Neap:

Trial Examination 2008

VCE Biology Unit 4

Written Examination

Question and Answer Booklet

Reading time: 15 minutes
Writing time: 1 hour 30 minutes

Student's Name: _____

Teacher's Name: _____

Structure of Booklet

Section	Number of questions	Number of questions to be answered	Number of marks
A	25	25	25
B	6	6	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 booklet of 22 pages.
Answer sheet for multiple-choice questions.

Instructions

Write your **name** and **teacher's name** on this booklet and in the space provided on the answer sheet for multiple-choice questions. All written responses should be in English.

At the end of the examination

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

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

Students are advised that this is a trial examination only and cannot in any way guarantee the content or the format of the 2008 VCE Biology Unit 4 Written Examination.

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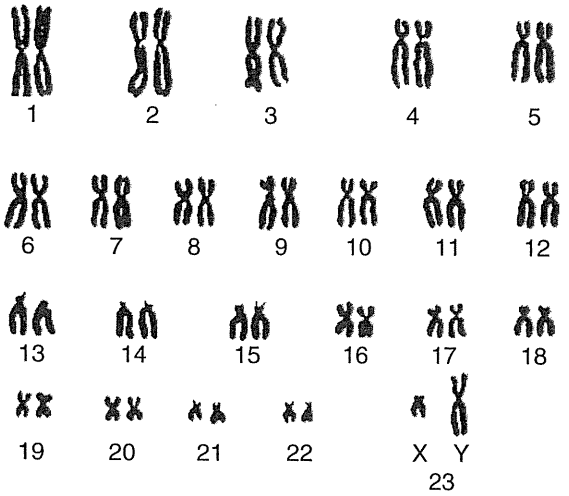
SECTION A: MULTIPLE-CHOICE QUESTIONS

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.

The following information relates to Questions 1, 2 and 3.

The diagram below shows a normal human male karyotype.



Question 1

Each chromosome, as shown in the karyotype above, comprises

A. two centromeres and one chromatid.
B. two centromeres and two chromatids.
C. one centromere and one chromatid.
D. one centromere and two chromatids.

Question 2

The karyotype would have been constructed

A. during the stage prior to DNA replication.
B. during the G1 phase.
C. during the S phase.
D. after the G2 stage.

Question 3

In the karyotype, the number of copies of **each** autosomal gene is

A. 2
B. 4
C. 23
D. 46

Question 4

The division of prokaryotic cells is called

A. apoptosis.
B. mitosis.
C. binary fission.
D. meiosis.

The following information relates to Questions 5 and 6.

The *Drosophila* genes for eye colour and body colour are both carried on the X chromosome (but not on the Y chromosome). Red eye colour (**w+**) is dominant to white eye colour (**w**), and tan body colour (**y+**) is dominant to yellow body colour (**y**).

Question 5

A red-eyed, yellow-bodied female who is homozygous for eye colour has the genotype

A. $X^{w+y}X^{w+y}$
B. $X^{w+y+}X^{w+y+}$
C. $X^{wy}X^{wy}$
D. $X^{wy+}X^{wy+}$

Question 6

In a mating, the chance of a red-eyed male producing a white-eyed daughter is

A. 100%
B. 75%
C. 50%
D. 0%

Question 7

Two parents who do not exhibit a genetic condition called phenylketonuria (PKU) have a daughter with PKU.

From this situation, it can be concluded that

A. the allele for PKU is located on the Y chromosome.
B. PKU is an autosomal dominant trait.
C. PKU is an autosomal recessive trait.
D. PKU is an X-linked recessive trait carried by the father.

Question 8

An animal has the genotype **AaBBccDd**.

With respect to these four loci, the number of different gamete genotypes this individual could produce is

A. 2
B. 4
C. 8
D. 16

Question 9

If an individual is assigned the genotype $\frac{\mathbf{AB}}{\mathbf{ab}}$, this means that

A. genes A and B are independently inherited.

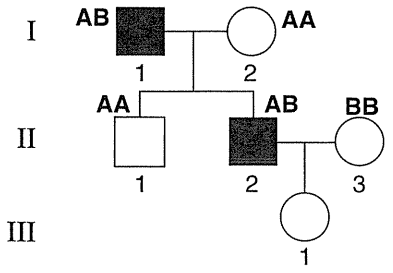
B. genes A and B are linked, and a crossover has occurred between the two genes.

C. genes A and B illustrate a monohybrid cross.

D. genes A and B are linked.

Question 10

In the pedigree below, **A** and **B** represent alleles at a 'marker locus' closely linked to a disease locus. Individuals affected by the disease are shaded. The disease status of individual III–1 is unknown.



It is correct to say that

A. the probable pattern of inheritance shown by the disease is autosomal recessive.

B. if recombination does not occur and III–1 has the genotype **AB**, the probability that she will be affected is 100%.

C. if recombination does not occur and III–1 has the genotype **BB**, the probability that she will be affected is 100%.

D. if recombination does occur and III–1 has the genotype **AB**, the probability that she will be affected is 100%.

Question 11

Three mRNA bases that bind to a tRNA anticodon to specify the placement of an amino acid in a protein are collectively called a(n)

A. protein.

B. exon.

C. triplet.

D. codon.

Question 12

At a particular locus in the slug *Mucosus nauseatus*, there are three possible genotypes: **A1A1**, **A1A2** and **A2A2**. The relative genotype frequencies and the volume of mucus secreted by slugs of these genotypes are shown in the table below.

