VICTORIAN CURRICULUM AND ASSESSMENT AUTHORITY

Victorian Certificate of Education 2012

SUPERVISOR TO ATTACH PROCESSING LABEL HERE

STUDENT NUMBER

									Letter
Figures									
Words									

BIOLOGY

Written examination 2

Friday 2 November 2012

Reading time: 9.00 am to 9.15 am (15 minutes)
Writing time: 9.15 am to 10.45 am (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	8	8	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 23 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.

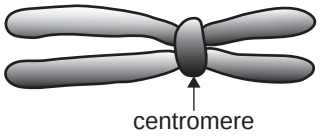
A correct answer scores 1, an incorrect answer scores 0.

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

Consider the following diagram of a cellular structure.



This structure is

A. visible only using an electron microscope.

B. found only in eukaryotic organisms.

C. found in all living organisms.

D. made up entirely of DNA.

Use the following information to answer Questions 2 and 3.

The genome of the woodland strawberry *Fragaria vesca* has been recently sequenced to show a relatively small genome of just 206 million base pairs. *F. vesca* is an ancestor of the garden strawberry and is a relative of apples and peaches.

Question 2

The genome of *F. vesca*

A. is found only in the stem cells of the woodland strawberry.

B. includes all of the proteins made by *F. vesca*.

C. comprises all of the genes of *F. vesca*.

D. is the same as the genome of the apple.

Question 3

It is expected that an offspring produced from sexual reproduction of *F. vesca*

A. translates all of its 206 million base pairs.

B. has equal numbers of adenine and cytosine nucleotides.

C. receives half of its chromosomes from the female parent.

D. possesses the same combination of alleles as other strawberry plants from the same parents.

Question 4

The genetic material of prokaryotic cells is contained in

A. a circular chromosome and many small plasmids.

B. a haploid number of threadlike chromosomes.

C. a diploid number of circular plasmids.

D. many circular chromosomes.

Question 5

The following information shows the chromosome number in root tip cells from a range of plants.

Species	Common name	Chromosome number
Arabis holboellii	rockcress	14 or 21 or 28
Nasturtium spp.	flowery peppery goodness	32 or 64
Vitis vinifera	common grape vine	38 or 57 or 76
Viola spp.	violets	12 or 24 or 36 or 48

It is reasonable to conclude that

A. common grape vine plants all show triploidy.

B. only two of the three kinds of rockcress could reproduce by seed.

C. those plants with odd numbers of chromosomes must be haploids.

D. many of the flowery peppery goodness plants would be unable to carry out meiosis.

Question 6

A couple, each phenotypically normal, have a child with phenylketonuria, an autosomal recessive trait. The chance that their second child will have the trait is

A. one in four.

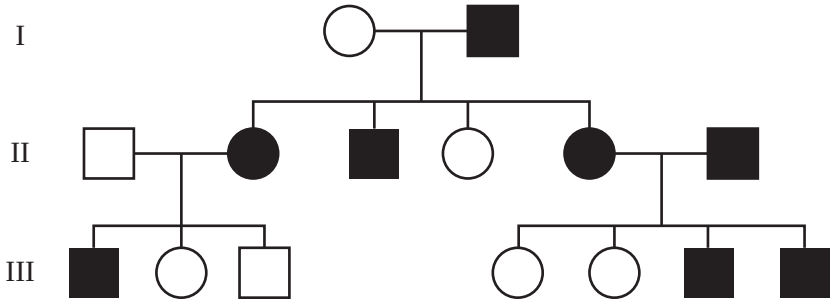
B. two in three.

C. one in three.

D. three in four.

Question 7

In the following pedigree, shaded individuals have a particular genetic trait.



The mode of inheritance of the trait is

A. X-linked dominant.

B. X-linked recessive.

C. autosomal recessive.

D. autosomal dominant.

Use the following information to answer Questions 8 and 9.

Sufferers of the disease cystic fibrosis (CF) produce thick, sticky mucus in their airways. Scientists are trialling a gene transfer technique to introduce the normal allele for the gene (CFTR) into some CF-diseased airway cells. The normal allele for the gene is introduced into the airway cells in delivery particles that have been built using highly modified components of the HIV-1 (AIDS) virus.

