Neap:

Trial Examination 2010

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	7	7	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 20 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 2010 VCE Biology Unit 4 Written Examination.

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SECTION A: MULTIPLE-CHOICE QUESTIONS

Instructions for Section A

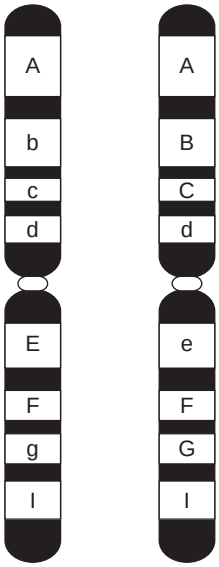
Answer **all** questions in pencil on the answer sheet provided for multiple-choice questions.
Choose the response that is **correct** for the question.
A correct answer scores 1, an incorrect answer scores 0.
Marks will **not** be deducted for incorrect answers.
No marks will be given if more than one answer is completed for any question.

Question 1

The genome of an organism refers to

A. the entire DNA complement possessed by an organism.
B. all of the DNA possessed by an organism that is transcribed.
C. all of the DNA possessed by an organism that is translated.
D. all of the DNA possessed by an organism that is translated in a fully differentiated cell.

The following diagram relates to Questions 2 and 3.



Question 2

The term used to correctly describe these chromosomes would be

A. autosomal.
B. homologous.
C. heterozygous.
D. haploid.

Question 3

The number of genes illustrated in the diagram is

A. 1
B. 2
C. 8
D. 16

Question 4

A cell cycle consists of

A. mitosis and meiosis.
B. the G1, S, and G2 phases.
C. interphase and mitosis.
D. meiosis and fertilisation.

Question 5

You are given a nucleic acid that you think is single-stranded DNA, but you are not sure. You analyse the nucleotide composition of the sample.

The composition of nucleic acid that would best confirm your thinking is

A. adenine 38%; cytosine 12%; guanine 12%; uracil 38%
B. adenine 21%; cytosine 31%; guanine 29%; thymine 19%
C. adenine 38%; cytosine 12%; guanine 12%; thymine 38%
D. adenine 12%; cytosine 38%; guanine 38%; thymine 12%

Question 6

The following are steps involved in the synthesis of a protein in a eukaryotic cell:

I. A complementary RNA copy of DNA is made.
II. The DNA double helix unwinds.
III. mRNA binds to ribosomes.
IV. Exons are removed.
V. The amino acids of two adjacent tRNAs form a peptide bond.
VI. mRNA leaves the nucleus.
VII. An anticodon of tRNA recognises an mRNA codon.

The correct order of steps is

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

Question 7

When examining the genetic code, it is apparent that

A. the code is ambiguous in that the same codon can code for two or more amino acids.

B. there can be more than one amino acid for a particular codon.

C. because there are only twenty amino acids, the code is degenerate and there are 'stop' and 'start' codons that do not code for any amino acid.

D. because there are only twenty amino acids, the code is degenerate and there can be more than one codon for a particular amino acid.

Question 8

In the ABO blood group system, a single gene with three alleles determines the antigens a person has on their red blood cells.

$\mathbf{I^A}$ (production of antigen A) and $\mathbf{I^B}$ (production of antigen B) are co-dominant and **i** (no antigen production) is recessive.

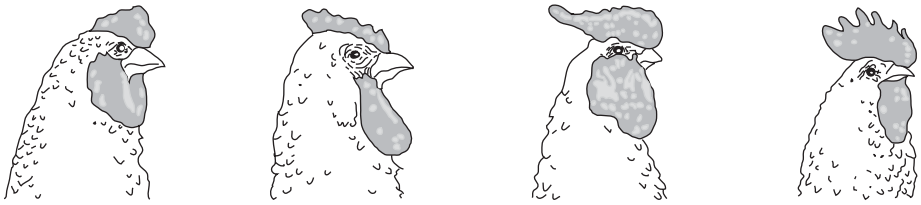
In one family, each of the four children had a different blood group. Their mother was group A and their father was group B.

