Neap:

Trial Examination 2009

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 21 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 2009 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.

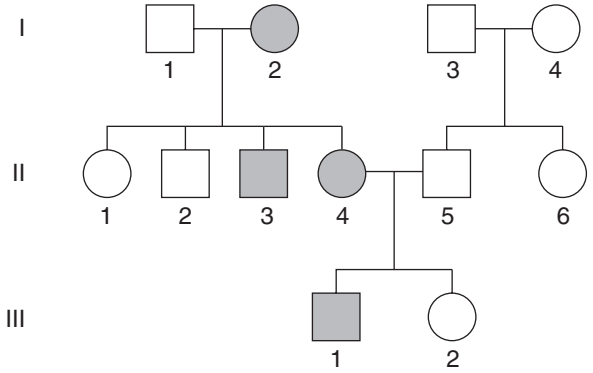
A correct answer scores 1, an incorrect answer scores 0.

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 is relevant for Questions 1, 2 and 3.

Hypertrichosis is a rare genetic disorder characterised by excessive hair growth on the face and upper body for which reason it has been dubbed 'Werewolf' syndrome. The following pedigree illustrates a family showing some members expressing the phenotype. This provided researchers with a rare opportunity to track the gene and hypothesise it was inherited in an X-linked dominant fashion.



Question 1

The number of individuals definitely heterozygous for hypertrichosis in the pedigree is

A. one.

B. two.

C. three.

D. four.

Question 2

The chance that individuals II-4 and II-5 could have another child with hypertrichosis would be

A. 0.

B. $\frac{1}{4}$.

C. $\frac{1}{2}$.

D. $\frac{2}{3}$.

Question 3

The individual that could be shaded and thus eliminate X-linked dominant as the likely pattern of inheritance would be

A. I-3.
B. II-1.
C. II-2.
D. III-2.

Question 4

To study chromosomes of a single organism, geneticists cut images of stained chromosomes from a photomicrograph and arrange them to produce a karyotype.

The statement that correctly concerns karyotypes is:

A. The length and shape of the chromosomes in a karyotype are the same.
B. Karyotypes are prepared from cells that are at any stage in the cell cycle.
C. Scientists can examine the chromosomes under a microscope to determine the nucleotide sequence.
D. Normal individuals from the same species have the same number of chromosomes in a karyotype.

Question 5

Chromosome number is reduced during meiosis because the process consists of

A. two cell divisions without any chromosome replication.
B. a single cell division without any chromosome replication.
C. two cell divisions and only a single round of chromosome replication.
D. four cell divisions with no chromosome replication.

Question 6

Barbie and Ken have their first child. Barbie knows her blood type is A, but Ken does not know his blood type. However, Ken knows that both his mother and father have type B blood. Their first child is a boy named Skip. Skip has type O blood. Barbie and Ken do not understand how this happened.

The best explanation of this information is

A. Barbie's genotype is AA, and Ken's genotype is OO; thus, Skip expresses the O phenotype.
B. Barbie's genotype is AO, and Ken's genotype is OO; thus, Skip expresses the O phenotype.
C. Because Ken's parents are both type B, Ken cannot be Skip's father.
D. Skip's blood type will need to be checked after his first month of life if Barbie and Ken want to know his blood type, as it takes about a month for the blood type to develop in a newborn child.

Question 7

A man and a woman who both appear normal have a child together who has sickle cell anaemia. Sickle cell anaemia is an autosomal recessive trait. The woman becomes pregnant again and is told that she is carrying non-identical twins.

The probability that both of the couple's twins will develop sickle cell anaemia is

A. $\frac{1}{16}$.

B. $\frac{1}{4}$.

C. $\frac{1}{2}$.

D. $\frac{9}{16}$.

Question 8

Coat colour in Labrador retrievers is controlled by two genes. The first gene controls coat colour, with black coat colour (*B*) being dominant to brown coat colour (*b*). The second gene controls the expression of colour, with the expression of colour (*E*) being dominant to not expressing colour (*e*). Failure to express colour results in a yellow Labrador retriever regardless of genetic coat colour (black or brown).

