Neap:

Trial Examination 2012

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 2012 VCE Biology Unit 4 Written Examination.

Copyright © 2012 Neap ABN 49 910 906 643 96–106 Pelham St Carlton VIC 3053 Tel: (03) 8341 8341 Fax: (03) 8341 8300 TEVBIOU4_QA_2012.FM

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

In humans, the nucleus of a somatic cell during G1 phase of the cell cycle contains _____ molecule/s of DNA?

A. 1
B. 23
C. 46
D. 92

Question 2

Which of the following is a post-transcriptional modification often seen in the production of mRNA in eukaryotes?

A. 5′-capping, 3′-poly(A) tail addition, splicing
B. 3′-capping, 5′-poly(A) tail addition, splicing
C. removal of exons, insertion of introns, capping
D. 5′-poly(A) tail addition, insertion of introns, capping

Question 3

The diagram below describes the way in which DNA directs the synthesis of proteins in cells.

This model dates from 1956 but more recent research has added a complication to this simple model of information conversion.

What is this complication?

A. The Human Genome Project has shown that protein synthesis does not occur this way.
B. Research into gene expression shows that the proteins produced by a cell are dependent on the genetic information contained in the regions of DNA that have been transcribed.
C. Gene regulation limits the amount of genetic information that is transcribed into RNA.
D. Research into introns and exons shows that the translated RNA does not contain exactly the same information as the transcribed RNA.

Question 4

A mutation that results in the deletion of a single nucleotide pair from the coding region of a gene might

A. only result in the translation of a different sequence of amino acids from the point of the mutation onward.

B. only result in a protein shorter than that produced without the mutation.

C. only result in a protein longer than that produced without the mutation.

D. result in a longer, shorter or different protein.

Question 5

While the most frequent forms of Down's syndrome are caused by non-disjunction of chromosome 21 during meiosis, Down's syndrome occasionally runs in families.

The cause of this form of familial Down's syndrome is most likely to be

A. an inversion involving chromosome 21.

B. too many X chromosomes.

C. the translocation of all or part of chromosome 21 to another chromosome, usually chromosome 14.

D. a maternal age effect.

Question 6

Androgen insensitivity disease (AID) is a recessive, sex-linked inherited disease that reduces the ability of a sufferer's cells to respond to 'maleness' hormones, such as testosterone.

A man who does not have the disease is having a child with a woman who is a carrier. Through prenatal testing, they discover they are having a boy.

The chance the boy will suffer from AID is

A. 0%

B. 25%

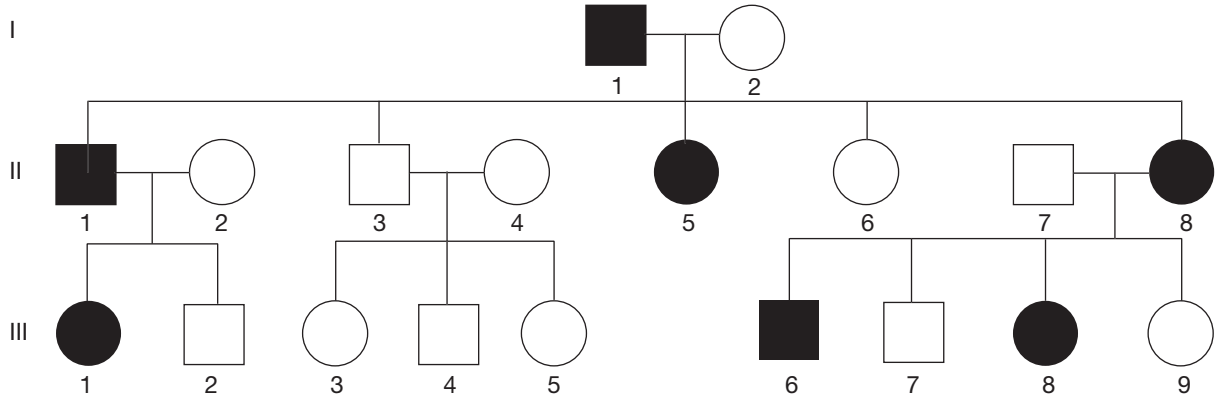
C. 50%

D. 100%

The following information relates to Questions 7 and 8.

Question 7

The following pedigree illustrates how a rare genetic disease called hypercholesterolemia has been passed through three generations. Individual I-2 had no prior history of this disease in her ancestry.