Question 8

These delivery particles

A. contain mucus.

B. are being used as vectors.

C. are capable of causing AIDS.

D. would be absorbed by all CF-diseased airway cells.

Question 9

In this example of gene therapy, the treatment is successful if the

A. normal allele for the gene is inserted into the nuclear DNA of airway cells.

B. delivery particles do not cause side effects, such as inflammation.

C. normal allele for the gene is expressed in the airway cells.

D. delivery particles enter the airway cells.

Use the following information to answer Questions 10 and 11.

In humans, the ABO blood group has a single autosomal gene locus with three possible alleles. There are four different blood group types. The different blood group types and their genetic make-up are shown in the following table.

Blood group type	Possible alleles
Group O	ii
Group A	I^AI^A or I^Ai
Group B	I^BI^B or I^Bi
Group AB	$I^A I^B$

Question 10

A woman of blood group A, whose genotype is unknown, and a man of blood group O have a child. Genetically, this is an example of a

A. self cross.

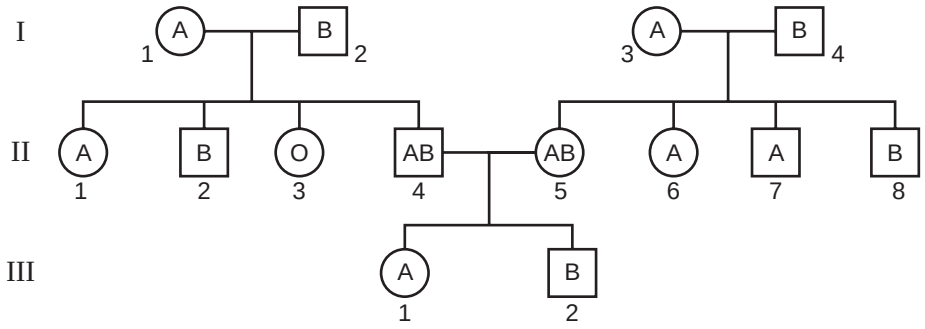
B. test cross.

C. dihybrid cross.

D. sex-linked cross.

Question 11

Examine the following pedigree, which shows the phenotype with respect to the ABO gene locus of each individual.



Individuals that would be homozygous at the ABO gene locus include

A. I3.

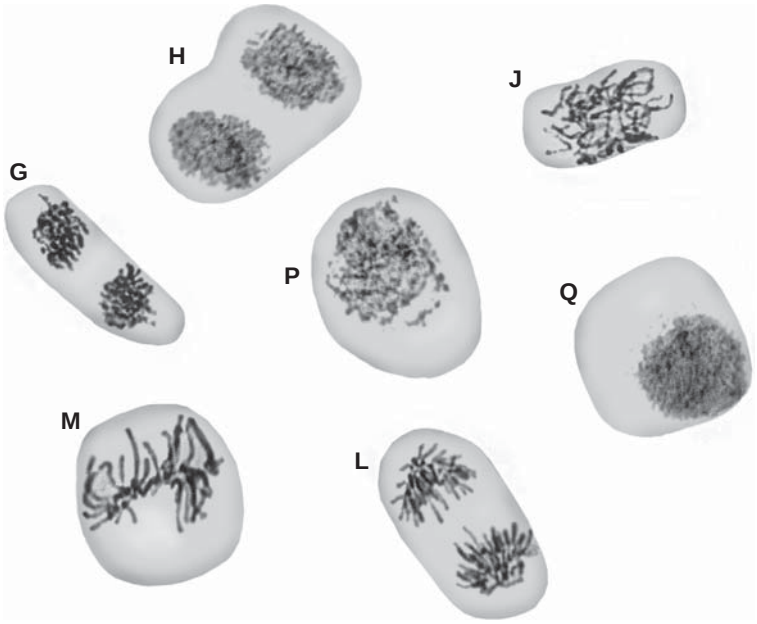
B. II2.

C. II6.

D. III2.

Question 12

The following images show plant cells from a tissue that is undergoing mitosis.