Genotype	Relative frequency	Volume of mucus generated (mL/day)
A1A1	0.64	10
A1A2	0.16	8
A2A2	0.20	2

It is true to say that

A. heterozygous slugs have a selective advantage.

B. **A1** is the most frequently occurring allele at this locus.

C. **A2** is the most frequently occurring allele at this locus.

D. slugs that secrete mucus must have a selective advantage.

Question 13

It has been suggested that cystic fibrosis (an autosomal recessive condition) has a high prevalence in some populations because heterozygotes are resistant to the effects of diarrhoea and dysentry.

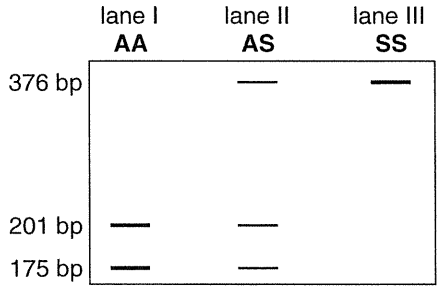
This is best described as an example of

A. mutation.
B. gene flow.
C. genetic drift.
D. natural selection.

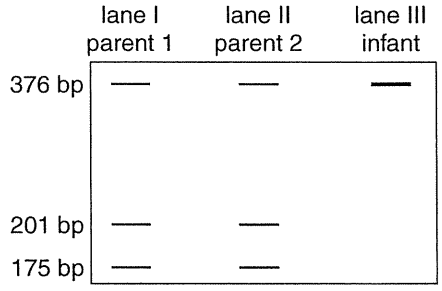
Question 14

Sickle cell anaemia is a genetic disorder. Gel electrophoresis and radioactively labelled probes are used to identify the normal allele and the mutant (sickle cell) allele. In this way, carriers of the sickle cell anaemia allele and infants that are homozygous for the trait can be identified.

In the reference data shown below, lane I contains DNA from a non carrier (genotype **AA**), lane II contains DNA from a carrier (genotype **AS**) and lane III contains DNA from a sickle cell anaemia sufferer (genotype **SS**).



The data below shows DNA from two parents (lanes I and II) and their infant (lane III).



It is correct to say that

A. the infant is homozygous for the sickle cell trait (**SS**).
B. the infant is a carrier of the sickle cell trait (**AS**).
C. the infant is a non-carrier of the sickle cell trait (**AA**).
D. it cannot be determined whether the infant will have sickle cell anaemia.

Question 15

Considerable information about the mechanisms and rates of extinctions of species is retained in the geological record.

The information gathered from the geological record demonstrates that extinctions

A. occur only as a result of major global events such as asteroid impacts and climate changes.
B. are sufficiently uncommon that, excepting dinosaurs, most families of animals are still present today.
C. are rare and have not been seen since the Cambrian explosion.
D. may occur massively after a global catastrophe, or at a relatively constant rate when global environmental conditions are relatively stable.

Question 16

Of the following, the factor which is responsible for non-random genetic changes in populations is

A. selection.
B. mutation.
C. genetic bottlenecks.
D. founder effects.

Question 17

When the eggs of the North American leopard frog (*Rana pipiens*) are fertilised by sperm of the wood frog (*R. sylvatica*), the embryos do not succeed in developing or the resulting tadpoles do not metamorphose into adults.

The processes which prevent successful reproduction after mating between members of these two different populations are called

A. prezygotic isolating mechanisms.
B. postzygotic isolating mechanisms.
C. hybridisation mechanisms.
D. allopatric isolating mechanisms.

Question 18

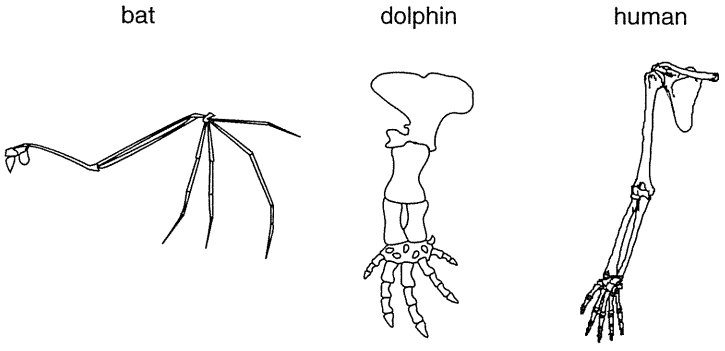
It is a misleading half-truth to say that "evolution is concerned with survival of the fittest".

Survival is important, but only in so far as it contributes to

A. speciation.
B. microevolution.
C. reproductive success.
D. adaptation.

Question 19

The diagrams below represent the forelimbs of three very different organisms. They possess a similar bone arrangement within their forelimbs.