The genotypes that correctly show the blood type of the children's parents is

	Mother's genotype	**Father's genotype**
A.	$\mathbf{I^AI^A}$	$\mathbf{I^BI^B}$
B.	$\mathbf{I^Ai}$	$\mathbf{I^BI^B}$
C.	$\mathbf{I^Ai}$	$\mathbf{I^Bi}$
D.	$\mathbf{I^AI^A}$	$\mathbf{I^Bi}$

The following information relates to Questions 9 and 10.

Chickens have a structure on their heads called a comb. The diagram shows four types of comb: walnut, pea, rose and single.



Two genes control the type of comb; each gene has a dominant and a recessive allele. The two genes are inherited independently, but interact to produce the four types of comb, as follows. (The symbol **–** indicates that either the dominant allele or recessive allele could be present.)

Genotype	Phenotype
A– B–	walnut
A– bb	pea
aa B–	rose
aa bb	single

Question 9

With respect to gene **A** and gene **B**, the number of pure breeding genotypes that are possible is

A. three
B. two
C. five
D. four

Question 10

A male with a pea comb, heterozygous for gene **A**, was crossed with a rose-combed female, heterozygous for gene **B**.

The expected ratio of comb phenotypes in the offspring of this cross would be

A. 1 walnut : 1 pea : 1 rose : 1 single
B. 1 pea : 1 rose
C. all walnut
D. 9 walnut : 3 pea : 3 rose : 1 single

Question 11

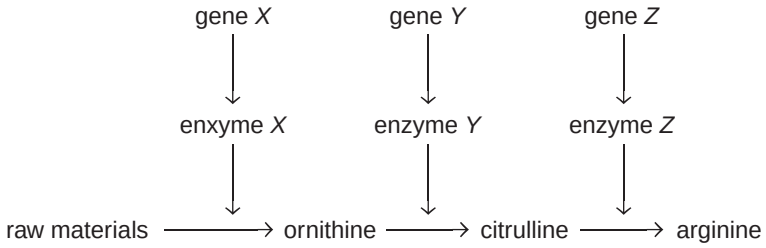
The *lac* operon of *E. coli* is a segment of DNA that includes an operator gene (which can be activated only after a repressor chemical is removed), and three structural genes that code for lactose-metabolising enzymes. The presence of lactose activates these genes.

In the *lac* operon, RNA polymerase

A. binds to the operator when the repressor is removed due to the presence of lactose.
B. binds to the operator when the repressor remains due to the presence of lactose.
C. translates the structural genes.
D. is coded for by the structural genes of the *lac* operon.

Question 12

The bread mould, *Mucor haemalis*, normally produces its own amino acids from raw materials through a system of enzymes.



The production of arginine is controlled by the following (minimum) number of genes

A. two

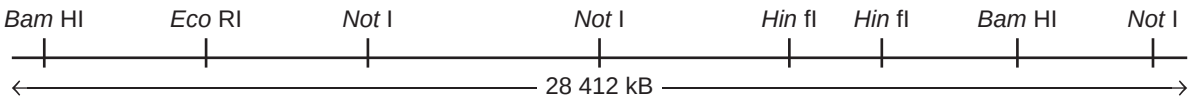
B. one

C. four

D. five

Question 13

The figure below represents a length of DNA and the locations of the recognition sequences for the restriction enzymes *Not* I, *Hin* fI, *Eco* RI and *Bam* HI.



Incubation of this DNA in a tube containing

A. *Not* I would result in three pieces of DNA.

B. *Hin* fI would result in two pieces of DNA.

C. *Eco* RI and *Not* I would result in five pieces of DNA.

D. *Bam* HI and *Hin* fI would result in four pieces of DNA.

Question 14

In preparing a recombinant plasmid for the insertion of a selected gene into a bacterium, it is most important to