The likely pattern of inheritance for hypercholesterolemia is

A. autosomal dominant.

B. autosomal recessive.

C. sex-linked dominant.

D. sex-linked recessive.

Question 8

Individual III-8 is concerned about her genetic status. A genetic counsellor would tell her that the chance of being heterozygous would be

A. 33%

B. 50%

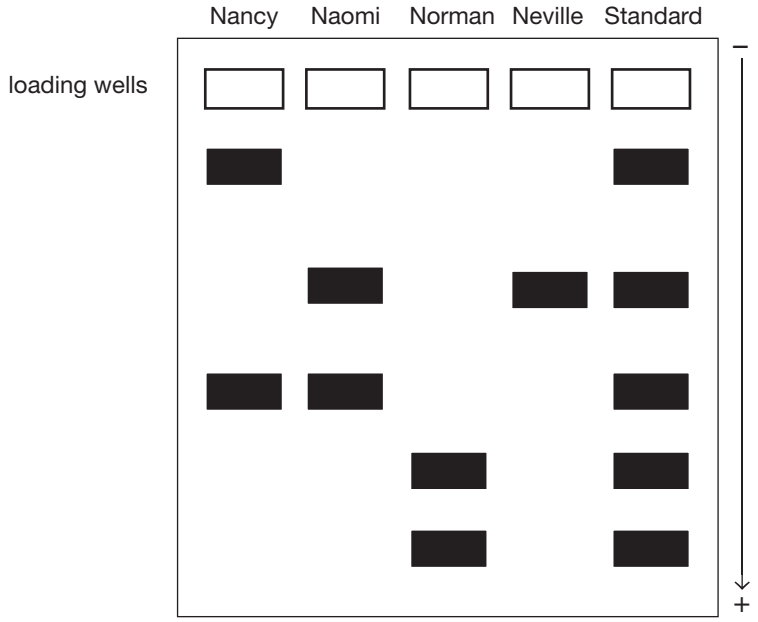
C. 66%

D. 100%

The following information relates to Questions 9 to 11.

Samples of DNA were taken from two men, Norman and Neville, involved in a paternity case. A sample was also taken from the mother, Nancy, and the child, Naomi. The region of DNA of interest was on chromosome 6. In this region of chromosome 6, DNA base sequences are repeated. The number of repeats varies between individuals.

The results of the DNA analysis of the four individuals are shown on the gel.



Question 9

If the standard consists of pieces of DNA with 5, 8, 10, 12 and 15 repeats, which of the following genotypes is correct?

A. Nancy – 15 and 12
B. Naomi – 8 and 10
C. Norman – 8 and 5
D. Neville – 10 and 10

Question 10

Which of the following individuals is probably homozygous?

A. Nancy
B. Naomi
C. Norman
D. Neville

Question 11

A reasonable conclusion that could be made based on the information provided would be that

A. Norman could be Naomi's father.
B. Nancy cannot be the biological mother.
C. Neville is most likely the father of Naomi.
D. Naomi is more genetically similar to Norman than any other person represented on the gel.

Question 12

Gene therapy is where

A. a person's genes are sequenced to detect abnormalities.

B. normal functioning genes are inserted into cells that contain mutated genes.

C. millions of copies of a segment of a person's DNA are made.

D. a faulty gene is removed, repaired and returned to a cell.

Question 13

The goal of one application of biotechnology is to produce a large quantity of a particular protein, such as insulin. This might require the use of a recombinant DNA plasmid.

Once a recombinant DNA plasmid has been formed, the next step in the process to produce the protein is

A. to use restriction enzymes to cut the plasmid.

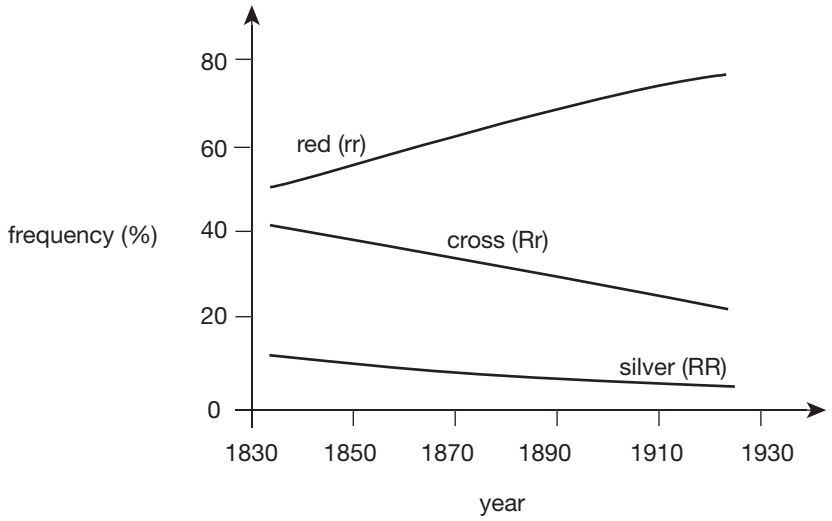
B. to insert the recombinant plasmid into bacterial cells.

