukaryotic and a prokaryotic chromosome

- prokaryotic chromosome and a plasmid?

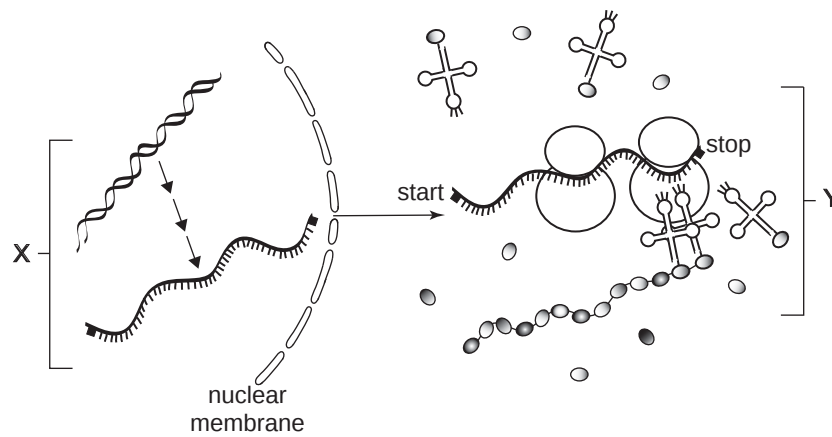
1 + 1 = 2 marks

Total 5 marks

SECTION B – continued
TURN OVER

Question 2

The following diagram outlines processes that occur in living cells.



- a. i. Name the process represented at X.

- ii. Describe the sequence of events that occur during the process at X.

1 + 3 = 4 marks

- b. i.** Name the process represented at **Y**.

- ii.** Describe the sequence of events that occur during the process at **Y**.

1 + 3 = 4 marks

Total 8 marks

Question 3

Humans have 46 chromosomes in each of their body cells.

- a. How many autosomes are present in a single normal gamete?

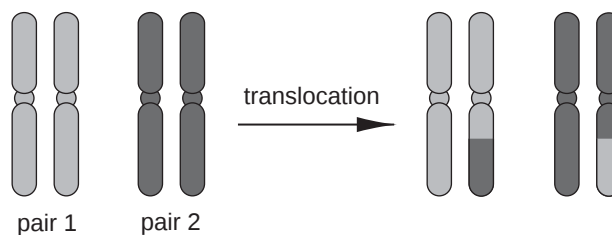
1 mark

During gamete formation, homologous chromosomes pair and exchange genetic material. This process is known as crossing over.

- b. What is the advantage of crossing over in gamete formation?

1 mark

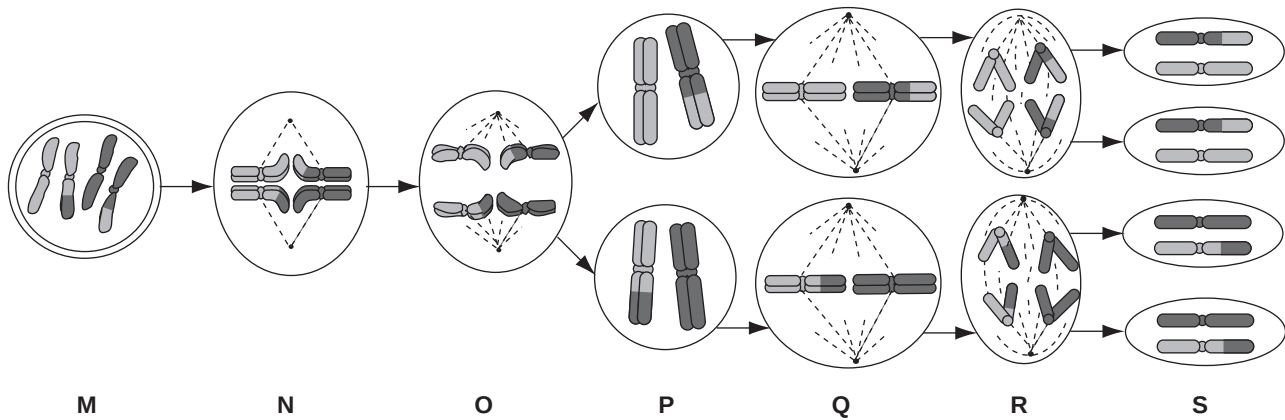
One kind of translocation of genetic material between chromosomes occurs when part of one chromosome exchanges with a part of a different chromosome. If a translocation is present in a fertilised egg, all cells of the individual that has developed will carry the translocation. A phenotypically normal man carried a translocation involving chromosomes 1 and 2.