A. cut the plasmid using a restriction enzyme that produces ‘sticky ends’ which are complementary to DNA ligase.

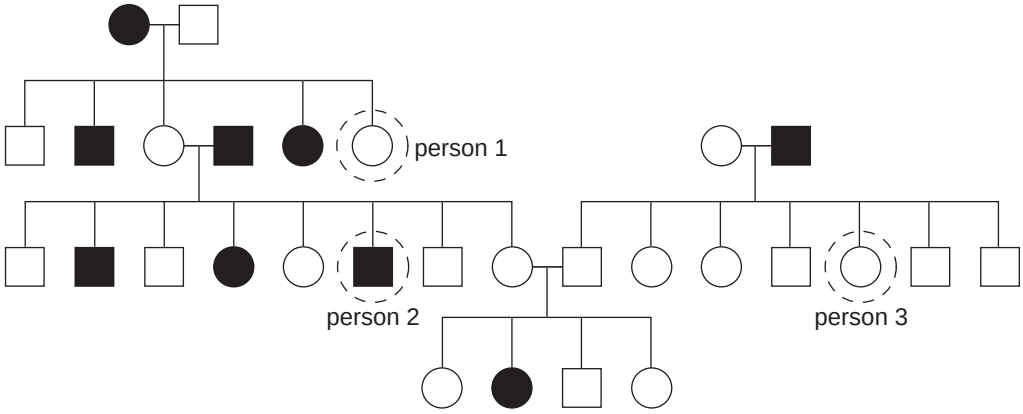
B. choose a plasmid which contains antibiotic resistance genes.

C. use a restriction enzyme to make an initial ‘blunt end’ cut which changes the plasmid from a ring of DNA into linear DNA.

D. cut the plasmid with the same type of restriction enzyme that was used to cut the gene out of the ‘donor’ DNA, so that complementary ‘sticky ends’ are produced.

The following diagram relates to Questions 15 and 16.

The following pedigree illustrates the inheritance pattern of a rare genetic skin condition called ichthyosis.



Question 15

The most likely pattern of inheritance is

A. autosomal dominant.

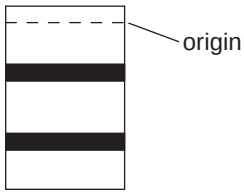
B. autosomal recessive.

C. sex-linked dominant.

D. sex-linked recessive.

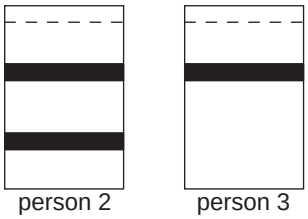
Question 16

The faulty allele is smaller than the normal allele for the ichthyosis gene and both alleles can be amplified by polymerase chain reaction (PCR).The resulting samples can be analysed using gel electrophoresis. The genetic profile for person 1 is shown below.

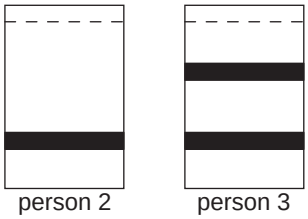


The genetic profiles for person 2 and person 3 would be

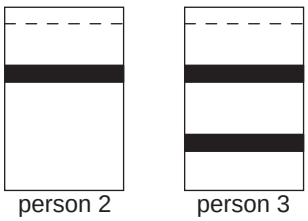
A.



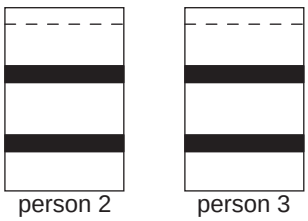
B.



C.