C. for the recombinant DNA to be transcribed.

D. to clone the gene.

Question 14

The graph below illustrates changes in the frequency of the silver and red phenotypes of the fox (*Vulpes vulpes*) in Eastern Canada between 1830 and 1930 (about 100 generations).



Source: Allendorf, FW & Hard, JJ (2009) Proceedings of the National Academy of Sciences (USA) June 16, vol. 106
http://www.pnas.org/content/106/suppl.1/9987/F2.expansion.html

The best explanation for this change in phenotype frequencies over time would be

A. a decrease in the selective advantage of the red phenotype.

B. an increase in the mutation rate of gene **R**.

C. an increase in the frequency of allele **r**.

D. an overall increase in the population of foxes.

Question 15

A population of peppermint stick insects (*Megacrania batesii*) lives in and feeds on *Pandanus* palm trees in North Queensland. One of its major predators is Boyd's forest dragon (*Hypsilurus boydii*), which also preys on earthworms, ants, termites, many other insects and birds' eggs. These lizards swallow the stick insects whole, but there are physical limits to the size of prey they can swallow. These limits are imposed by the size of the reptile's head and throat.

In this context, which of the following predictions is most consistent with Darwin's theory of evolution by natural selection?

A. Over many generations, the average length of an adult peppermint stick insect in this population will increase.

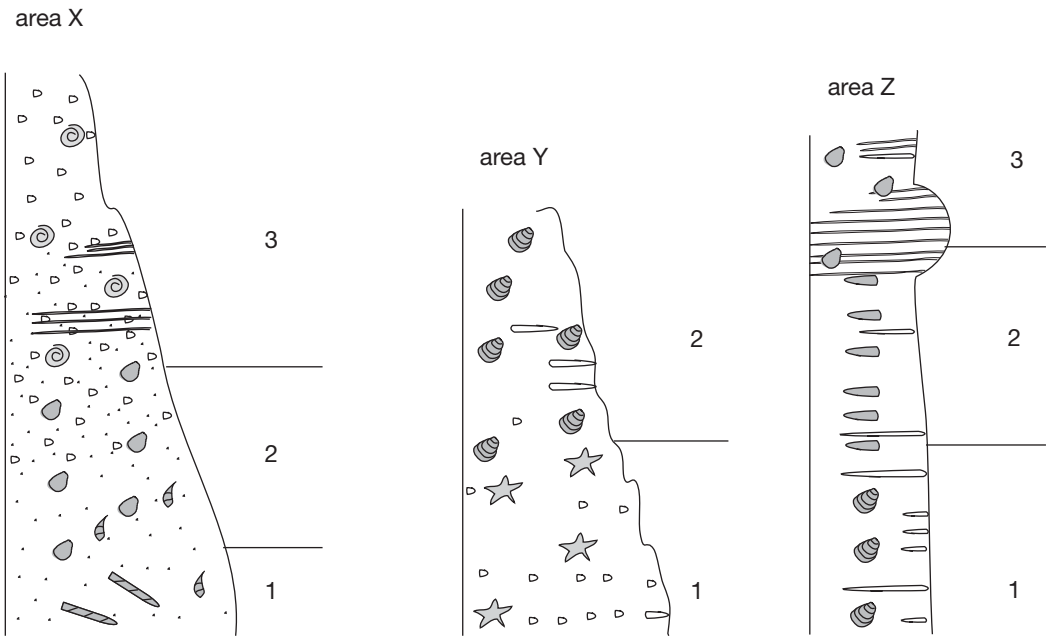
B. Over many generations, the average head and throat size in the local population of Boyd's forest dragons will increase.

C. Over many generations, the average length of an adult peppermint stick insect in this population will decrease.

D. Over many generations, both the average length of adult peppermint stick insects and the average head and throat size of Boyd's forest dragons will increase.

Question 16

The diagram below represents three outcrops of fossil-bearing rocks in the Flinders Ranges of South Australia. The outcrops are located 20–30 km away from each other. The fossils are shaded.