The order of the cells in a single mitotic phase would be

A. Q P J M L G H.

B. P Q M G J L H.

C. P G L M J Q H.

D. Q H J P L G M.

Question 13

Two genes for coat colour in dogs have the following alleles.

Gene 1	Gene 2
B : black	**S** : solid colour
b : brown	**s** : white spotting

It is reasonable to conclude that a dog with the genotype

A. **BB Ss** would be black with white spotting.

B. **Bb Ss** would be brown with white spotting.

C. **bb SS** would be a solid brown colour.

D. **bb ss** would be a solid black colour.

Question 14

Activator molecules that are present in cells can turn genes on.

Only liver cells produce the protein albumin and only lens cells produce the protein crystallin.

The difference in protein production between these two cells can be explained by

A. lens cells containing activator molecules for the gene coding for crystallin.

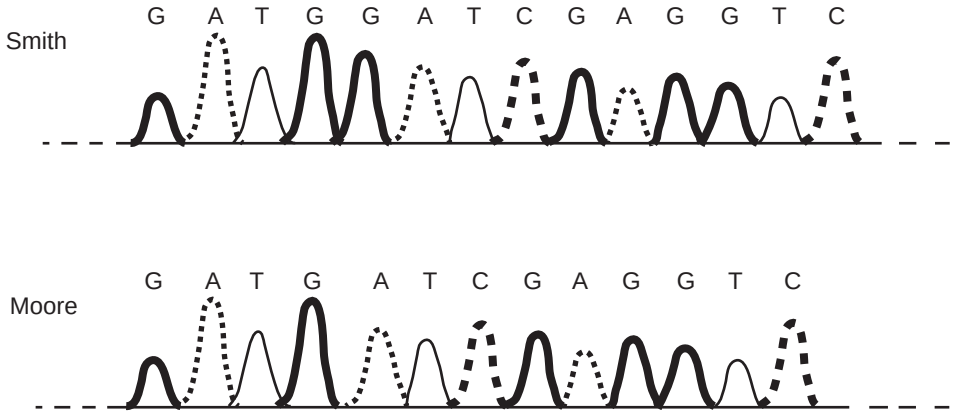
B. the presence of RNA polymerase in lens cells but not in liver cells.

C. liver cells not having the gene that codes for crystallin.

D. both cells containing identical activator molecules.

Question 15

A fragment of DNA from chromosome 7 of each of two persons, Smith and Moore, are sequenced. The nucleotide sequences in corresponding regions are shown below. This DNA fragment controls the production of an enzyme that, when faulty, results in a rare genetic disorder. Smith is unaffected while Moore has the recessive disorder.



It is reasonable to conclude that

A. the complement of Smith's DNA strand would have the sequence
G A T G G A T C G A G G T C.

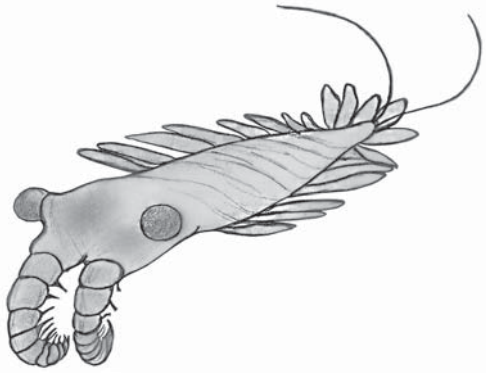
B. the amino acid sequence in the polypeptides translated from the DNA of Moore and of Smith would be identical.

C. the mRNA transcribed from Smith's DNA would have the sequence
G A T G G A T C G A G G T C.

D. Moore's genetic disorder could be due to a deletion of one of the nucleotides.

Use the following information to answer Questions 16–18.

Anomalocaris fossils have been found at Emu Bay in South Australia. *Anomalocaris* was a predatory, shrimp-like invertebrate measuring 60 cm in length. It had long, spiny, frontal appendages and a powerful, disc-shaped mouth made of overlapping, hard plates. The Emu Bay fossils were found in layers of shale and dated back to about 520 million years ago. *Anomalocaris* fossils that have been found around the world suggest that this genus existed for at least 50 million years.