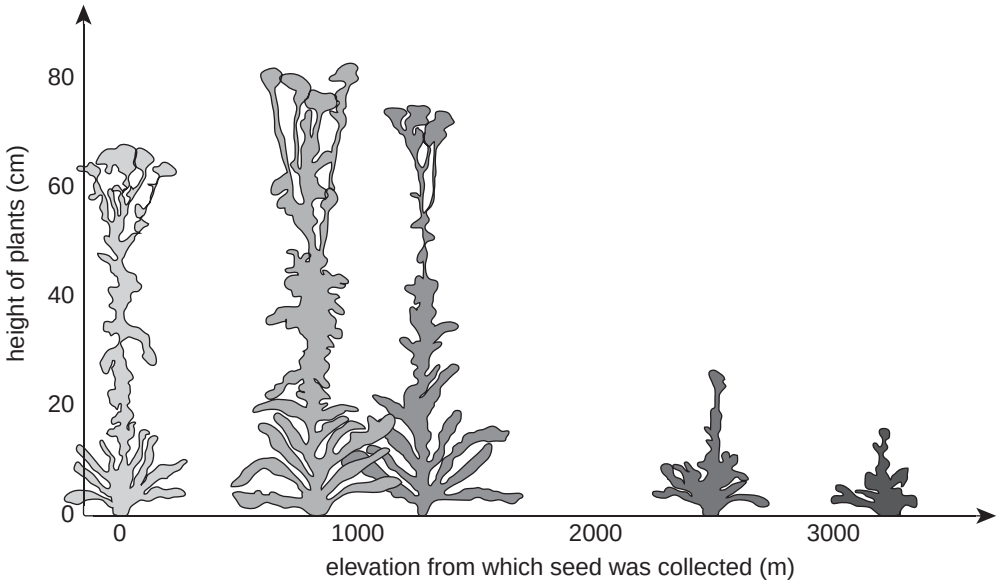


D.



The following information relates to Questions 17 and 18.

An experiment illustrating the effect of environment on phenotype was carried out using a common plant, *Achillea millefolium*. The graph below shows the height distribution of this plant with altitude.



Question 17

The different plants illustrated in the graph definitely have

A. different genotypes.

B. the same genotype.

C. different phenotypes.

D. the same phenotype.

Question 18

An experiment was set up to investigate if the height of the plants was inherited or environmentally determined.

The method that would generate the most convincing data would be to

A. take seeds randomly from plants at each altitude and plant them randomly at different altitudes.

B. take seeds from the smallest plant and plant them at the same altitude.

C. take seeds from plants at an altitude of 1000 m and plant them at an altitude of 1200 m.

D. take seeds from plants at sea level and plant them at an altitude of 3000 m.

Question 19

A scientist measured the average beak length of a wild population of several thousand seabirds over a period of ten generations. During this period, he observed a gradual increase in average beak length.

This increase could be accounted for by way of

A. genetic drift only.
B. genetic drift, emigration, natural selection and immigration.
C. natural selection only.
D. emigration and immigration only.

Question 20

Parasitic bacteria typically evolve more quickly than their hosts because

A. bacteria usually have a shorter generation time than their hosts.
B. bacteria lack DNA.
C. parasitic bacteria usually kill their hosts.
D. bacteria are always under stronger selection pressure than their hosts.

Question 21

There is a striking similarity in both the form and the function of the enlarged horns observed in males of the staghorn beetle and the reindeer.

This is best accounted for by way of

A. adaptation.
B. evolution by natural selection.
C. convergent evolution.
D. gene flow.

Question 22

A BBC Natural History Unit recently found a lost world of new species in the crater of Mount Bosavi, an extinct volcano in Papua New Guinea. The newly discovered species included a frog with fangs, *Litoria sauroni*.

The most reasonable explanation for the origin of this new species of frog is

A. the spontaneous mutation of a pre-existing species of frog to produce a fanged population.
B. the geographical isolation of a population of frogs in which a fanged mutation arose that offered a selective advantage.
C. the accidental arrival in the extinct volcano of a small group of mutant fanged frogs from which the modern population has descended.
D. the chance survival of a small ancestral group of mutant fanged frogs after a volcanic eruption eliminated the remainder of the population.

Question 23

Hominid evolution shows that developments in physical characteristics did not all occur at the same time.

Evidence from the fossil record suggests that

A. the S-shaped vertebral column occurred before the development of the sloping forehead.

B. the sloping forehead occurred before the development of the flatter face.

C. teeth reduced in size before the development of the flatter face.

D. teeth reduced in size before the development of the S-shaped vertebral column.

Question 24

A radio commentator was overheard to say that samples of stone tools associated with the earliest known hominin fossils had been found at a site in East Africa. She went on to say that these samples had been sent for radiocarbon dating.