A breeder repeatedly crosses a brown Labrador and a yellow Labrador. All of the resulting puppies are either black or yellow. The pair never produces any brown puppies.

The genotypes of the parents are

A. *bbee* and *Bbee*.

B. *bbEE* and *Bbee*.

C. *bbEe* and *Bbee*.

D. *bbEe* and *BBee*.

Question 9

Several DNA fragments were subjected to electrophoresis ('+' represents the positive electrode and '–' the negative electrode).

The order of fragments on the stained gel would be

A. + AATCGCCC, GGCCAC, AATTG, ATAT, GGG –

B. + AATCGCCC, AATTG, ATAT, GGCCAC, GGG –

C. + GGG, ATAT, AATTG, GGCCAC, AATCGCCC –

D. + GGCCAC, GGG AATCGCCC, AATTG, ATAT –

The following information is relevant for Questions 10 and 11.

A geneticist was interested in observing the patterns of inheritance of two linked genes. Each gene had a dominant (*A* and *B*) and recessive (*a* and *b*) form. He decided to carry out a test cross with an F1 hybrid.

Question 10

The number of genes and alleles illustrated in the work the geneticist carried out is

A. one gene; four alleles.

B. four genes; two alleles.

C. two genes; two alleles.

D. two genes; four alleles.

Question 11

The genotype of the F1 hybrid used in the test cross could be

A. *AaBb.*

B. *Aa*/*Bb.*

C. *AB*/*ab.*

D. *Ab*/*ab.*

Question 12

If a molecule of mRNA, prior to intron splicing, has 15% A, 20% G, 30% U, and 35% C, the composition of the double-stranded DNA that it was transcribed from is

A. 15% T, 20% C, 30% A, 35% G.

B. 15% G, 20% A, 30% C, 35% T.

C. 22.5% T, 22.5% A, 27.5% G, 27.5% C.

D. 17.5% G, 17.5% A, 32.5% T, 32.5% C.

Question 13

Second Position													
First Position		U		C		A		G			Third Position
	U	UUU	Phe	UCU	Ser	UAU	Tyr	UGU	Cys	U	
		UUC		UCC		UAC		UGC		C	
		UUA	Leu	UCA		UAA	*Stop*	UGA	*Stop*	A	
		UUG		UCG		UAG	*Stop*	UGG	Trp	G	
	C	CUU	Leu	CCU	Pro	CAU	His‘	CGU	Arg	U	
		CUC		CCC		CAC		CGC		C	
		CUA		CCA		CAA	Gin	CGA		A	
		CUG		CCG		CAG		CGG		G	
	A	AUU	Ile	ACU	Thr	AAU	Asn	AGU	Ser	U	
		AUC		ACC		AAC		AGC		C	
		AUA		ACA		AAA	Lys	AGA	Arg	A	
		AUG	Met	ACG		AAG		AGG		G	
	G	GUU	Val	GCU	Ala	GAU	Asp	GGU	Gly	U	
		GUC		GCC		GAC		GGC		C	
		GUA		GCA		GAA	Glu	GGA		A	
		GUG		GCG		GAG		GGG		G	

Using the codons and their corresponding amino acids in the table above, the number of amino acids translated in the mRNA sequence below is

5′-AUGUUCCAAGUGAUGCAUAAAGAGUAG-3′

A. 27.
B. 7.
C. 8.
D. 9.

Question 14

The type of mutation that involves the addition or deletion of single nucleotides is

A. nonsense.
B. silent.
C. frameshift.
D. inversion.

Question 15

When an organism gains or loses one or more chromosomes but not a complete haploid set, the condition is known as

A. aneuploidy.
B. polyploidy.
C. triploidy.
D. trisomy.

Question 16

A biologist studying a population of beetles observes that their average body size had increased over a number of generations.

The factor(s) that can account for this is(are)

A. natural selection.
B. an improvement in local food supply.
C. a local decline in the population of predators.
D. all of the above

Question 17

'Fitness', as used in evolutionary biology, is a synonym for

A. natural selection.
B. relative reproductive success.
C. adaptation.
D. probability of survival.

Question 18

When certain bacteria are treated with an effective antibiotic, some cells do not die.