Question 16

Factors that would have contributed to the fossilisation of this animal include

A. its predatory way of life.

B. the action of waves and currents.

C. the salt content of the water in which it lived.

D. its hard-plated mouth and spiny appendages.

Question 17

In order to estimate the age of *Anomalocaris* fossils, paleontologists would have most likely used

A. index fossils.

B. carbon-14 dating.

C. a molecular clock.

D. DNA hybridisation.

Question 18

A likely explanation for the extinction of *Anomalocaris* is that

A. its populations had high genetic diversity.

B. its disc-shaped mouth was unsuitable for ingesting prey.

C. it produced offspring that were suited to their environment.

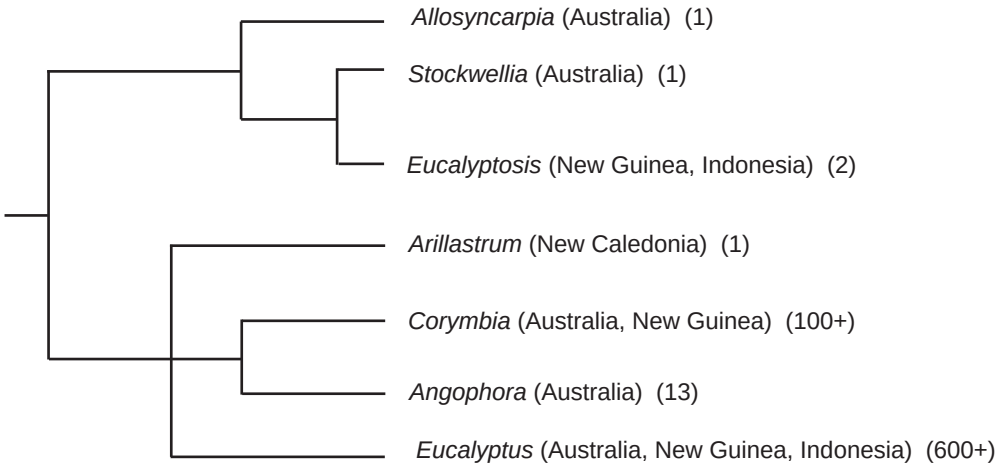
D. selection pressures changed dramatically due to rapid climate change.

Use the following information to answer Questions 19 and 20.

Eucalypts, commonly known as gum trees, are Australian trees. They have been recently classified into seven different genera on the basis of nuclear and chloroplast DNA sequencing.

Question 19

A proposed phylogeny for the seven genera is shown in the diagram below, along with the countries in which they are found.



Key Numbers in brackets ( ) refer to the numbers of species in the genus.

It would be reasonable to conclude that

A. DNA sequences in *Eucalyptosis* would be more similar to those in *Allosyncarpia* than to those in *Stockwellia*.

B. speciation in *Eucalyptus* was assisted by different selecting pressures.

C. the greater the number of species in a genus, the younger the genus.

D. the genus that evolved most recently was *Angophora*.

Question 20

Another source of DNA that could be used to determine evolutionary relationships among eucalypts would be

A. plasmids.

B. ribosomes.

C. mitochondria.

D. reverse copy DNA.

Question 21

Retinitis pigmentosa (RP) is an autosomal recessive trait that results in progressive blindness in humans.

On the island of Tristan da Cunha in the Atlantic Ocean, the frequency of the allele causing RP is four times greater in its population of a few hundred individuals than in the original British population from which it was colonised in the early 1800s. No natural disasters have occurred on the island since it was colonised.

The process that is most likely responsible for this observation related to allele frequency is

A. genetic drift.

B. founder effect.

C. bottleneck effect.

D. natural selection.

Question 22

Charles Darwin and Alfred Wallace proposed a theory of evolution in the late 1850s.

One observation made by Darwin that helped formulate the theory was

A. the environment remaining constant during the lifetime of an organism.

B. individual organisms losing a trait that was not in use.

C. individual organisms evolving in their own lifetime.

D. inherited variation existing within a population.

Question 23

Early in 2012, biologists announced the discovery of a new lizard species.