- c. Explain why the male is phenotypically normal in spite of carrying the translocation shown.

1 mark

The following diagram outlines one meiotic division that occurred in the male.



- d. What stage of meiosis is shown in step **R** of the diagram above?

1 mark

The particular makeup of gametes produced by meiosis depends on the orientation of the chromosome pairs at stage **N**. One example is given above. However, this is not the only orientation possible and, during gamete formation in testes, all possible orientations occur.

- e. i. What is the chance that a sperm from the man will contain a normal chromosome 1 and a normal chromosome 2?

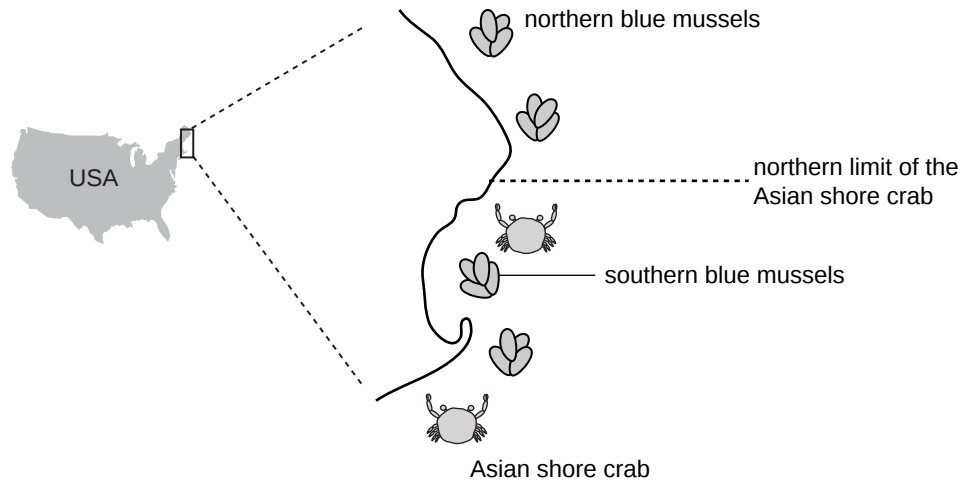
- ii. Outline your reasoning.

1 + 1 = 2 marks

Total 6 marks

Question 4

The blue mussel, *Mytilus edulis*, lives along the northeastern coastline of the USA. A species of Asian shore crab, *Hemigrapsus sanguineus*, was accidentally introduced into the area about 15 years ago. As shown below, the Asian shore crab has only migrated to the southern half of the total area inhabited by the blue mussel.



The Asian shore crab feeds off the blue mussels. The thinner the mussel shell, the easier it is for the crab to crush and eat the mussel.

In recent times, scientists have observed that the overall population of the southern blue mussel has a thicker shell than that of the northern blue mussel. This contrasts with 15 years earlier when there was no difference in the range of shell thickness in northern and southern blue mussel populations.

- a. Explain the process of natural selection that has occurred in the population of southern blue mussels over the last 15 years that has resulted in thicker shells.

3 marks

Assume that the Asian shore crab is unable to migrate past the northern limit line into the northern blue mussel area.

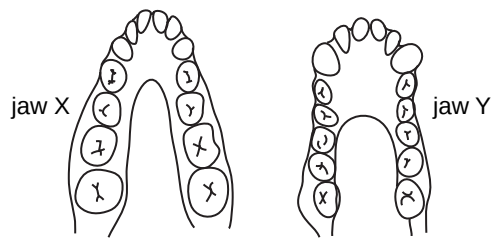
- b.** What would you expect to happen to the shell thickness of the northern blue mussels over time? Explain your reasoning.

2 marks

Total 5 marks

Question 5

The following diagram shows two lower jaws, one from Australopithecus and the other from a gorilla (*Gorilla gorilla*).



