

Trial Examination 2000

VCE Biology Unit 4

Written Examination

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
1 Multiple-choice	24	24
2 Short answer	8	8

Directions to students

Materials

Question and answer booklet of 19 pages.

Answer sheet for multiple-choice questions. You should have at least one pencil and an eraser.

The task

Please ensure that you write your name and teacher's name on this booklet and in the space provided on the answer sheet for multiple-choice questions.

This paper consists of two sections, Section 1 and Section 2.

Answer **all** questions from Section 1. Section 1 is worth 24 marks.

Section 1 questions should be answered on the answer sheet provided for multiple-choice questions.

Answer **all** questions from Section 2. Section 2 is worth 51 marks.

Section 2 questions should be answered in the spaces provided in this booklet.

There is a total of 75 marks available.

All written responses should be in English.

At the end of the task

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

Students are advised that this is a trial examination only and cannot in any way guarantee the content or the format of the 2000 VCE Biology end-of-year examination.

SECTION 1**Specific instructions for Section 1**

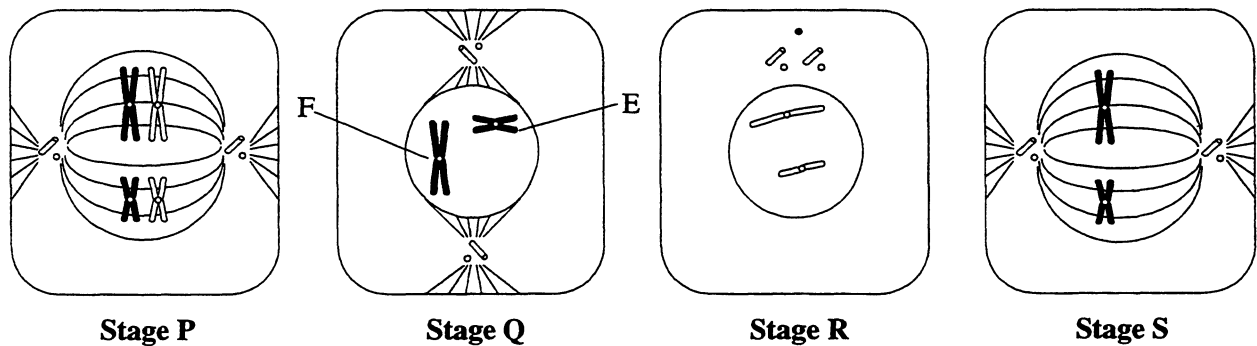
Section 1 consists of 24 multiple-choice questions, each worth one mark. You should attempt all questions. You should spend approximately 30 minutes answering this section of the paper.

Choose the response that is **correct** or **best answers the question**, and mark the corresponding letter on the multiple-choice answer sheet according to the instructions on that sheet.

A correct answer is worth 1 mark, an incorrect answer is worth no marks. No mark will be given if more than one answer is shown for any question. Marks will **not** be deducted for incorrect answers. You should attempt every question.

The following diagram relates to Questions 1 to 4.

The diagram represents how a sample of an organism's chromosomes behave in cell division.

**Question 1**

The cells represented above could be found in

- A. the anther of a plant.
- B. the skin of a frog.
- C. the testes of a dog.
- D. the sporangium of a fern.

Question 2

E indicates

- A. a chromosome.
- B. a chromatid.
- C. an homologous pair of chromosomes.
- D. a centromere.