To claim that the lizards belong to a new species, the biologists must show that the lizards

A. look different from one another.

B. look different from known species.

C. have similar genetic sequences to known species.

D. do not produce fertile offspring with members of known species.

Question 24

Genetic screening is an example of human intervention in natural evolutionary processes.

An example of genetic screening would be

A. testing an individual to identify the presence of a particular allele.

B. preventing individuals with particular alleles from breeding.

C. removing a mutated allele from a chromosome.

D. curing an individual of an inherited disease.

Question 25

Biological evolution

A. includes changes in the learnt behaviour of individuals in a population.

B. involves inherited change in a population over many generations.

C. occurs faster than technological evolution.

D. is defined as simply change over time.

END OF SECTION A

CONTINUES OVER PAGE

SECTION B – Short answer questions

Instructions for Section B

Answer this section in pen.

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

Question 1

In Australia, Alzheimer's disease is the most common form of dementia. Alzheimer's disease is associated with the development of a toxic protein in the brain known as amyloid beta-protein. The amyloid beta-protein builds up to form plaques in the brain. This causes symptoms such as memory loss.

The synthesis of amyloid beta-protein occurs in two stages.

a. Name the two stages of protein synthesis.

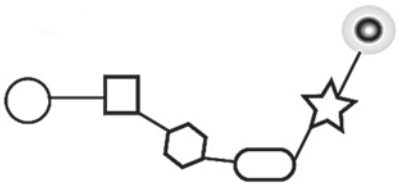
1 mark

b. Describe the main steps of the **first stage** of synthesis of amyloid beta-protein.

3 marks

c. Consider the diagrams of the following six structures.

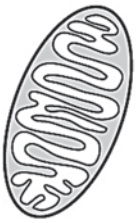
M



J

R

L



K

S

not to scale

Choose three of the structures shown above that are involved in the **second stage** of protein synthesis. Explain the role of each in producing amyloid beta-protein.

Letter representing structure chosen	Role of structure in second stage of amyloid beta-protein synthesis

3 marks

Question 2

The terms ‘discontinuous variation’ and ‘continuous variation’ are used in the description of the phenotypes of organisms.

Compare discontinuous and continuous variation by completing the table below.

Point of comparison	Discontinuous variation	Continuous variation
number of genes and/or alleles involved		
impact on phenotypes		

2 marks

Question 3

Genetic information in humans can be obtained by DNA profiling.

In DNA profiling, the polymerase chain reaction is used by a scientist to amplify a particular sequence of DNA.

a. Briefly describe the steps of this technique.

4 marks

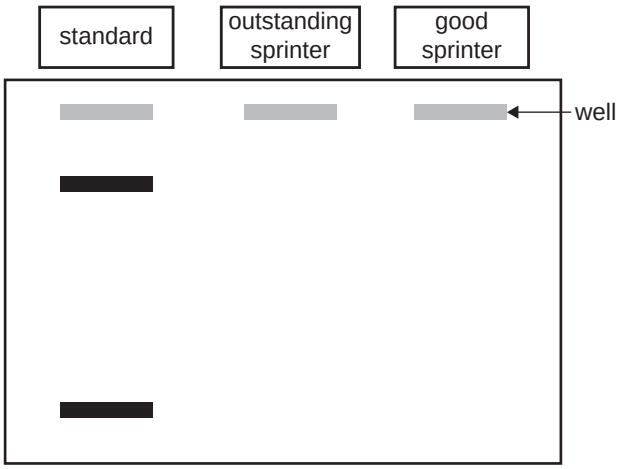
Scientists investigating the performance of athletes found that one gene contributing to the performance of sprinters is the ACTN3 gene. There are two alleles of the gene, the 577R allele and the 577X allele.

The 577X allele codes for a very short protein fragment in muscle fibres due to a stop codon mutation.

The table below summarises the athletic potential for the three possible genotypes for the ACTN3 gene.