Which of the following statements is true?

A. The age of the rock layers increases in the order Y1, Y2 = Z1, X1 = Z2, X2 = Z3, X3.

B. The presence of fossils in some outcrops but not in others could mean that the organisms that produced those fossils only lived in a restricted locality.

C. All outcrops contain the same fossils and are the same age.

D. The age of the rock layers decreases in the order X3, X2 = Z3, X1 = Z2, Y2 = Z1, Y1.

Question 17

The following data illustrates the radioactive decay rate of a particular isotope, which could prove useful in dating some fossils.

Time elapsed	Undecayed Isotope Remaining
0 years	100 grams
10 000 years	75 grams
15 000 years	50 grams
30 000 years	25 grams
37 000 years	17 grams
45 000 years	12.25 grams
49 000 years	10 grams

The half-life of the radioisotope is

A. 10 000 years.
B. 15 000 years.
C. 30 000 years.
D. 49 000 years.

Question 18

With respect to evolution, the term 'homologous structures' is used to describe

A. characteristics present in two species that were present in a common ancestor.
B. characteristics present in two species that were not present in a common ancestor.
C. structures that have a similar function.
D. structures that are the result of convergent evolution.

Question 19

Cytochrome c is a protein. The table below shows the sequence of the last six amino acids in cytochrome c in humans and three other animals.

Animal	Sequence of amino acids in cytochrome c
Human	lys–ile–phe–ile–met–lys
I	lys–thr–phe–val–glu–lys
II	lys–ile–phe–ile–met–lys
III	lys–ile–phe–val–glu–lys

The three other animals are a monkey, a fish and a horse.

One of these three animals is in the same Order as humans and two are in the same Class.

Which of the following statements correctly identifies the three animals being compared to the human?

A. I = monkey; II = fish; III = horse
B. I = monkey; II = horse; III = fish
C. I = horse; II = fish; III = monkey
D. I = fish; II = monkey; III = horse

The following information relates to Questions 20 to 22.

The Antarctic skua (*Catharacta maccormicki*) is a predatory and scavenging seabird the size of a large seagull. This species of skua nests all around continental Antarctica.

Several different populations of skuas are found breeding on the separate islands of an Antarctic archipelago. Each population contains 100 individuals. In these particular populations, the melanic, dark brown-coloured skua has the dominant phenotype, due to an allele, **M**. Heterozygous individuals are dark brown. The homozygous recessive phenotype (**mm**) is white. Every generation, 10 individuals from each population disperse to other islands in the archipelago.

Question 20

The statement that most correctly represents the information provided above is

A. Allele flow is probably sufficient to negate the effects of genetic drift in each population.

B. Each skua population is undergoing allopatric speciation.

C. Genetic drift could lead to the extinction of some of these island populations due to the fixation of deleterious alleles.

D. The Antarctic skua is not evolving.

*The following **extra** information relates to Questions 21 and 22.*

During a typhoon, two male skuas and two females are blown 350 kilometres to an isolated island previously uninhabited by skuas. They reproduce and generate a new population. There is no migration with this new population. All four original colonists were white-coloured skuas.

Question 21

The new frequency of **m** is

A. 0.00

B. 0.19

C. 1.00

D. 0.81

Question 22

The difference in colour between the new skua population and the old populations is due to the evolutionary phenomenon known as

A. natural selection.

B. founder effect.

C. mutation.

D. allopatric speciation.

Question 23

Evidence for the first intentional use of fire by the ancestors of humans is associated with

A. *Australopithecus afarensis.*

B. *Homo habilis.*

C. *Homo erectus.*

D. *Homo sapiens.*

Question 24

Mitochondrial DNA (mtDNA) evidence supports the 'Out of Africa' hypothesis. A large study of specific mitochondrial alleles was conducted, with mtDNA from six human populations (listed below) being compared in detail.

1. East Asia
2. India
3. Middle East
4. America
5. North Europe
6. Africa

Which of the following results that would best support the 'Out of Africa' hypothesis?

A. The African mitochondrial DNA would be more similar within that population.

B. The American mitochondrial DNA would be the most diverse within that population.

C. The middle eastern mitochondrial DNA would be more similar to the African mitochondrial DNA than any of the other populations.

D. The order of diversity of the mitochondrial DNA within each population from most diverse to least diverse is: America, East Asia, Africa, Northern Europe, Middle East and India.