The best explanation for this occurrence is:

A. The antibiotic causes mutations for resistance to arise.
B. Genes coding for antibiotic resistance are already present in the population.
C. The antibiotic prevents mutations for resistance from arising.
D. The antibiotic reduces competition from other bacteria, increasing chances for survival.

Question 19

Given enough time, the expected result for genetic drift is that the frequency of any given allele will

A. increase steadily until the allele is eliminated from the population.
B. decrease steadily until the allele becomes fixed in the population.
C. fluctuate randomly until the allele is either eliminated or fixed, with equal probability.
D. fluctuate randomly until the allele is either eliminated or fixed, with a probability that depends on its initial frequency.

Question 20

The biological species concept defines a species in terms of

A. reproductive capability.
B. appearance and behaviour.
C. geographical distribution.
D. phylogeny.

Question 21

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.

This is an example of

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

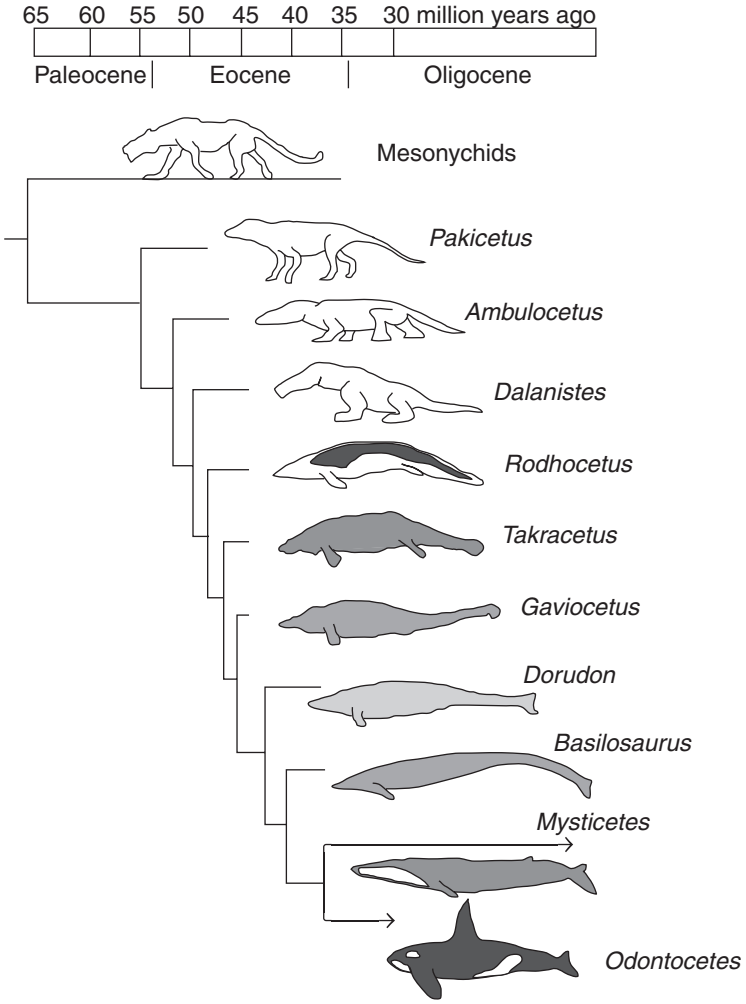
Question 22

The observation that placental mice in North America are very similar in appearance to marsupial mice in Australia, even though they are not closely related to one another, is an example of

A. homology.
B. analogy.
C. convergent evolution.
D. divergent evolution.

The following information is relevant for Questions 23 and 24.

The evolutionary tree below illustrates the evolution of the modern toothed (*Odontocetes*) and baleen (*Mysticetes*) whales.



Question 23

According to this information the evolutionary descent of the whales

A. was from a terrestrial ancestor.

B. was entirely marine.

C. shows the Mesonychids are the common ancestor to modern whales.

D. shows 12 evolutionary branches.

Question 24

The modern whales branched from the now extinct *Ambulocetus*

A. 35 million years ago.

B. during the Paleocene epoch.

C. during the Oligocene epoch.

D. 52 million years ago.

Question 25

Biologists extracted DNA from animal and plant fossil material found at the excavation site. One section of the analysed DNA has three regions which identify the type of organism from which the DNA has been extracted.