ACTN3 genotype	Athletic potential
577R / 577R	outstanding sprinter
577R / 577X	good sprinter or long-distance runner
577X / 577X	very good long-distance runner

A scientist tested sprinters to see if they possessed the 577R allele. Samples were obtained from athletes' muscle fibres. A standard containing proteins of the same lengths as the proteins coded for by both alleles 577X and 577R was used as a comparison. The standard and the samples were exposed to gel electrophoresis. In gel electrophoresis, protein molecules separate according to size and charge in the same way as DNA molecules. The result for the standard is shown below.



b. On the diagram of the gel above, draw the bands expected for an outstanding sprinter and for a good sprinter.

Explain why you have placed the bands in these positions.

3 marks

Question 4

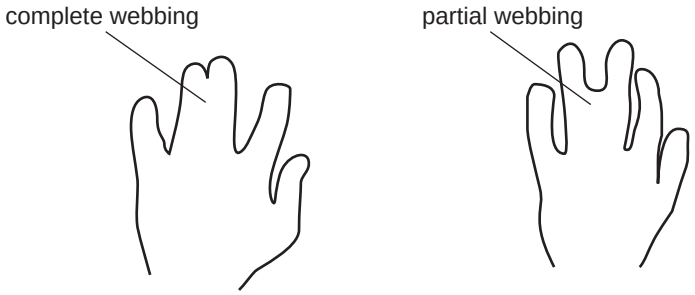
a. Draw a labelled diagram to outline the process of DNA replication.

4 marks

b. Briefly describe how the process of binary fission varies from that of mitosis.

2 marks

The following diagram shows a hand from two individuals who have each been born with syndactyly.



Syndactyly is a condition in which two or more fingers or toes do not separate during fetal development. An individual may have either complete or partial webbing.

Apoptosis plays a role in the presence or absence of webbing between fingers and toes.

c. Define apoptosis and outline the role it plays with respect to the prevention of syndactyly.

2 marks

Syndactyly is inherited as an autosomal dominant trait.

Ruby and her father have syndactyly. Ruby's mother has normal fingers and toes. Ruby marries Jonah, who has normal fingers and toes.

d. What is the chance that a child of Ruby and Jonah will have syndactyly? Assign symbols to represent the alleles of syndactyly. Show all working.

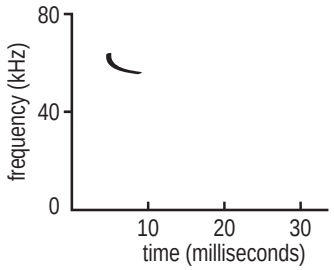
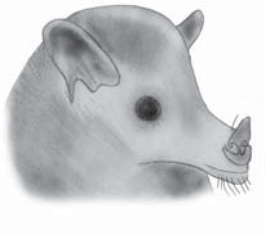
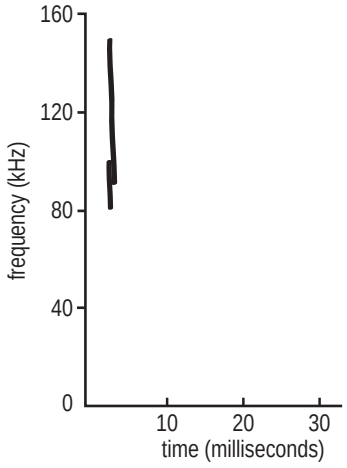
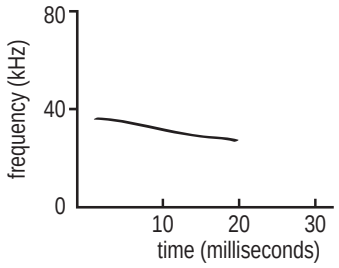
2 marks

Question 5

Barro Colorado Island is a small island covered by tropical forest in Central America. Seventy-four different species of bats live in the forest.

Bats are nocturnal, flying mammals. To find their way around in darkness, many bat species emit high-frequency sound pulses that bounce off obstacles and prey. These pulses enable them to judge the distance to an object. This behaviour is called echolocation.

Three of the Barro Colorado Island species are described in the table below.