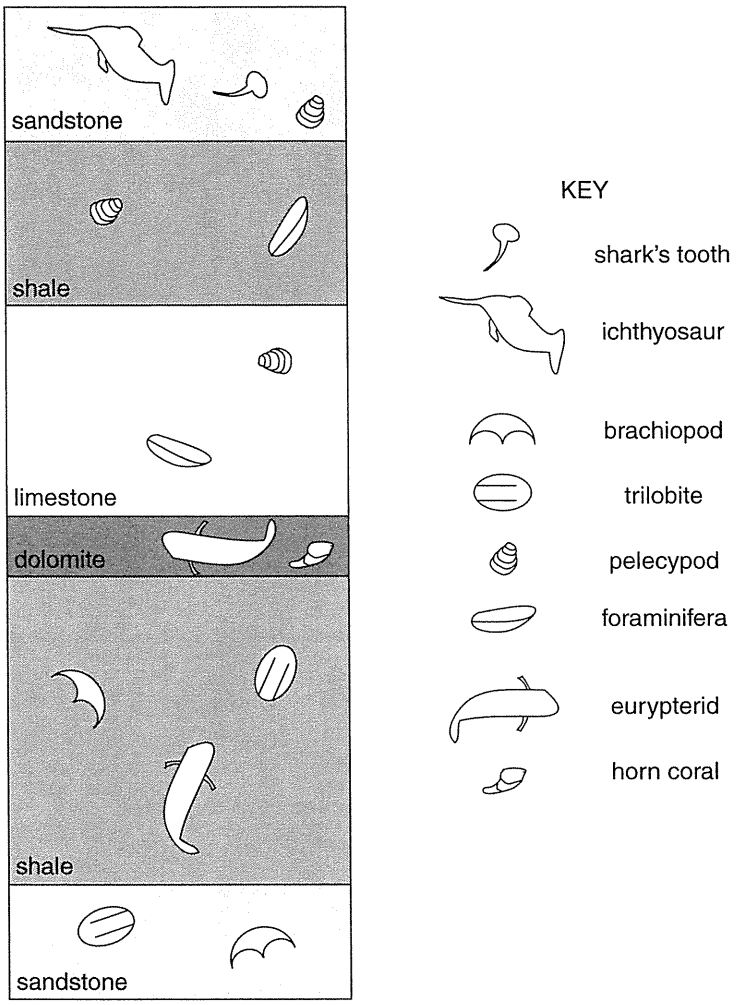


This information provides evidence for

A. convergent evolution.
B. structural analogies.
C. divergent evolution.
D. allopatric speciation.

Question 20

The strata layer in the diagram below is from the side of a deep canyon. The various rock types and the fossils found in each layer are shown.



It is correct to say that

A. ichthyosaurs are the oldest fossils.

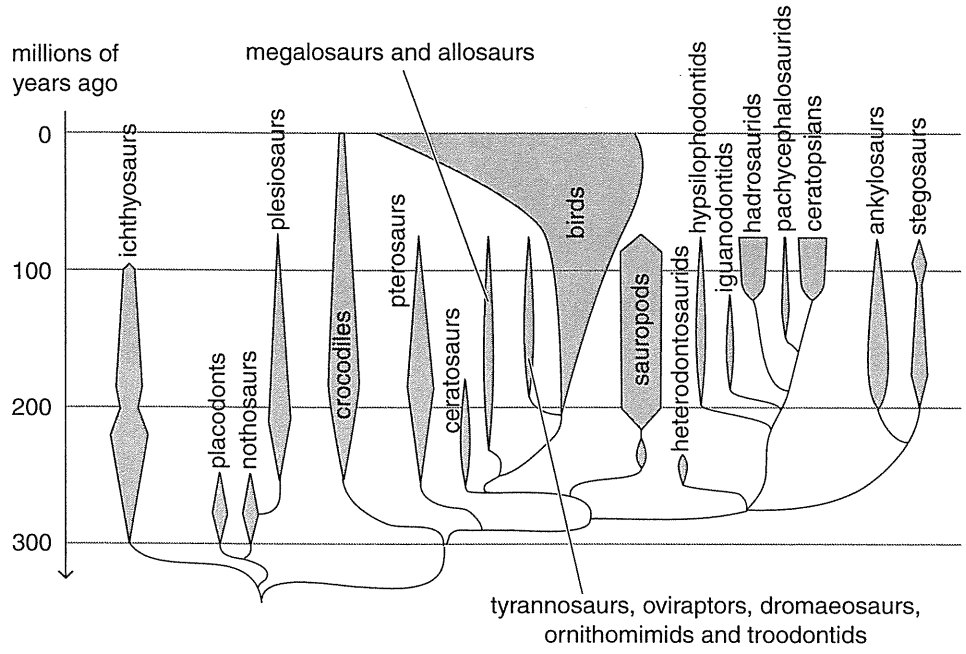
B. foraminifera are only found in shale.

C. the oldest fossils are found in a sandstone layer.

D. the dolomite layer would contain transition fossils.

Question 21

The evolutionary tree below shows the relationship between different groups of dinosaurs and modern birds. The width of the evolutionary lines reflect the number of genera and the vertical line illustrates when particular groups existed.