Question 3

The correct order of events for cell division would be stages

- A. P, Q, R, S
- B. Q, P, R, S
- C. R, Q, S, P
- D. P, Q, S, R

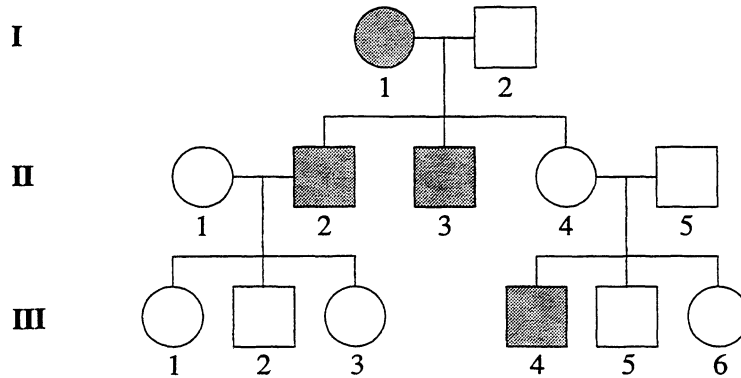
Question 4

In the resting phase of the cell (represented by the diagrams) prior to cell division there are 11.8 picograms of DNA. The amount of DNA at a particular stage is

- A. P 11.8
- B. Q 5.9
- C. R 5.9
- D. S 5.9

Question 5

The pedigree below shows the incidence of colour blindness in a family. The condition is X-linked recessive.

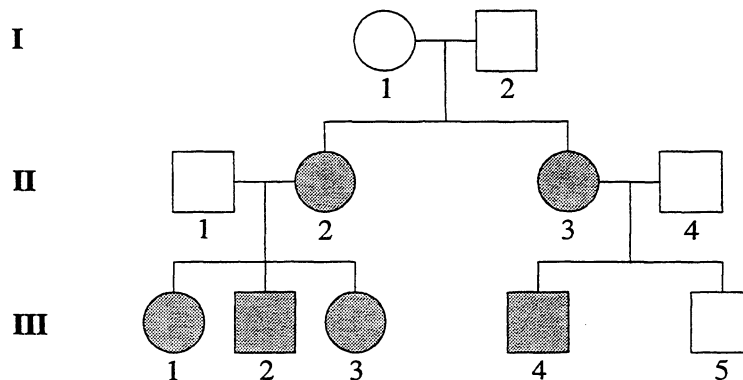


The probability that II 4 is heterozygous is

- A. 1
- B. $\frac{1}{2}$
- C. $\frac{1}{4}$
- D. $\frac{2}{3}$

Question 6

Consider the pedigree below. Shaded individuals have the condition under investigation.

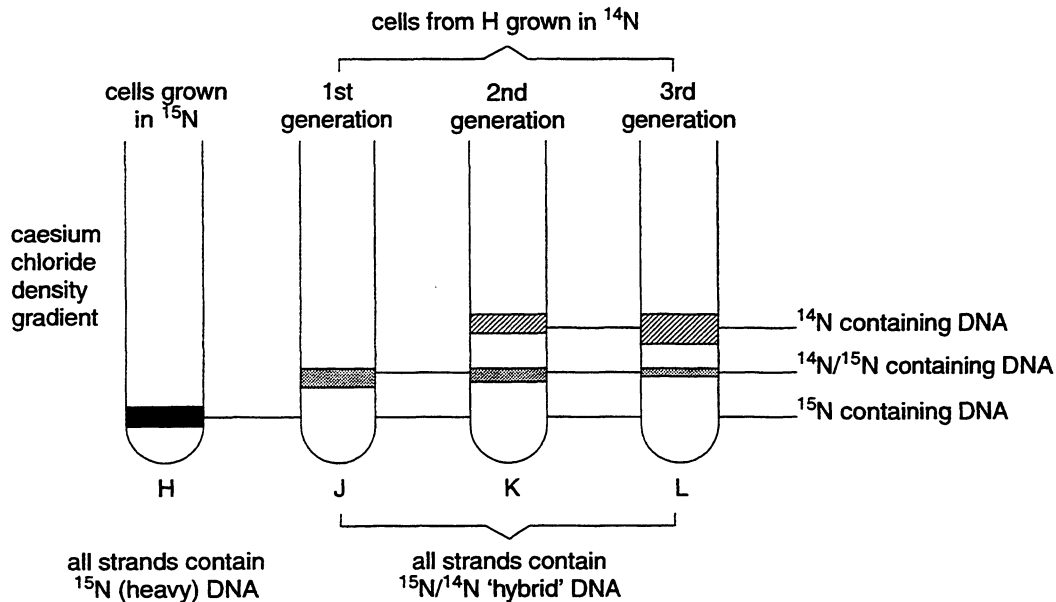


The most likely pattern of inheritance is

- A. autosomal dominant.
- B. autosomal recessive.
- C. X-linked dominant.
- D. X-linked recessive.