- a. Outline the differences between two characteristics, other than tooth number, that enable you to distinguish which jaw is that of Australopithecus.

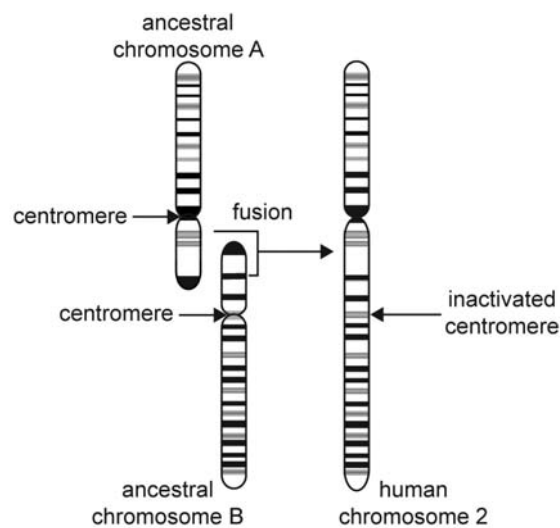
Difference 1 _____

Difference 2 _____

2 marks

Molecular techniques allow detailed examinations of DNA sequences of chromosomes and the rearrangements that have taken place during evolution.

Two chromosomes of the last common ancestor that humans had with chimpanzees fused and gave rise to human chromosome number 2. This fusion is represented in the following diagram.



After fusion of the chromosomes, one of the centromeres from the fused chromosomes was inactivated.

- b. Why was the inactivation of one of the centromeres a significant step in human evolution?

2 marks

Total 4 marks

SECTION B – continued

Question 6

DNA sequencing is often performed to help produce phylogenetic trees or to classify organisms. Sections of nuclear DNA from similar organisms are sequenced and compared for similarities.

- a. Name and describe another DNA method that is used to determine how closely related two species are.

Name _____

Brief description _____

2 marks

Scientists use a specific mitochondrial gene called *cox1* in comparative studies in fish. The *cox1* gene lacks introns and is only 654 bp long, making it economical and easy to sequence. The sequenced gene appears like a 'barcode' found on grocery products, for example



A worldwide database has over 45 000 *cox1* gene sequences obtained from different kinds of fish.

Illegal fishing occurs in Australian waters. Often only a small portion, such as a fin, is kept by the fishermen and the remainder is thrown overboard.

- b. How would the barcode database be used to identify the fish species that had been caught by the fishermen? Provide an example of a situation (other than illegal fishing) when humans would want to identify the fish species.

2 marks

Scientists using the *cox1* gene have seen that even within the same species of fish, differences within the DNA sequence can occur.

The scientists believe this is often due to the redundancy in the genetic code.

- c. Explain what redundancy in the genetic code means.

1 mark

As the database grows it is hoped that at least five samples for each species will be collected and analysed. The species samples will be taken from as many different locations as possible.

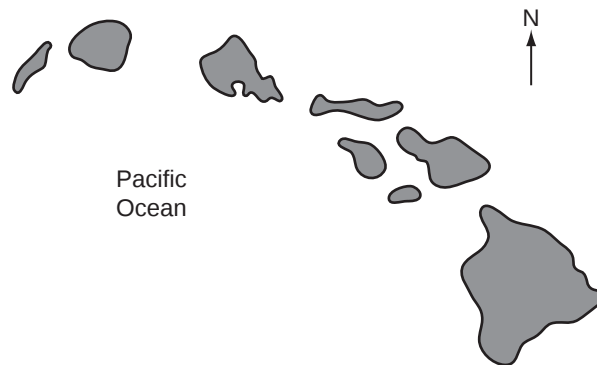
- d. Why is it important to sequence multiple samples from the same species?