This evolutionary tree shows

A. the extinction of most of the dinosaurs by 150 million years ago.

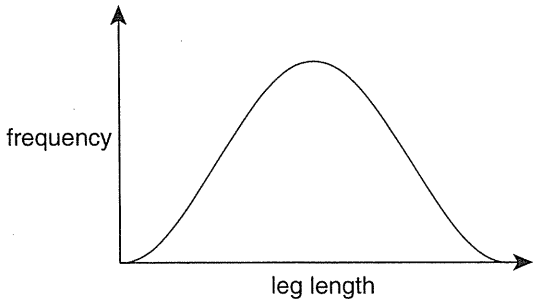
B. birds having a common ancestor about 210 million years ago.

C. crocodiles having the largest amount of genera for the longest time.

D. all the dinosaurs having a common ancestor about 300 million years ago.

Question 22

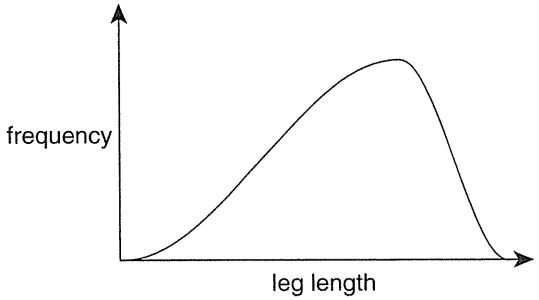
The graph below depicts the frequency of leg lengths in a population of grazing animals. In this species, leg length is directly related to speed, which is a heritable characteristic.



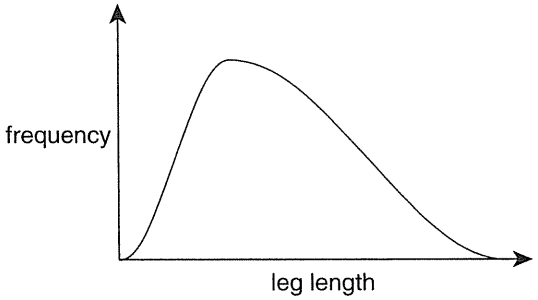
These grazers are being preyed on by a newly introduced species of swift-running predators.

After this selection pressure has been applied over a long period of time, the graph will look like

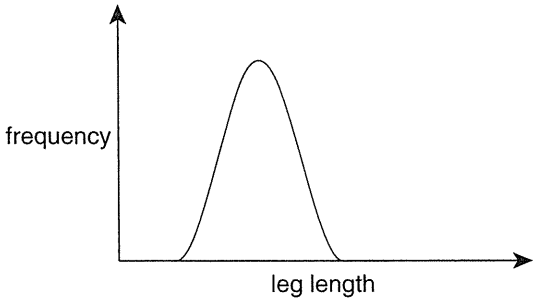
A.



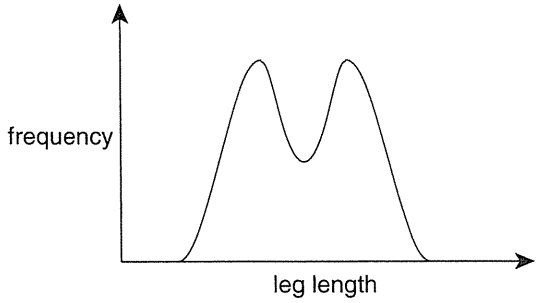
B.



C.

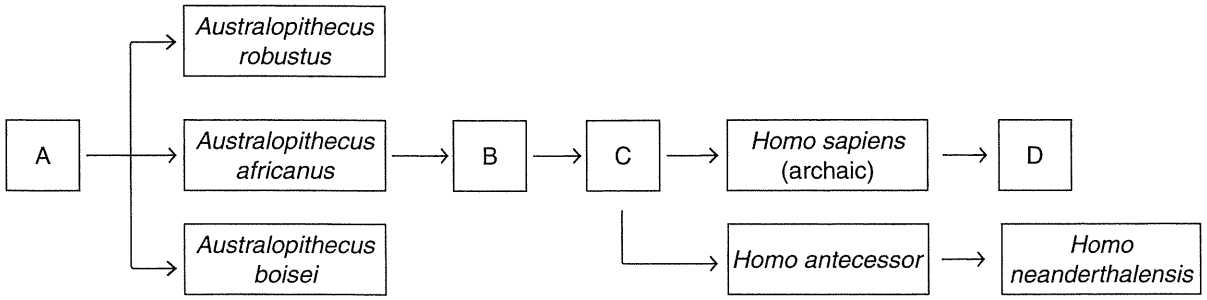


D.



Question 23

The diagram below shows one possible pathway of human evolution.



Hominin 'C' is

A. *Homo habilis.*

B. *Ardipithecus ramidus.*

C. *Homo erectus.*

D. *Pan troglodytes.*

Question 24

Which of the following is the **best** example of cultural evolution?

A. A macaque (a type of monkey) that uses a stone to break open crabs for food is copied by other macaques until the whole troop has acquired the skill.

B. The invention and use of antibiotics by humans has led to the evolution of drug-resistant 'super bug' bacteria.

C. The gradual improvement of crop yields by the selective breeding of crop varieties is now being supplemented by crop improvement through recombinant DNA technology.