Region *X*	Region *Y*	Region *Z*
Common to all animals	Characteristic of mammals	Variable within animals

Four fossil DNA samples were collected. It was thought that one DNA sample was from a wombat-like animal, another from an emu-like bird and another from a fern-like plant. Comparisons of the DNA from the three fossil samples were made to this section of DNA from a living wombat. The results of the comparisons are summarised in the following table.

	Comparison with modern-day wombat DNA		
Fossil sample DNA	**Region *X***	**Region *Y***	**Region *Z***
Sample I	matched	matched	no match
Sample II	matched	no match	no match
Sample III	no match	no match	no match
Sample IV	matched	matched	matched

The sample which has most likely come from an emu-like bird is

A. sample I.

B. sample II.

C. sample III.

D. sample IV.

SECTION B: SHORT-ANSWER QUESTIONS

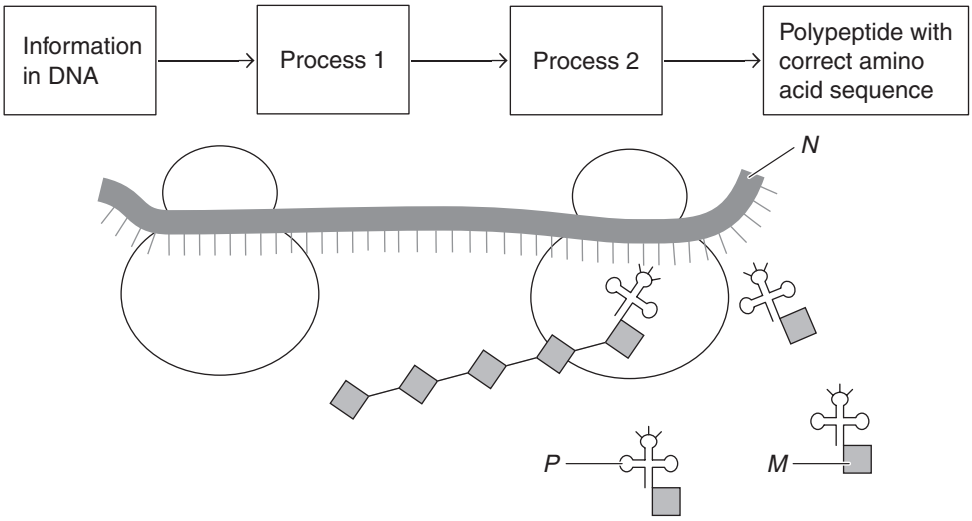
Instructions for Section B

Answer this section in pen.

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

Question 1

The following flow chart shows the process of protein synthesis as developed by Crick and Watson in the late 1950s. The diagram beneath it shows some of the biochemical structures involved in protein synthesis.



a. Which process (1 or 2) does the above diagram represent? Name the process.

_____

1 mark

b. Structures *P* and *N* in the above diagram are different forms of the same molecule.

Identify and name these two structures.

_____

_____

2 marks

c. Describe the function of *P* in the process named in part **a.**

_____

_____

1 mark

d. The formation of structure *N* was considered by Crick and Watson to be a straightforward, single-step process. However, more recent research has added a complication to this seemingly simple process.

Explain this complication.

_____

_____

_____

_____

2 marks

Total 6 marks

Question 2

Kary Mullis was awarded a Nobel prize in 1993 for developing a technique by which DNA molecules could be mass-produced from incredibly small amounts of material. The process was called Polymerase Chain Reaction (PCR) which made it much easier to characterise and compare the genetic material from different individuals and organisms.

a. Name a technology in which PCR has been of benefit and discuss its importance in making that technology either faster or more accurate.

_____

_____

_____

_____

2 marks

PCR not only amplifies small amounts of DNA but it also amplifies small specific sections of DNA depending on the needs of the biotechnologist.

b. What aspect of PCR technology enables small specific sections of DNA to be targeted? Explain how this is achieved.