Species name	Facial appearance of bat	Diet	Feeding location	Echolocation signal
Black myotis bat (*Myotis nigricaris*)		insects	around trees at forest's edge and in clearings	
Mexican long-tongued bat (*Choeronycteris mexicana*)		nectar and pollen flowers that open at night, for example cactus, agave	narrow gaps and small spaces	
Velvety free-tailed bat (*Molossus molossus*)		insects	above trees, in open spaces	

a. From the information provided, state one selection pressure operating on the bats of Barro Colorado Island.

_____

_____

1 mark

b. **i.** In terms of time, which of the three species emits the longest echolocation signal?

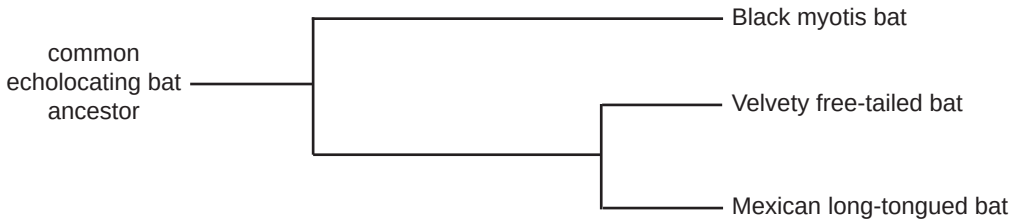
ii. Explain how this could be a selective advantage for this bat species.

1 + 1 = 2 marks

c. A biologist suggested that the three species shown evolved from a recent common ancestor.
What is this type of evolution called?

1 mark

The biologist wanted to establish the order in which each species had evolved from the common ancestor. DNA hybridisation between the various species was carried out. After analysing the results, the scientist drew the following phylogenetic tree.



d. What results would have been obtained from the DNA hybridisation that led the biologist to construct this phylogeny?

2 marks

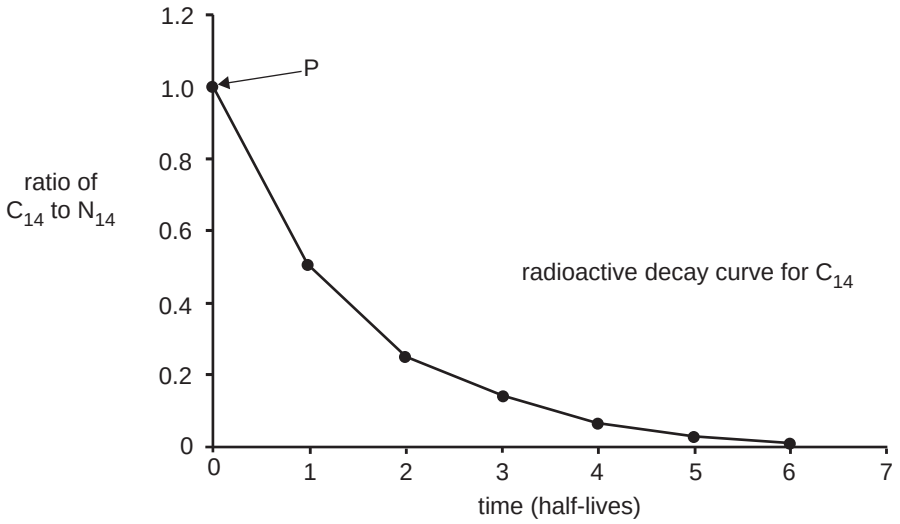
e. A student suggested that the evolution of the three species was an example of allopatric speciation.
Explain why you agree or disagree with the student.

2 marks

Question 6

One form of dating the age of a fossil is by radioactive carbon dating. The ratio of carbon-14 to nitrogen-14 ($C_{14} : N_{14}$) in the fossil is analysed and compared with the ratio of these elements in an organism living today.

The graph below shows the rate of decay for carbon-14.



Key	Point P on the graph represents the ratio of C_{14} to N_{14} found in present-day organisms.

A fossil kangaroo skull was found in a limestone cave. The skull's $C_{14} : N_{14}$ ratio was analysed and found to contain one-quarter ($\frac{1}{4}$) of the carbon-14 of a kangaroo that died in 2012.

a. **i.** Place an X on the curve to show the fossil's $C_{14} : N_{14}$ ratio.

ii. Given the half-life of carbon is approximately 6000 years, what is the approximate age, in years, of the kangaroo skull?