The commentator's statements are incorrect because

A. radiocarbon dating can only be carried out on organic materials containing carbon, not stone tools.

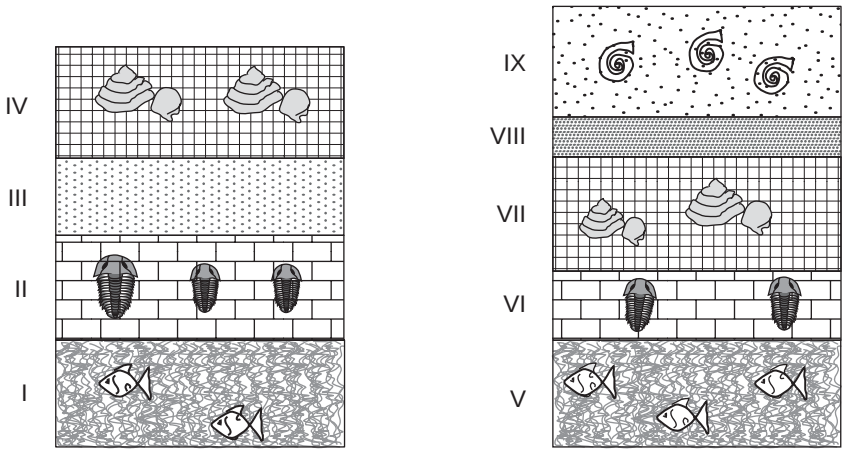
B. the earliest known hominin fossils were not found in East Africa.

C. the rate of decay of radioisotopes of carbon is too rapid to be useful in measuring the age of fossils.

D. radiocarbon dating is only useful on materials that are older than the fossils found at this site.

Question 25

The diagrams below show strata of sedimentary rocks from two different locations.



rock strata from location 1 rock strata from location 2

Based on the sequence of rock strata in the two locations, it could be concluded that

A. the fossils in layer IX are younger than those in layer IV.

B. the fossils in layer I are younger than those in layer V.

C. the fossils in layer II are the same age as those in layer VII.

D. the fossils in layer VI are older than those in layer V.

SECTION B: SHORT-ANSWER QUESTIONS

Instructions for Section B

Answer this section in pen.

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

Question 1

Coat colour in rabbits is determined by a single gene, the C locus, which has four separate alleles. The gene is **not** sex linked.

- The allele for agouti colour, $\mathbf{C^A}$, is dominant to all the other alleles.
- The allele for albino, $\mathbf{C^a}$, is recessive to all the other alleles.
- The allele for chinchilla, $\mathbf{C^{Ch}}$, is dominant to the Himalayan allele, $\mathbf{C^H}$.

a. State all the possible genotypes for the following phenotypes.

i. chinchilla

_____

ii. agouti

_____

1 + 1 = 2 marks

A young girl owns a pet female Himalayan rabbit called Big Ears. She wants to know whether Big Ears is homozygous (pure breeding) for this trait. Her friend owns a male albino rabbit, and says that if they cross the two rabbits and they find any albino offspring she can be sure that Big Ears is not pure breeding.

b. The friend's statement is valid. Use a genetic diagram to show why.

2 marks

The Himalayan rabbit colour phenotype is usually white, but the ears, feet and nose turn black in winter. The black colour is due to the colouration of both skin and hair by the dark pigment, melanin. Melanin is formed from the amino acid tyrosine through the action of an enzyme, tyrosinase, which is encoded by a gene at the C locus. Black agouti rabbits do not undergo any seasonal colour change.

c. Suggest a genetic explanation for why Himalayan rabbits undergo a seasonal colour change while black agouti rabbits do not.

_____

_____

_____

_____

_____

2 marks

The continual eruption and growth of the teeth predispose pet rabbits to dental problems. Any malocclusion (abnormality in the shape, position or structure of the teeth) interferes with normal wear. Problems of overgrown teeth can be severe: teeth may protrude from the mouth or grow in a curve to eventually pierce the palate. Hereditary malocclusion is a recessive trait (*m*) carried on a different autosome to the C locus.

d. Big Ears is heterozygous for both fur colour and malocclusion. Big Ears was crossed with an agouti rabbit that is also heterozygous for malocclusion and which had an albino mother.