_____

_____

_____

_____

_____

2 marks

c. The process of PCR also involves a series of cycles where specific sections of DNA are replicated. These cycles involve temperature changes ranging from 40 °C to 90 °C yet the DNA continues to replicate faithfully regardless of these fluctuations in temperature.

i. Explain one aspect of PCR that enables DNA to replicate through a series of cycles at such high temperatures.

_____

_____

_____

_____

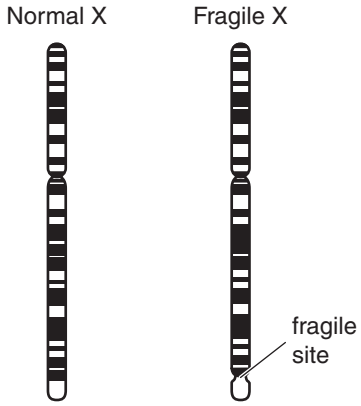
ii. If one single strand of a DNA molecule was exposed to PCR for ten cycles, how many molecules of that DNA would be generated as a result?

_____

1 + 1 = 2 marks
Total 6 marks

Question 3

Fragile X syndrome is the most common cause of inherited mental impairment worldwide. It is called fragile X syndrome due to the appearance of the bottom arm of the X chromosome. This is the location of a gene (FMR-1) which if not activated, leads to the symptoms of the syndrome. The diagram below shows the appearance of the fragile X chromosome in comparison to a normal X chromosome.

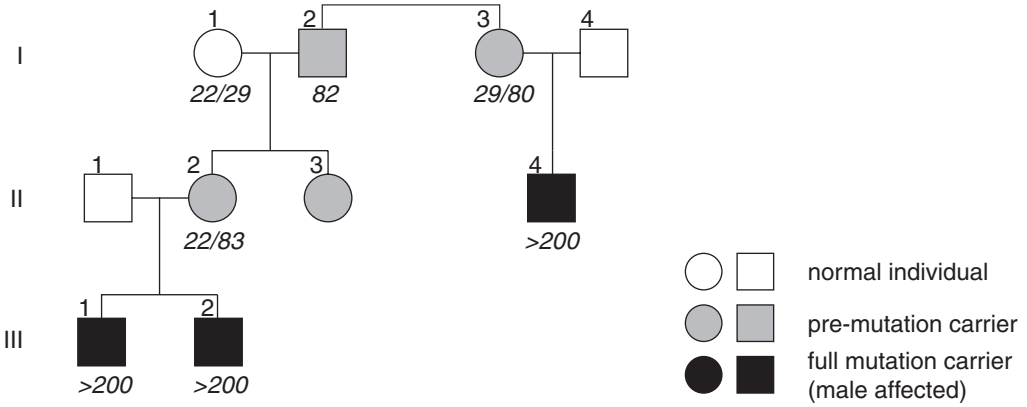


a. Use the diagrams above as a guide to show how a carrier female, who is heterozygous for this condition, could pass the fragile X chromosome to a son.

2 marks

In front of the FMR-1 gene is the DNA sequence ′CGG′. This sequence is normally repeated between 6 and 50 times. In some people, this sequence is repeated between 50 to 200 times and is called a *pre-mutation*, which causes few or no symptoms of fragile X syndrome. In a woman with the pre-mutation, the size can expand to over 200 repeats when that X chromosome is passed on in her egg. This is called a *full mutation* and fragile X syndrome is the result. **Males with the fragile X pre-mutation will pass that X chromosome, without a change, on to all of their daughters.**

The pedigree below is an example of the inheritance pattern of fragile X. The values represent the number of ′CGG′ repeats in front of the FMR-1 gene.



b. **i.** What is the chance that individual III-2 inherited the fragile X syndrome from his father?

_____

ii. Explain your answer to **b. i**.

_____

_____

1 + 1 = 2 marks

c. The symbols below represent the alleles of the FMR gene.

X : Normal

X^F: Pre-mutation

X^f: Full mutation

How many possible genotypes are there in the human population?