Question 25

When comparing a chimpanzee (*Pan troglodytes*) with *Homo neanderthalensis*, the Neanderthal is uniquely a

A. hominid.

B. hominoid.

C. anthropoid.

D. hominin.

SECTION B: SHORT-ANSWER QUESTIONS

Instructions for Section B

Answer this section in pen.

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

Question 1

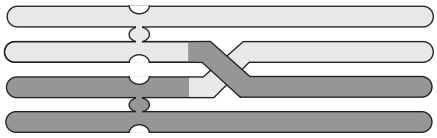
a. Explain how independent assortment leads to variation in gametes.

_____

_____

1 mark

b. The diagram below shows a pair of homologous chromosomes during one stage of meiosis.



i. On the diagram, use the letter *C* to label a centromere.

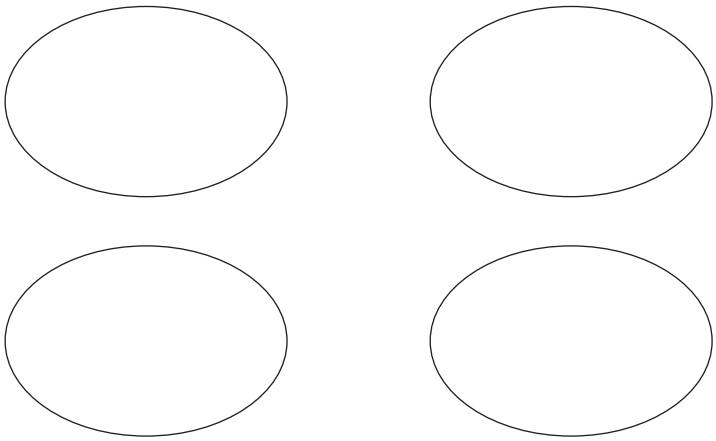
ii. What is meant by *homologous* chromosomes?

_____

_____

1 + 1 = 2 marks

c. Complete the diagram below to show how the chromatids from the diagram above would be distributed in the four nuclei produced at the end of meiosis.

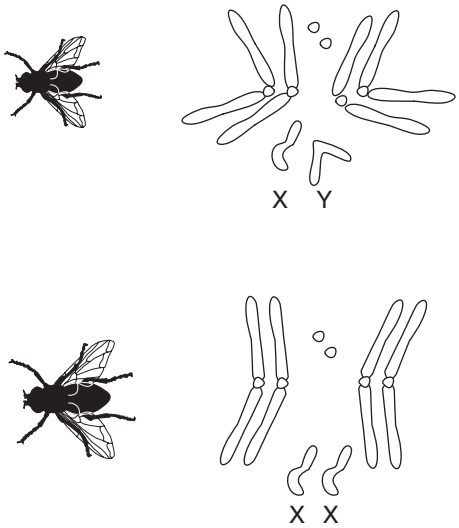


2 marks

Total 5 marks

Question 2

Drosophila melanogaster (fruit fly) has been used as a genetic tool for over 100 years. The diagram below shows a male and female fruit fly and the corresponding chromosomes found in their somatic cells.



a. **i.** What is the diploid number of *Drosophila melanogaster*?

_____

ii. Explain why 50% of a typical population of *Drosophila melanogaster* are male.

_____

_____

_____

_____

1 + 2 = 3 marks

A geneticist was interested in three *Drosophila melanogaster* genes (eye colour, body colour and wing length). He carried out the following genetic crosses and made conclusions based on the results of the crosses.

Cross number	Parental Phenotypes	Offspring Phenotypes and Ratios
1	Red-eyed females crossed with white-eyed males	all offspring red-eyed
2	White-eyed females with red-eyed males	all males white eyes, all females red eyes
3	Brown-bodied males and females	25% of offspring black-bodied 75% of offspring brown-bodied
4	Long-winged males and females	25% of offspring short wings 75% of offspring long wings

b. **i.** Which cross(es) allows the geneticist to conclude that a particular characteristic is recessive?

_____

ii. What proportion of the male offspring would have white eyes if the white-eyed male offspring from cross 2 were bred with the red-eyed female offspring from cross 1?

1 + 1 = 2 marks

c. Heterozygous brown bodied flies with long wings were test-crossed. The offspring displayed a phenotypic ratio that enabled the geneticist to conclude that the genes were independently inherited.

Explain why the geneticist could make such a conclusion. You may like to use a diagram to illustrate your answer.