D. In developed countries, the onset of puberty is now two years earlier, on average, than it was 100 years ago.

Question 25

The 'Out of Africa' model of human evolution proposes that

A. *Australopithecus afarensis* was the first hominin to migrate out of Africa at least 3.5 million years ago and later evolved into *Homo sapiens* elsewhere.

B. anatomically modern *Homo sapiens* evolved in Africa between 200 000 and 100 000 years ago, with members of one branch leaving Africa between 55 000 and 60 000 years ago.

C. *Homo erectus* was the first hominin to migrate out of Africa at least 1.5 million years ago and later evolved into *Homo sapiens* elsewhere.

D. all steps in the evolution of the genus *Homo* took place outside of Africa.

SECTION B: SHORT-ANSWER QUESTIONS

Instructions for Section B

Answer this section in pen.

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

Question 1

Cat hair colour is caused by the presence of melanin. Microscopic melanin granules of varying shape, size and arrangement are deposited in the hair shafts, resulting in a variety of colour phenotypes.

a. Define the term 'phenotype'.

_____

_____

1 mark

The most variation is found in the black-based colours. The table below illustrates how six phenotypic variations of black coat colour arise.

	Dense (D–)	**Dilute (dd)**
Black (B–)	black	blue
Brown (bb, bb^1)	chocolate	lilac
Light brown (b^1b^1)	cinnamon	fawn

Mutations of gene **B** ('black') give rise to the chocolate and cinnamon phenotypes. Chocolate is recessive to black, and cinnamon is recessive to chocolate. Mutations of gene **D** ('dense') give rise to blue, lilac, and fawn phenotypes. Dilution is recessive to dense coloration.

b. **i.** Using the information in the table, list the symbols for each of the alleles.

black

_____

brown

_____

light brown

_____

dense

_____

dilute

_____

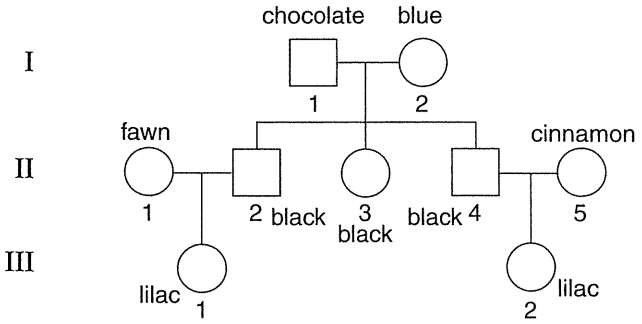
ii. Write the genotype of a chocolate cat that is heterozygous for both genes.

_____

iii. If the cat from part **ii** breeds with a fawn cat, what would be the predicted genotypic and phenotypic ratios of the offspring? Show your working.

2 + 1 + 2 = 5 marks

c. A cat breeder was interested in developing a pure-breeding line of lilac cats. He was provided with a group of nine cats who were related to each other according to the following pedigree. Note that individuals I–1 and I–2 are pure-breeding.



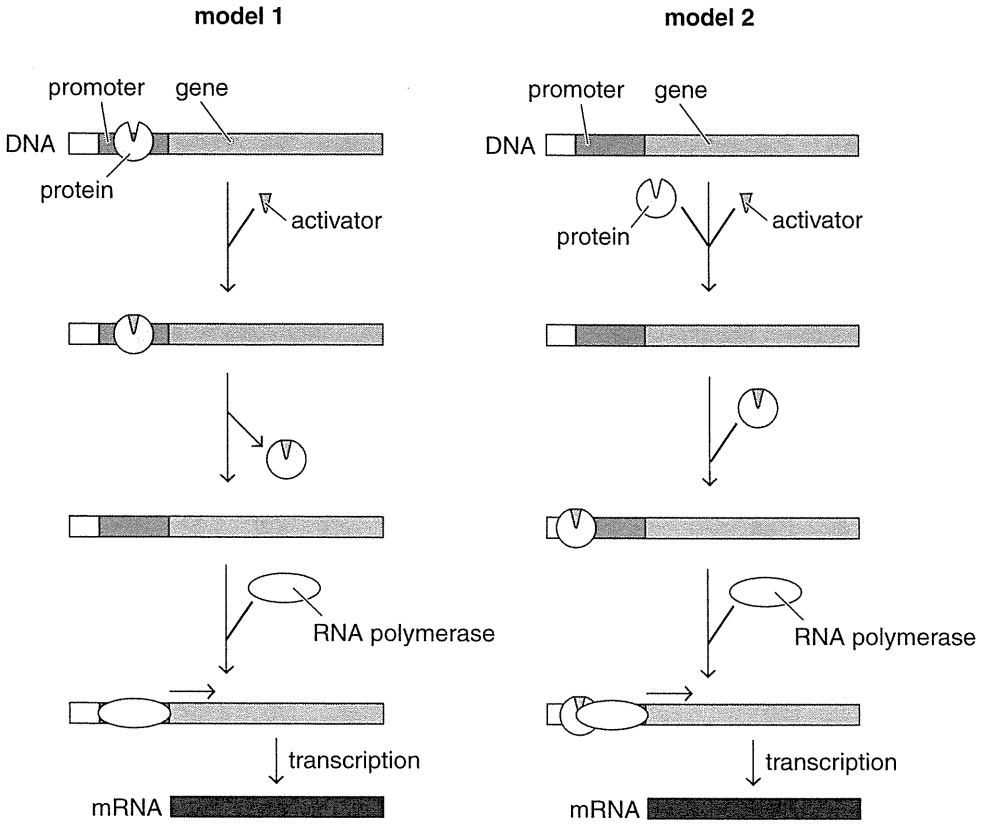
i. Which two cats you would recommend the cat breeder choose to use as his breeding pair? Explain your answer.

ii. If the two cats you nominated in part **i** were mated, what proportion of their offspring would be pure-breeding lilac cats?