_____

1 mark

d. A situation arose in which individual II-4 (from the pedigree) intended to have a child with a female who carries the pre-mutation.

i. What is the chance of them conceiving a daughter?

_____

ii. Discuss the chance of this daughter expressing fragile X syndrome. In your answer show the genotypes of both parents and the daughter.

_____

_____

_____

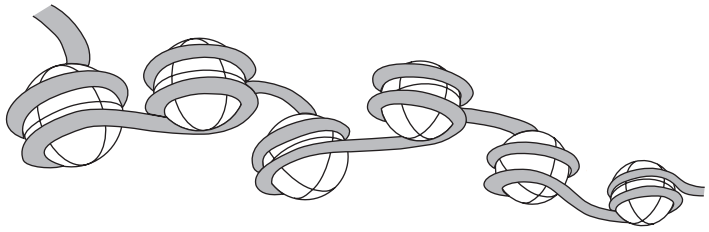
_____

1 + 3 = 4 marks

Total 9 marks

Question 4

For eukaryotes, cell–cell differences are determined by expression of different sets of genes. The default state of gene expression is 'off' rather than 'on', because of the chromatin (the complex of DNA and histone proteins found within the cellular nucleus). When a specific gene is tightly bound with histone, that gene is 'off'. The diagram below shows a series of six genes where each gene is switched off.



a. **i.** Label the histone and genes on the diagram.

ii. Use the information above and your knowledge of biology to describe the steps involved in switching a gene on.

_____

_____

1 + 2 = 3 marks

Once a gene is switched on, the steps involved in the expression of that gene can take place and proteins specific for that cell can be formed. Different cells in the one individual have a different combination of proteins expressed. This leads to cell differentiation, a very important phenomenon with respect to multicellular organisms.

b. **i.** Describe the function of one enzyme involved in gene expression and explain its role in this process.

_____

_____

ii. Use this information to hypothesise how different cell types exist within the same multicellular individual.

_____

_____

2 + 1 = 3 marks

c. Stem cell technology is a promising field of science that is using undifferentiated cells and programming them to change into specific types of cells such as skin and nerve. There are two main sources of stem cells. Adult stem cells are usually extracted from places such as the bone marrow. Embryonic stem cells are derived from a blastocyst, a few days after fertilization is induced in a laboratory. Each type of stem cell can potentially be very useful for the treatment of injuries such as burns and spinal chord injuries.

i. Embryonic stem cells show more promise than adult stem cells for these types of treatment.

Give a **biological** reason as to why this may be the case.

_____

_____

_____

_____

ii. Using embryos for this type of treatment is controversial.

What role can governments play in controlling the exploitation of this type of technology?

_____

_____

2 + 1 = 3 marks
Total 9 marks

Question 5

Cabbage is one of the most popular vegetables in Thailand. It is grown throughout the year. A serious pest of the cabbage is the diamondback moth, *Plutella xylostella*.

The diamondback moth has been controlled by spraying the cabbages with insecticides. One of these insecticides is obtained from a soil bacterium, *Bacillus thuringiensis*. This bacterium produces a toxin (called Bt) which has been an effective insecticide against the diamondback moth and is also an environmentally friendly chemical. Since 2005, strains of the diamondback moth which are resistant to the Bt toxin have been increasing in the population.

a. **i.** What change has occurred in the frequency of the Bt-resistant allele in the diamondback moth population in Thailand since 2005?

_____

ii. Explain the steps which have occurred to bring about this change in the frequency of the Bt-resistant allele in the population of diamondback moths.

_____

_____

_____

_____

_____

_____

_____

_____

1 + 3 = 4 marks

b. It has been suggested that the Bt-resistant phenotype is recessive and the Bt-sensitive phenotype is dominant. In Thailand a resistance-management strategy is currently being organised. This strategy recommends that a cabbage field untreated with the Bt insecticide should be grown alongside a cabbage field treated with the Bt insecticide.

Explain how this strategy might help to control the increase in Bt resistance in the population of diamondback moths.