_____

_____

2 marks

Total 7 marks

Question 3

One form of severe combined immunodeficiency (ADA-SCID) is an autosomal recessive metabolic disorder. It is caused by a mutation of the gene that codes for the enzyme adenosine deaminase (ADA), which is necessary for the breakdown of purines (adenine and guanine). It is also known as the 'bubble boy disease' because its victims are extremely vulnerable to infectious diseases and have to live in sterile environments.

a. The primary structure of the ADA protein consists of 363 amino acids.

What is the minimum number of nucleotide bases needed to code for the amino acids in ADA?

_____

1 mark

b. State **one** factor which might increase the frequency at which mutation occurs in a gene.

_____

1 mark

The most common treatment for SCID is bone marrow transplantation, but more recently gene therapy has been trialled as an alternative. In 1990, Ashanthi DeSilva became the first patient to undergo successful gene therapy for ADA-SCID. Researchers collected samples of Ashanthi's blood, isolated some of her white blood cells, and used a virus to insert a healthy ADA gene into them. These cells were then injected back into her body, and began to express a normal enzyme. Her immune system began to function normally shortly afterwards.

c. Explain why Ashanthi would **not** be able to pass on the healthy ADA gene to her children.

_____

_____

_____

_____

2 marks

d. A virus was used to deliver the healthy ADA gene into Ashanthi's cells.
Give **one** reason for using a virus to transfer genes into cells.

_____

_____

1 mark

e. Explain why a mutation involving a deletion of a single base in the ADA gene may have a greater effect than one involving substitution of one base for another.

_____

_____

_____

_____

2 marks
Total 7 marks

Question 4

The largest and most rigorous twin study of its kind to date has found that shared environmental factors – experiences and exposures common to both twin individuals – have more of a contributing effect to autism spectrum disorders (ASD) than originally thought. The study showed that the environment accounts for 58% of ASD and genetic heritability about 38%.

a. **i.** Define the term phenotype.

_____

_____

ii. The test was 'the largest and most rigorous twin study of its kind'.

What factor would the scientists need to be mindful of when conducting the study?

_____

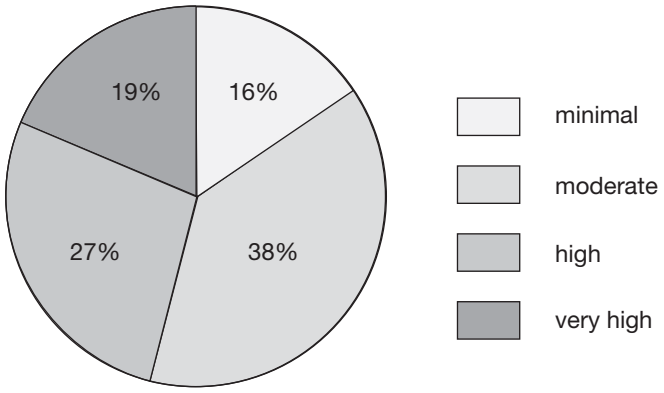
_____

_____

1 + 1 = 2 marks

One environmental factor that seems to have more support as a factor that can contribute to autism is diet. One such diet study in 2008 was called the GFCF diet (Gluten Free, Casein Free). The results of this test are illustrated below.

GFCF Diet – Level of Improvement
Ratings by parents of children with ASD
n = 829



b. **i.** What proportion of the parents of children suffering ASD observed a better than moderate level of improvement?

_____

ii. Does this mean all sufferers of ASD would have their symptoms reduced as a result of a GFCF diet? Explain your answer.

_____

_____

_____

1 + 2 = 3 marks

There is strong evidence suggesting that autism and coeliac disease (a disease of the gut) are linked. The gene for coeliac disease is located on the short arm of chromosome 6. However, a gene for autism is yet to be located.

c. **i.** Describe the location of a gene for autism if it is linked to coeliac disease.

_____

ii. Explain why autism and coeliac disease are not always inherited together.

_____

_____

1 + 1 = 2 marks

d. There is a genetic test for coeliac disease which could prove a useful tool for indirectly diagnosing ADS.

Discuss one advantage and one disadvantage of this type of indirect testing for ADS.