_____

1 + 1 = 2 marks

Carbon-dating analysis is not always possible and the age of the fossil can be estimated by dating the rock in which it is found.

b. **i.** Why is carbon-dating analysis not always possible?

_____

_____

_____

ii. Name another absolute dating technique that can determine the age of the rock surrounding a fossil.

_____

1 + 1 = 2 marks

Question 7

Embryonic studies of zebra fish and humans have shown common features exist. DNA studies have shown there are common genes for particular traits, such as body pigments. The nucleotide sequence of the zebra fish and human gene coding for body pigment are about 70% identical.

a. Explain why zebra fish and humans have a gene coding for the same trait but have variation within the gene.

2 marks

In Victoria, regulations require fishermen who catch golden perch fish (*Macquaria ambigua*) to return small fish to the water. Only medium-sized and large fish can be kept. In a Biology class, some students stated that returning small fish to the water was an example of selective breeding. Other students thought it was an example of natural selection.

b. Explain the difference between selective breeding and natural selection.

2 marks

Salmon is a species of fish. A biotechnology company has engineered a faster-growing salmon by splicing genes from another species of fish into the salmon DNA.

c. What general name is given to an organism that contains genes from other species?

1 mark

Question 8

In 2008, two incomplete, fossilised skeletons were found in cave deposits in South Africa. The scientists compared the newly discovered bones with those of members of the genus *Australopithecus*, early *Homo*, modern humans and apes. The fossilised skeletons, named *Australopithecus sediba*, displayed an unusual mix of characteristics. They partly resembled primitive, ape-like animals.

Like the apes, *A. sediba* was of small stature. Scientists determined that *A. sediba*, like apes, was suited to climbing in trees.

a. What feature of the *A. sediba* skeleton allowed scientists to reach this conclusion?

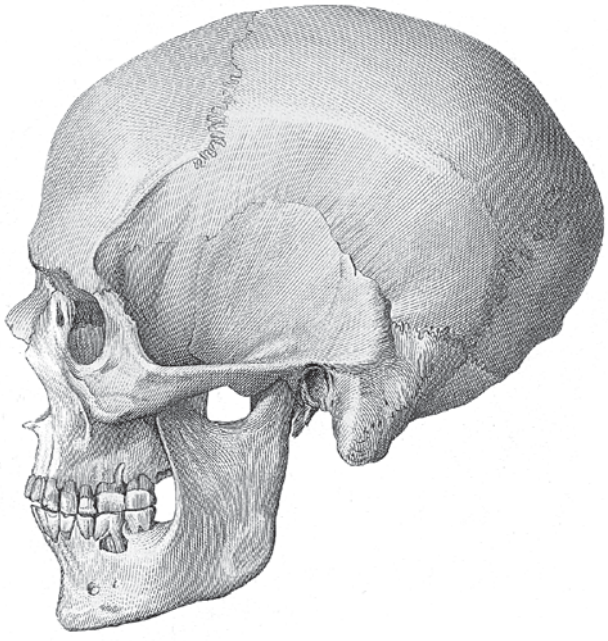
1 mark

A. sediba was found to have many characteristics in common both with the members of the genus *Australopithecus* and with the genus *Homo*. Two characteristics shared with the genus *Homo* included a projecting nose and hands with a precision grip.

b. Explain how each of these characteristics may have given *A. sediba* an advantage over other *Australopithecus* species.

2 marks

Below is a drawing of the skull of a modern-day human.



c. Using the drawing, suggest one feature of modern-day humans that makes humans more advanced than other *Homo* species. Explain the significance of this feature to the evolution of modern humans.

2 marks

Fossil evidence from South Africa has shown that early humans (approximately 77 000 years ago) constructed sleeping mats from local plants. Later evidence from approximately 73 000 years ago indicates that the bedding was burnt on a regular basis.

d. Suggest the cultural and/or technological significance of each of these findings.

2 marks

END OF QUESTION AND ANSWER BOOK