_____

_____

_____

_____

2 marks

Total 6 marks

Question 6

Museum Victoria's Head of Sciences, Dr John Long, accepted the 2008 Australasian Science Prize for his discovery of a fossil fish embryo with an umbilical cord attached. This discovery is not only the first time ever that a fossil embryo has been found with an umbilical cord, but it is also the oldest known example of any creature giving birth to live young rather than laying eggs.

Source: http://museumvictoria.com.au/about/MV-News/2008/Mother-fish/

The fossil lived 380 million years ago (the Late Devonian Period) and was found in limestone in the Gogo area of north-west Western Australia. The 'gogo fish' has been formally named *Materpiscis attenboroughi* after the famous naturalist Sir David Attenborough.

a. **i.** Describe the conditions that would have been necessary for fossilisation of the gogo fish.

_____

_____

ii. The scientists chose not to use carbon dating to determine the age of this fossil.

Explain why carbon dating was not appropriate in this case.

_____

_____

1 + 1 = 2 marks

Another Gogo fossil is *Gogonasus*, initially described from only a snout but discovered as a complete fish fossil in 2005. *Gogonasus* had large holes on top of the skull called spiracles, which were used for taking in air. The front fin of *Gogonasus* is similar to the forelimbs of all land vertebrates (tetrapods) in having a well-developed humerus, ulna and radius. It is suggested that a fish like *Gogonasus* was the common ancestor of amphibians such as frogs, salamanders and newts.

b. What term is used to describe the similar anatomy of the forelimbs of tetrapods such as toads, lizards and rats?

_____

1 mark

c. As mentioned above, it has been suggested that a fish like *Gogonasus* was the common ancestor of amphibians such as frogs, salamanders and newts.

Suggest the environmental changes that may have caused such evolution to take place.

_____

_____

_____

2 marks

d. Cuddie Springs in New South Wales is a shallow wet-season lake surrounded by saltbush scrub. More than 30 000 years ago the lake was a permanent feature of the landscape and nearby excavations have uncovered a series of layers of undisturbed sediments. These sediments contain fossil remains of the inhabitants of the area over the last 100 000 years including some of Australia's unique Megafauna. These giant animals appear to have become extinct about 28 000 years ago. The table below provides further details of the Cuddie Springs fossils.

Sediment layer	Age of sedimentary layer (age in years)	Fossil remains
I	100 000 to 35 000	*Palorchestes* (giant marsupial 'kangaroo') *Genyornis* (giant emu-like flightless bird) Huge reptiles (horned turtles, crocodiles, predatory goanna)
II	35 000 to 28 000	*Genyornis* *Diprotodon* (giant wombat) *Stenutus* (giant kangaroo) Stone tools and charcoal Stone tools associated with some animal bones Seed-grinding stones
III	28 000 to 19 000	Very hard, thin layer of rock formed during an extended dry period corresponding to the last Ice Age. The rock layer contains no fossils
IV	19 000 to recent	Animal remains (no Megafauna) Stone tools including seed-grinding stones

i. What inference can be made when different fossil remains are found in the one sedimentary layer?

_____

_____

ii. Using the information given, suggest why there are no fossils in the sediment layer III.