_____

_____

_____

_____

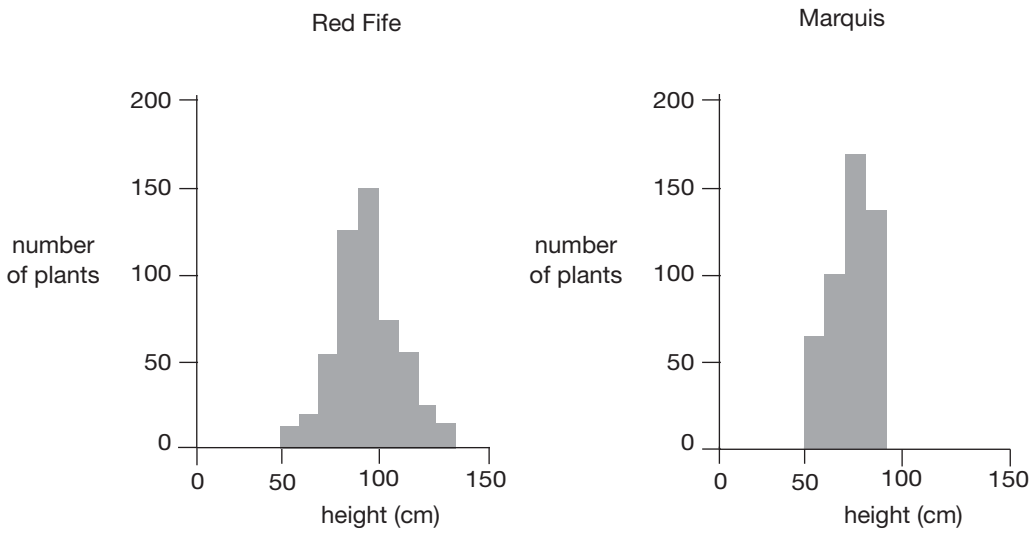
2 marks
Total 9 marks

Question 5

The Australian Government's Wheat Variety Classification Panel classifies new wheat varieties for use by the Australian wheat industry.

Red Fife and Marquis are varieties of wheat grown specifically to provide flour for bread-making.

Scientists grew 500 seedlings of each variety of wheat in identical conditions and measured the heights of the fully-grown plants. The results are shown in the diagram.



a. **i.** State the type of variation shown in Red Fife wheat.

_____

ii. Describe **two** ways in which the results for the Red Fife variety differ from the results for the Marquis variety.

1. _____

2. _____

1 + 2 = 3 marks

iii. From these results, suggest the advantage to a farmer of growing Marquis wheat rather than Red Fife.

_____

_____

1 mark

The original individuals of the Marquis variety were obtained in the early 1900s by crossing Red Fife wheat plants with those of another variety, Hard Red Calcutta. These original individuals were then subjected to artificial selection to increase the resistance of the variety to black rust, a disease of the leaves caused by the fungus *Puccinia graminis* which seriously reduces wheat yields.

b. Suggest how artificial selection for rust resistance in Marquis wheat might have been carried out.

_____

_____

_____

_____

_____

_____

_____

_____

3 marks
Total 7 marks

Question 6

A scientist determined the sequences of nucleotides in small samples of DNA obtained from the dried muscle of an extinct mammal, the thylacine.

a. What is meant by extinction?

_____

1 mark

b. Suggest a reason for the extinction of the thylacine.

_____

_____

1 mark

The scientist required a large quantity of DNA to make comparisons with other mammals, and used the Polymerase Chain Reaction (PCR) to amplify a small amount of thylacine DNA into a larger quantity.

c. Explain how each of the following is necessary to the process of producing a large quantity of DNA using PCR.

i. Primers:

_____

_____

ii. *Taq* polymerase:

_____

_____

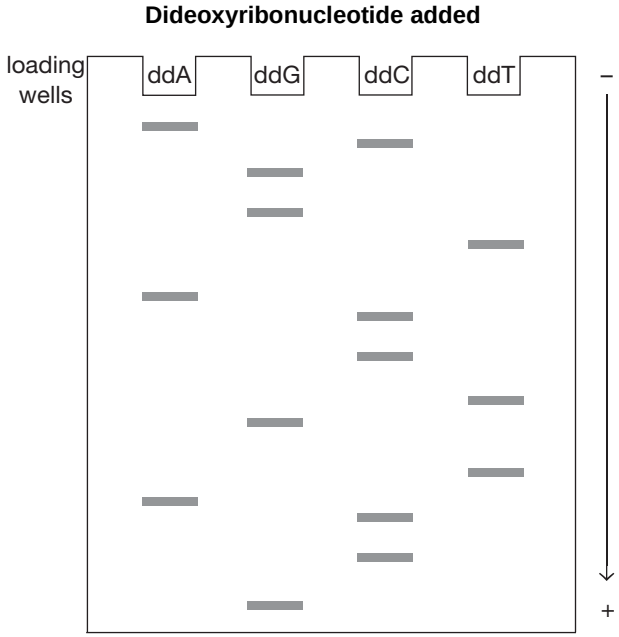
1 + 1 = 2 marks

To determine the nucleotide sequence, the thylacine DNA (template DNA) was prepared for PCR as a single template strand. However, mixed with the normal deoxyribonucleotides (A, T, C and G), a small amount of a **di**deoxyribonucleotide (**one** of ddA, ddT, ddC and ddG) was also supplied.