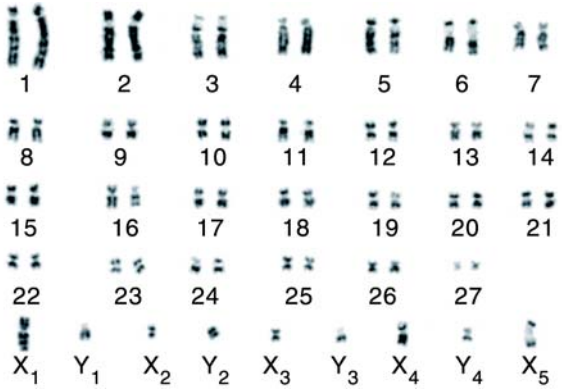
What proportion of the offspring of this cross would be expected to be affected agouti rabbits? Use a genetic diagram to explain your answer.

3 marks

Total 9 marks

Question 2

The platypus and echidna have nine sex chromosomes, rather than the single pair found in most other mammals. This is an unusual chromosomal arrangement and interest is currently focused on the way in which the chromosomes segregate during **male** meiosis to determine the sex of the zygote. The karyotype below is of a **male** echidna.



(Karyotype modified from Figure 2: Rens W, *et al*., 'The multiple sex chromosomes of platypus and echidna are not completely identical and several share homology with the avian Z' *Genome Biology* 2007, 8:R243.)

a. **i.** How many autosomes are present in a diploid male echidna cell?

_____

ii. How many molecules of DNA are present in chromosome pair number 1 shown in the karyotype?

_____

1 + 1 = 2 marks

In populations of echidna or platypus, there are equal numbers of male and females. Male echidnas typically produce two kinds of sperm – half with $X_1X_2X_3X_4X_5$ that determine female young and half with $Y_1Y_2Y_3Y_4$ that determine male young.

b. Do all of the sex chromosomes of the male echidna assort independently? Explain using evidence from the karyotype.

_____

_____

_____

2 marks

To understand more about chromosomal behaviour, scientists use a technique called 'fluorescence in situ hybridisation' (FISH). This technique uses fluorescent probes which are easy to track when bound to chromosomes.

c. **i.** What is a fluorescent probe?

_____

_____

ii. Why would a fluorescent probe of larger size give more precise results?

_____

_____

_____

1 + 1 = 2 marks
Total 6 marks

Question 3

Hepatitis is an inflammation of the liver which may be caused by viruses, alcohol and drugs. Symptoms include jaundice, fever, nausea and high levels of liver enzymes in the blood. The hepatitis A virus causes acute disease and rapid liver failure, but hepatitis B and C viruses cause chronic disease which results in more progressive liver damage. Liver cells infected by any strain of hepatitis virus switch on a gene called *Fas*, which causes them to self-destruct.

a. Name the cellular process normally controlled by the gene product of the *Fas* gene.

_____

1 mark

Pioneering research has produced a strikingly successful treatment for hepatitis in mice. The *Fas* gene was silenced by the technique of RNA interference. RNA molecules, 21 to 23 nucleotides long, were injected into mice with hepatitis. The sequence of this 'small interfering RNA' (siRNA) matched part of the *Fas* gene. Once in the liver cell the strands of siRNA were separated so that one strand could bind to the mRNA transcript of the *Fas* gene. This caused the mRNA to be destroyed by enzymes, therefore preventing the gene product from being made. This therapy prevented liver cell death and considerably increased the survival of mice with hepatitis.

b. Explain two differences in the functions of mRNA and DNA.

_____

_____

_____

_____

_____

2 marks

c. **i.** From the information given, draw two conclusions about how the structure of siRNA differs from that of mRNA.

_____

_____

_____

_____

ii. Describe in detail how one strand of the siRNA can bind to the mRNA of the *Fas* gene.

_____

_____

_____

_____

2 + 2 = 4 marks

d. Discuss the legitimacy of the statement that 'the mice with the siRNA injected will be able to pass on their resistance to hepatitis to their offspring'.