1 mark

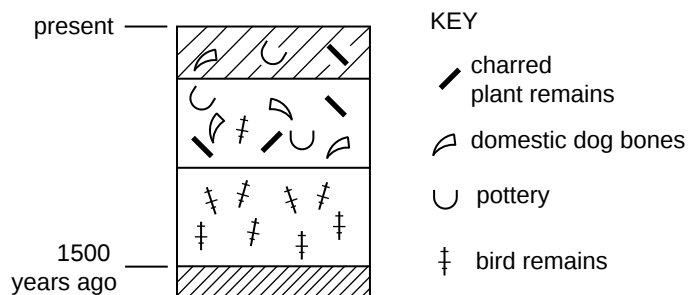
Total 6 marks

Question 7

The islands of Hawaii in the Pacific Ocean were formed as a result of volcanic action in which small land masses were thrown up by submarine volcanoes. The youngest of the islands lies to the east of the oldest.



A similar pattern of deposition has been found across all islands, shown by the profile below.



- a. What assumption is made about the formation of strata when interpreting profiles such as this?

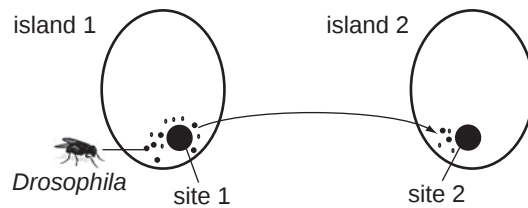
1 mark

- b. i. State a hypothesis to account for the disappearance of many of the bird species from the groups of islands.

- ii. Provide evidence to support your hypothesis.

1 + 1 = 2 marks

Biologists studied many species of the fruit fly, *Drosophila*, living on the Hawaiian islands. The species vary widely in appearance, behaviour and habitat. The diversity of *Drosophila* can be explained by the successive colonisation of newly formed islands by a small number of individuals ‘island-hopping’ from the neighbouring westerly island. This is represented in the diagram below.



- c. i. What name is given to this small group of colonising individuals?

- ii. Explain how the new and old colonies became separate species.

1 + 3 = 4 marks

Total 7 marks

Question 8

DNA includes sections that are called short tandem repeats (STR). Mutations in STRs occur, on average, every 500 generations.

Different numbers of these repeats have no obvious effect on the individual.

- a. What is the likely reason for this?

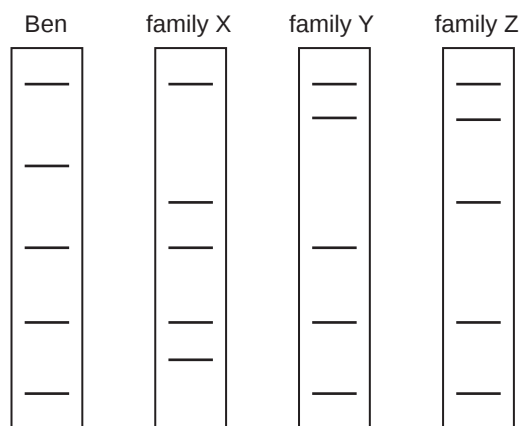
1 mark

A young man, Ben, wants to find out more about his genetic ancestry. He sends a sample of cells, obtained from a swab of his mouth, to a laboratory. On receipt of the sample, the laboratory treats the cells to release the DNA to enable identification of STR markers.

- b. Name the process used to produce many copies of the STR markers.

1 mark

Each of the STR markers produced is labelled with a dye and subjected to gel electrophoresis. Five of Ben's STR markers were compared with three family groups who have the same surname as him. The following gels resulted.



- c. Explain which family is Ben's most recent common ancestor.

2 marks

Total 4 marks

Question 9

Long before the development of agricultural crops, hunter-gatherers in southern Africa would pick the tastiest nutty fruits of the marula tree and scatter them around their camps. These would germinate and grow into fruit-bearing trees. The best seeds would be chosen from these trees and the process would be repeated.

- a. Explain how this practice is an example of selective breeding. In your answer include the selective agent and the phenotypic characteristic being acted on.

2 marks

Current domestication processes include marcotting. This involves peeling away bark from a branch, stimulating the branch to produce roots. The branch is then cut and planted in soil.

- b. i. What can you infer about the genotype of trees propagated through marcotting?

- ii. Outline one disadvantage of a plantation of marula trees grown through marcotting compared to a natural population of marula trees.

1 + 1 = 2 marks

- c. Should the fruit from marcotted marula trees be labelled as genetically modified (GM)? Explain why.

1 mark

Total 5 marks