Insertion of a **di**deoxyribonucleotide stops the polymerisation process. This fixes the length of the complementary strand. It also fixes the position in the strand of the base present in the **di**deoxyribonucleotide. For example, insertion of ddA as the sixth nucleotide gives a DNA fragment six bases in length, and identifies adenine as the sixth base in the sequence.

At the end of the polymerisation period, the fragments were separated by length from longest to shortest using gel electrophoresis.

The process was repeated four times, using a different **di**deoxyribonucleotide each time. The diagram below shows the banding patterns produced by a thylacine DNA template strand consisting of 15 nucleotides.



d. **i.** Why do the DNA fragments move different distances in the gel?

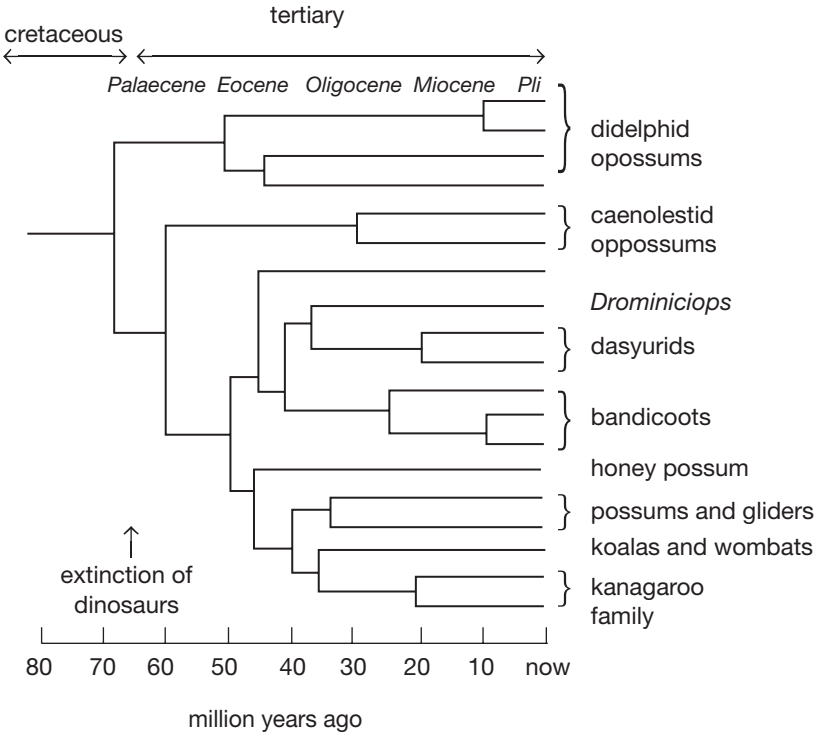
_____

ii. Write a possible structure of the double-stranded molecule of thylacine DNA used in this experiment. Clearly label the template strand and the complementary strand.

1 + 2 = 3 marks
Total 7 marks

Question 7

The phylogenetic tree (cladogram) below shows the suggested evolutionary relationships between the various groups of marsupial mammals. The didelphid opossums, caenolestid opossums and *Dromiciops* are found in South America. The remaining groups are all restricted to Australia.



a. **i.** Which group/s of indigenous Australian marsupials most recently branched from the kangaroos?

_____

ii. How long ago did caenolestid opossums and bandicoots have a recent common ancestor?

_____

iii. Describe a method using modern technology that could be used to determine the age of divergence of each group of marsupials illustrated in the cladogram above.

_____

_____

_____

_____

1 + 1 + 2 = 4 marks

b. Use the evidence provided to explain if you agree or disagree with the statement that 'marsupials evolved in both Australia and South America independently'.

_____

_____

_____

_____

_____

_____

2 marks

c. How could the extinction of dinosaurs lead to the adaptive radiation of the Australian marsupials?

_____

_____

_____

_____

_____

2 marks
Total 8 marks

END OF QUESTION AND ANSWER BOOKLET