_____

_____

_____

1 mark

Total 8 marks

Question 4

Sea slugs are marine molluscs. Sea slugs live in shallow coastal waters where they graze on animals that form colonies on rocks, like sponges and corals. Sea slugs are preyed upon by fish. Many sea slugs collect poisonous chemicals or defences such as stinging cells from their prey. They then make use of these in their own bodies. Sea slugs containing poisonous chemicals or other defences are generally brightly-coloured. Sea slugs evolved from sea snails by the loss of the shell. It is thought that being brightly-coloured is an advantage to poisonous animals as predators learn to avoid them.

a. Suggest why being poisonous or brightly-coloured is more common in species of sea slugs than in sea snails.

_____

_____

1 mark

A student set up an experiment to test whether fish could learn to associate an unpleasant taste with a particular colour. These are the steps of the student's experiment:

- A tank 0.6 m long containing two goldfish was used.
- At one end of the tank five pieces of untreated floating fish food were placed once a day into a red plastic ring suspended at the water surface.
- At the other end of the tank five pieces of food that had been soaked in a bitter chemical were placed in a yellow plastic ring at the surface.
- The student observed how many pieces of food were taken from each ring within twenty minutes of feeding time.
- The experiment ran for ten days.

b. Suggest three improvements that could be made to this experiment in order to collect valid data.

1. _____

_____

_____

2. _____

_____

_____

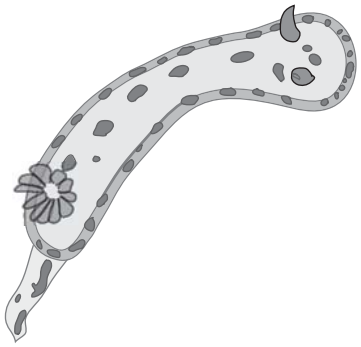
3. _____

_____

_____

2 marks

c. The waters of South-Eastern Australia are home to a genus of sea slugs found nowhere else. Ten distasteful species of the genus *Chromodoris* all share a pattern of bright red spots on a white background. This is an example of mimicry.



Chromodoris sp. (approximately actual size)

i. Explain why one warning pattern shared by ten species gives a greater selective advantage to the slugs than if each had its own distinctive warning pattern.

_____

_____

_____

_____

_____

ii. Describe how a South-Eastern Australian sea slug population that was originally white might have developed the red-spotted pattern over a period of time.