1 + 1 = 2 marks
Total 8 marks

Question 2

The following diagrams show two models of gene expression.



a. **i.** What is the function of the promoter region?

_____

_____

_____

ii. Describe the differences between the two models of gene regulation shown in the diagram.

_____

_____

_____

_____

_____

1 + 1 = 2 marks

b. The two models of gene regulation in the diagram above show gene expression controlled at the level of transcription.

Give a biological advantage for gene expression to be controlled at this level.

_____

_____

_____

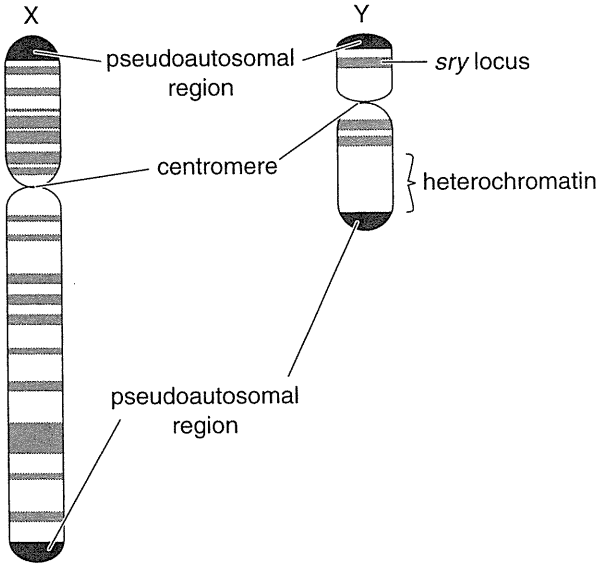
1 mark

c. What is the specific function of RNA polymerase after it binds to the promoter?

2 marks
Total 5 marks

Question 3

The diagram below shows the two human sex chromosomes.



The X and Y chromosomes have homologous regions (i.e. with matching gene loci) which pair up during meiosis (synapsis) and can undergo limited crossing over. These regions of homology are called pseudoautosomal regions. Any genes located within them (so far only nine have been found) are inherited just like any autosomal genes. Most of the genes along the X and Y chromosomes are not homologous.

a. Using your knowledge of inheritance patterns, why would some of the Y chromosome genes be classified as *pseudoautosomal*?

1 mark

b. The genes on the human Y chromosome code for only 23 distinct proteins. One of these genes is the *sry* gene. This intronless gene encodes a 204 amino acid protein, which initiates the development of male sexual anatomy.

i. What is an intron?

ii. How many base pairs long is the human *sry* gene?

1 + 1 = 2 marks

c. XX maleness is a syndrome with a frequency of 1 in 20 000–25 000 anatomical males. XY femaleness occurs in a similar frequency among women. These sex reversal syndromes occur when crossing over during meiosis results in the translocation of the *sry* gene from the X to the Y chromosome.

i. Using the above information and a labelled diagram, show how XX maleness and XY femaleness could occur.

ii. Suggest how XY femaleness could occur as a result of a point mutation.

2 + 1 = 3 marks

d. A test based on a gene probe for *sry* was used to ensure that anatomically female athletes with a *sry* gene were not permitted to participate as females in the 1996 Atlanta Olympics. This test has been abandoned since the 2000 Sydney Olympics.

i. What is a gene probe?

ii. Suggest a biological reason why this test was abandoned.

1 + 1 = 2 marks

e. The non-coding DNA regions of the Y chromosome are called heterochromatin. This accumulates mutations much more rapidly compared with the DNA contained within gene loci. The variable repeating sequences (VNTRs) in the heterochromatin of the human Y chromosome provide genetic markers that can be used by population biologists to determine the descent of individuals and track the movements of groups of humans over time scales of thousands or tens of thousands of years.

i. Why does Y chromosomal heterochromatin accumulate mutations more rapidly compared with the DNA of the gene loci?

_____

_____

_____

ii. Why would the VNTRs in the heterochromatin of the **Y chromosome** be useful in studies of human descent?