_____

_____

_____

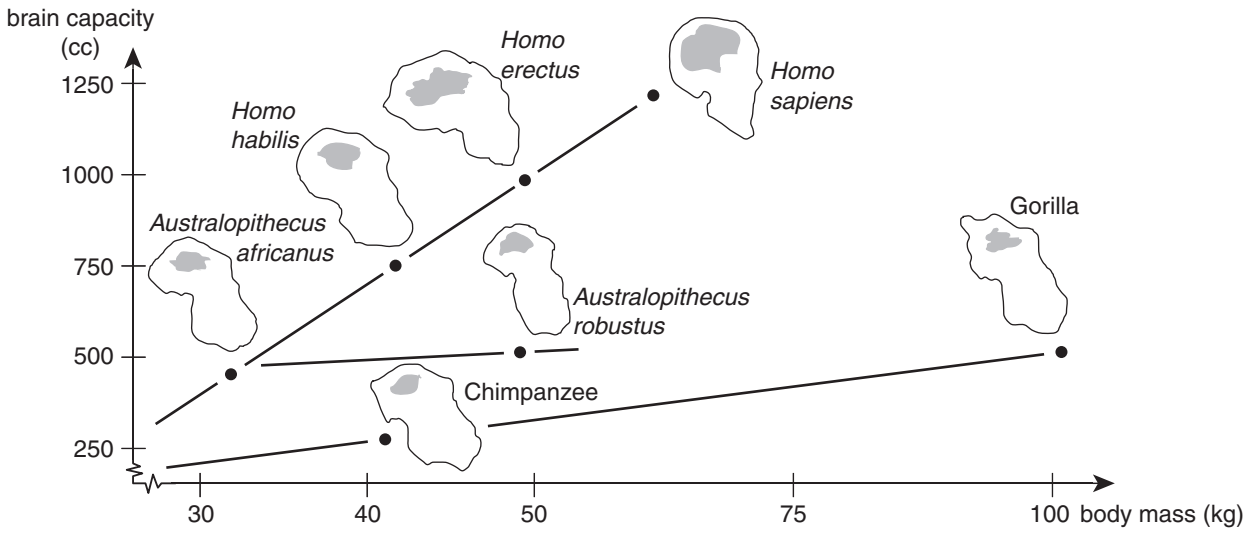
1 + 1 = 2 marks

Total 7 marks

Question 7

Hominin ancestry is a thoroughly researched science which integrates traditional fossil evidence with supporting data from modern biochemical comparisons.

The following graph shows the relationship between brain capacity and body mass of a variety of hominoids.



a. **i.** Compare the ratio of brain capacity to body mass in *A. africanus* to that in gorilla.

_____

_____

_____

ii. As a result of these ratios, what can be inferred about the cultural evolution of both?

_____

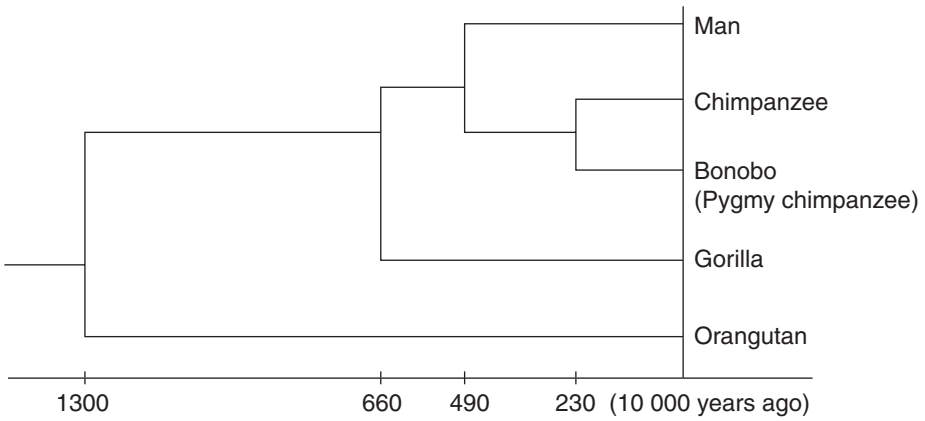
_____

_____

_____

1 + 1 = 2 marks

b. In biochemical evolution, comparison of DNA base configurations can be used to estimate the evolutionary distance between organisms. The graph below shows the date of separation according to mitochondrial DNA comparisons between five hominids.



i. Describe the properties of mitochondrial DNA that would enable conclusions to be made about the date of separation between these five hominids?

_____

_____

ii. Use the graph to estimate when gorillas diverged from humans.

_____

2 + 1 = 3 marks

c. The oldest hominin fossil, *Australopithecus ramidus*, discovered in Ethiopia in 1992, is said to be from 4.4 million years ago. If we take this and integrate it with the results of molecular evolution, then humanity can be said to have been born in Africa about five million years ago. The ecological basis for the primate's evolution into man is said to be the advance from the forest into the savannah.

How could advancement from the forest to the savannah provide a selective advantage for a hominin-type existence?

_____

_____

_____

_____

2 marks
Total 7 marks

END OF QUESTION AND ANSWER BOOKLET