_____

_____

_____

_____

_____

_____

_____

_____

_____

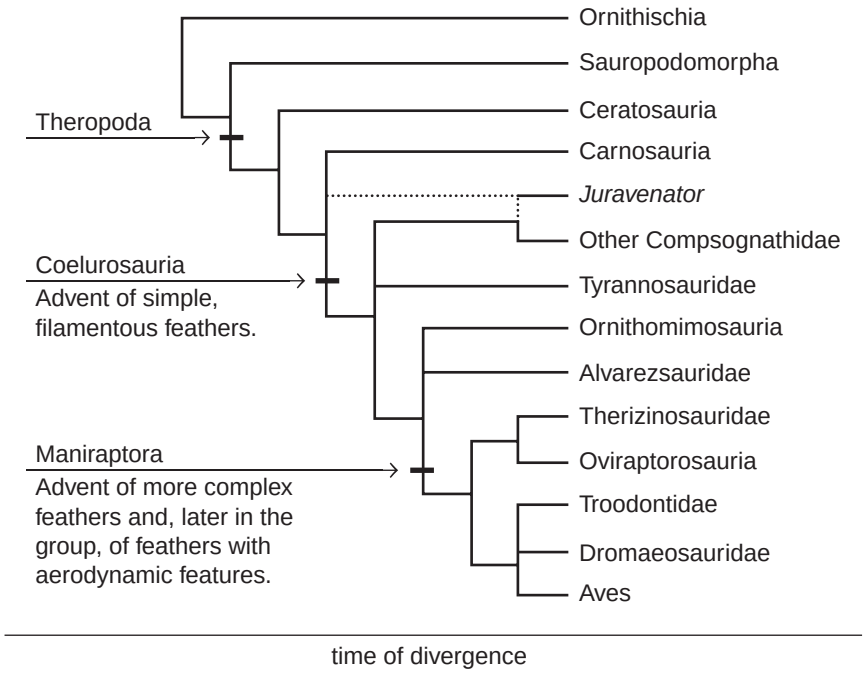
_____

_____

2 + 3 = 5 marks
Total 8 marks

Question 5

This evolutionary tree shows the possible occurrence of the main events in feather evolution. Feathers were long considered the defining anatomical feature of birds; however, many specimens of non-avian dinosaurs have been discovered that show that feathers are not restricted to birds. The evolutionary tree below illustrates a possible evolutionary 'relationship' based on feather anatomy.



a. **i.** Name one organism that would contain simple filamentous feathers but not complex feathers.

_____

ii. The evolutionary relationships of *Juravenator* are in dispute.

What **two** pieces of evidence would be useful in determining if *Juravenator* should be linked more closely with Carnosauria rather than Other Compsognathidae?

_____

_____

_____

_____

1 + 2 = 3 marks

Fossils in sedimentary rock (such as the one below) have recently been found to provide more evidence for the evolution of modern birds. This Coelurosaurian fossil shows the presence of feathers on a dinosaur-like skeleton that was dated to have existed about 175 million years ago.

b. **i.** Describe the conditions necessary for the formation of a fossil such as the Coelurosaurian.

_____

_____

_____

ii. Describe a technique that could be used to date this fossil.

_____

_____

_____

2 + 2 = 4 marks

It was proposed that more complex feathers evolved because a mutation that offered the advantage of flight occurred in the genes coding for simple feathers. This mutation occurred as a result of the environment to which the Coelurosaurians were exposed.

c. Discuss the accuracy of this proposal.

_____

_____

_____

2 marks
Total 9 marks

Question 6

Soybean plants have been prime targets for genetic modification for many years. Soybean line DP-356043-5 is very tolerant to the broad-spectrum herbicides due to two genes (*gat4601* and *gm-hra*) being inserted into the soybean genome. The mature plant expresses these genes which subsequently gives the plant tolerance to a variety of herbicides.

a. Why would this form of genetic modification be regarded as a form of technological evolution?

_____

_____

_____

2 marks

The *gat4601* gene is from a bacteria and the *gm-hra* gene is a modified version of a pre-existing soybean gene.

b. Describe a technique that could successfully insert the genes into the genome of the soybean plant.

_____

_____

1 mark

Food Standards Australia New Zealand's (FSANZ) mission is to protect the health and safety of people in Australia and New Zealand through the maintenance of a safe food supply. This mission is achieved by establishing food standards that are based on risk analysis using the best available scientific evidence. In 2010, soybean line DP-356043-5 was approved for commercial use.

c. Describe two pieces of scientific evidence that would be useful for FSANZ to approve the commercial use of DP-356043-5.

_____

_____

_____

_____

2 marks
Total 5 marks

Question 7

Homo floresiensis (affectionately known as the hobbit) is a fossil hominin that was recently discovered on the Indonesian island of Flores. The adult 'hobbit' stood less than 1.2 metres tall and had a brain about a third the size of a modern human.

a. Define the term 'hominin'.

_____

1 mark

The photograph below illustrates the structural differences in the skulls of *Homo floresiensis* (left) and *Homo sapiens* (right).

(Photograph of *Homo floresiensis* and *Homo sapiens* skulls used with permission.
Copyright Professor Peter Brown, University of New England.)

b. **i.** State a structural feature from the photograph that would be useful in concluding that the two organisms should be classified as two separate species.

_____

ii. What other evidence would need to be found that would contradict the 'separate species' evidence?

_____

_____

1 + 1 = 2 marks

c. If mitochondrial DNA from *Homo floresiensis* were found, explain how this could be used to determine how long ago they diverged from *Homo sapiens*.

_____

_____

_____

2 marks
Total 5 marks

END OF QUESTION AND ANSWER BOOKLET