_____

_____

_____

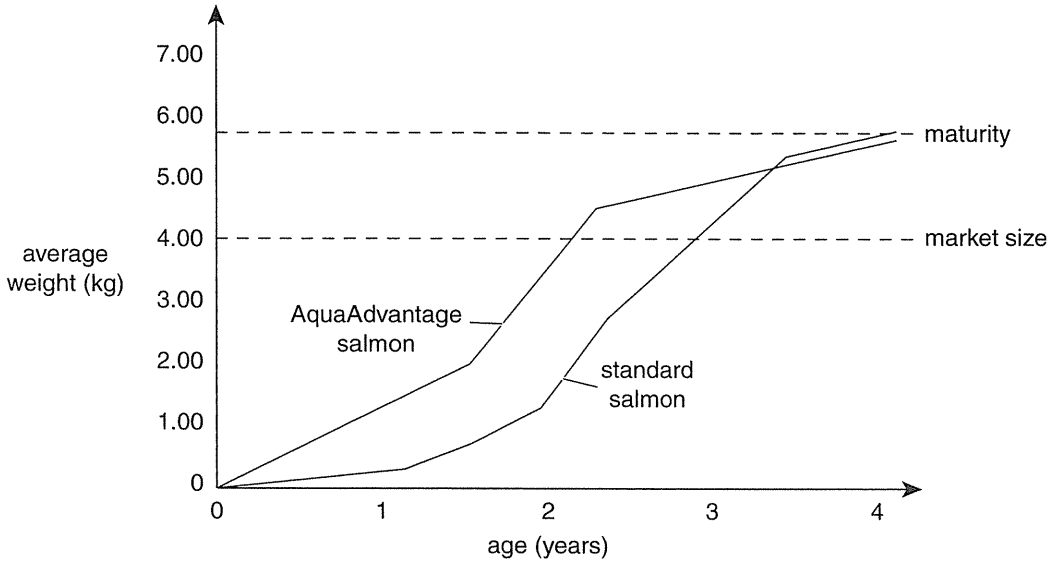
_____

1 + 1 = 2 marks
Total 10 marks

Question 4

Over the past 12 years, scientists have developed stable lines of transgenic Atlantic salmon (*Salmo salar*). These transgenic animals possess an antifreeze protein (AFP) gene from the ocean pout (*Macrozoarces americanus*) and a growth hormone promoter (GH) gene from Chinook (Pacific) salmon (*Oncorhynchus tshawytscha*). The phenotypic expression of these transgenes has now been demonstrated through the second (F_2), and third (F_3) generations.

The graph below shows the effect of this genetic modification on the growth of Atlantic salmon.



a. **i.** Using information from the graph, explain why salmon farmers might prefer to raise genetically modified (GM) salmon.

_____

_____

_____

ii. Give **one** biological reason why the marketing of such GM salmon might cause concern to the public.

_____

_____

_____

1 + 1 = 2 marks

b. The transgenes were originally prepared and cloned into a recombinant plasmid containing the chinook salmon GH gene, the ocean pout AFP gene and an antibiotic (ampicillin) resistance marker.

i. What is a plasmid?

_____

_____

ii. Using a labelled diagram, explain how a plasmid could be genetically modified into a vector for transferring the transgenes.

iii. Explain why the recombinant plasmid contained an ampicillin resistance gene.

_____

_____

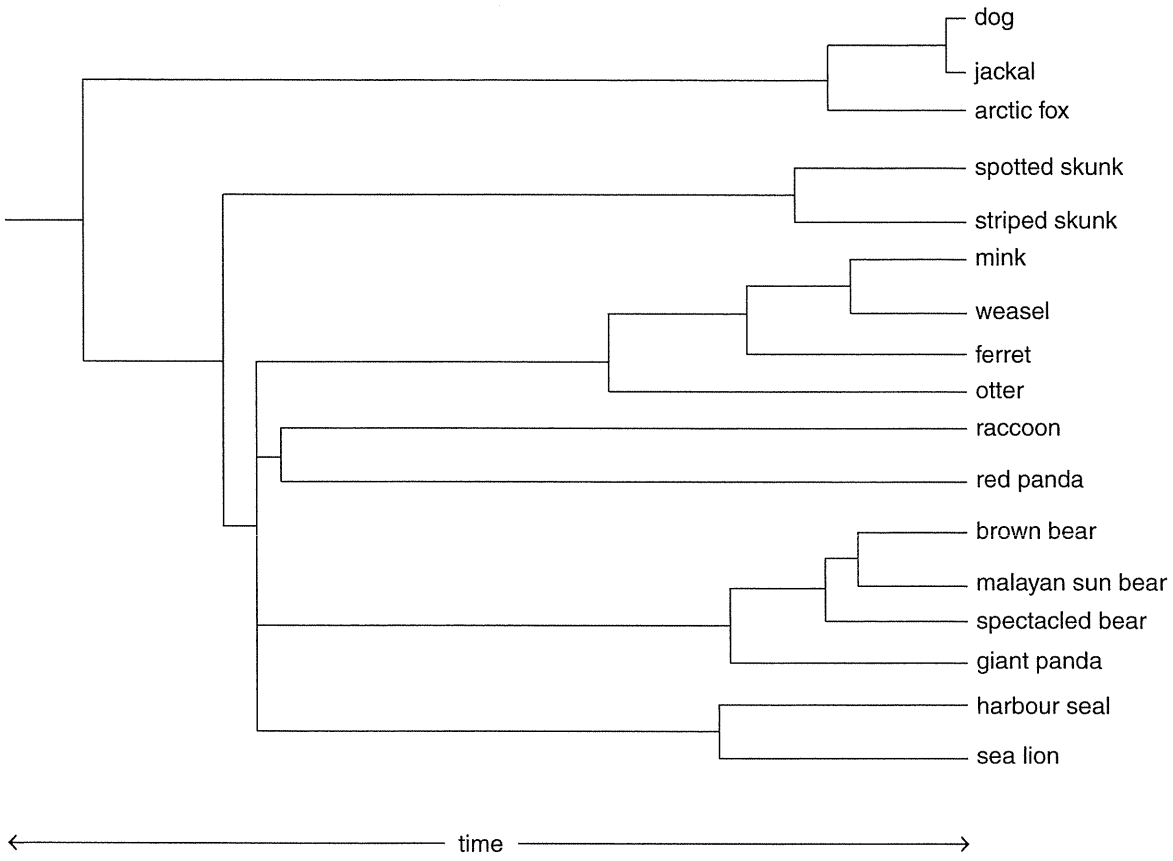
_____

_____

1 + 2 + 1 = 4 marks
Total 6 marks

Question 5

The dog family is a diverse group of species ranging in size and proportion from squat, dachshund-like bushdogs to long-legged, maned wolves and domesticated dogs. The evolutionary position of dogs within a larger group of carnivores is illustrated by the evolutionary tree shown below.



a. **i.** According to the evolutionary tree above, which group of carnivores is the closest relative to dogs?

_____

ii. Using evidence from the evolutionary tree, explain whether weasels and striped skunks **OR** ferrets and sea lions are more closely related.

_____

_____

_____

_____

1 + 2 = 3 marks

b. The table below illustrates some of the different species of dogs, their location and diploid numbers.

Species	Common name	Geographic range	Diploid (2n) number
Canis aureus	golden jackal	Old World	78
Canis lupis	grey wolf	Holarctic	78
Speothos venaticus	bushdog	North-East South America	74
Vulpes vulpes	red fox	Old World and New World	36
Alopex lagopus	arctic fox	Holarctic	50
Fennecus zerda	fennec fox	Sahara	64
Octocyon magalotis	bat-eared fox	Subsaharan Africa	72

i. What does the 'diploid number' refer to?

_____

_____

ii. The grey wolf and arctic fox have the same geographic range.

Does this mean they would be able to successfully breed with each other? Explain.

_____

_____

_____

1 + 1 = 2 marks

c. The earliest remains of the domestic dog *Canis familiaris* date from 10 to 15 thousand years ago. It is thought that domestic dogs may be derived from ancestral grey wolf populations, because their mitochondrial DNA sequences differ by less than 0.2%. In comparison, the mitochondrial DNA sequence of grey wolves differs from their closest wild relative, the coyote, by about 4%.

i. Explain why this mtDNA evidence supports the theory that domestic dogs are the descendants of grey wolves rather than coyotes.

_____

_____

_____

_____

ii. Some scientists think domestic dogs (*C. familiaris*) and grey wolves (*C. vulpes*) should be classified as the same species rather than different species.

What evidence would the scientist need to gather to support this idea?

_____

_____

2 + 1 = 3 marks

d. The domestication of dogs is an example of artificial selection.

Describe **two** differences between the processes of artificial selection and natural selection.

2 marks

Total 10 marks

Question 6

The fossil record provides evidence that primates have lived in East Africa since the early Miocene period (between 16 and 20 million years ago). *Proconsul africanus* fossils that have been dated between 5 and 23 million years old were thought to represent the sole ancestor of all the great apes since its first discovery in the 1960s. In November 2004, scientists reported the discovery of another possible ancestor of great apes, which they named *Pierolapithecus catalaunicus*, dating to about 13 million years ago.

a. i. List two conditions that allowed fossils of *P. africanus* and *P. catalaunicus* to form.

ii. Describe a method that would enable anthropologists to date 13 million year old *P. catalaunicus* fossils.

iii. Could *P. catalaunicus* be ancestral to *P. africanus*? Explain.

2 + 2 + 1 = 5 marks

b. Modern great apes (which include orangutans, chimpanzees, gorillas and humans) are thought to have diverged from the lesser apes (a group that contains modern gibbons and siamangs). The great apes and lesser ape ancestry can be linked to primates living in the Miocene period.

Describe the steps involved in the great apes diverging from the lesser apes.

_____

_____

_____

_____

_____

2 marks

c. Scientists found various fossilised bone fragments from a single skeleton and used them to reconstruct a complete *P. catalaunicus* skeleton. This individual was probably male and from its tooth shape appeared to be herbivorous. The rib cage, lower spine and wrists showed key signs of specialised climbing abilities that link this specimen with modern great apes.

i. Is it scientifically reasonable to reconstruct a whole skeleton from various fossilised bone fragments? Explain your answer.

_____

_____

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ii. Is it reasonable to associate particular features (such as tooth shape and wrist shape) of fossils with particular functions (such as diet and climbing activity) and therefore reconstruct the lifestyle of an organism such as *P. catalaunicus*? Explain your answer.

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1 + 1 = 2 marks

d. What other evidence would be useful in trying to piece together the ancestry or primates? How could this be of assistance?

_____

_____

_____

2 marks

Total 11 marks

END OF QUESTION AND ANSWER BOOKLET