Question 7

The following diagram represents the results of an experiment conducted by Meselson and Stahl into the process of DNA replication. Cultures of *E. coli* were grown over several generations in a medium containing the heavy isotope ^{15}N so that all the DNA became labelled with ^{15}N . These cells containing the labelled DNA were transferred to a culture medium containing the usual isotope of nitrogen (^{14}N) and were allowed to grow. After periods of time corresponding to the generation time for *E. coli*, samples were taken and the DNA extracted and centrifuged at 40 000 times gravity for 20 hours in a solution of caesium chloride. In the solution the DNA settled out in layers, with the denser strands containing ^{15}N settling lower than the lighter hybrid strands and ^{14}N strands. The position of these bands is shown below. The widths of the DNA bands in the centrifuge tubes reflect the proportions of the various types of DNA molecules. In tube K the ratio of the width is 1:1 and in L the ratio is 3:1.

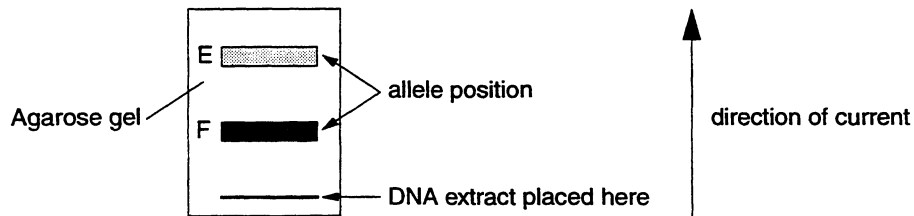


If a dotted line represents polynucleotide chains containing ^{14}N and a solid line represents those containing ^{15}N , the DNA strands you would expect to find in tube K would be

- A. B. C. D.

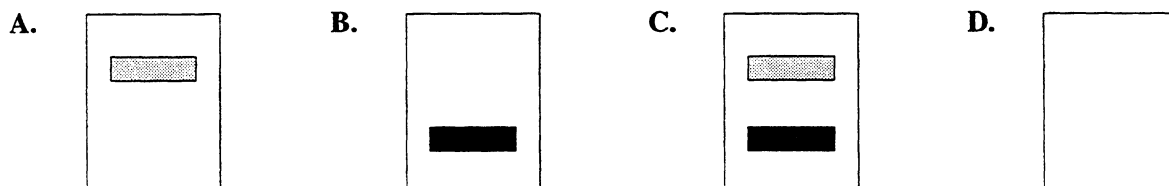
The following information relates to Questions 8 and 9.

Cystic fibrosis is an autosomal recessive disease. The allele responsible for the condition has bases deleted in the $\Delta 508$ position, compared to the normal allele. Scientists are able to test for the presence of the $\Delta 508$ allele by using the process of gel electrophoresis.



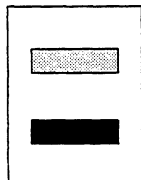
Question 8

A person suffering from cystic fibrosis would have the following profile.



Question 9

An individual's phenotype with a result



would be

- A. normal.
- B. heterozygous.
- C. affected.
- D. a carrier.

Question 10

mRNA which codes for a specific protein is made up of 126 nucleotides. The number of amino acids in this protein would be

- A. 40
- B. 42
- C. 63
- D. 126

Question 11

If one compared the mRNA to the DNA from which it was copied it would

- A. be shorter, as exons are removed.
- B. have a different protein base uracil and not thymine.
- C. be made of identical subunits.
- D. contain a different sugar.

Question 12

Mutations

- A. are always detrimental to an organism.
- B. are more likely to cause an effect if they occur in position 1 of a codon compared to position 3.
- C. are produced in response to environmental change.
- D. occur at a constant rate.

Question 13

A plasmid is

- A. a virus.
- B. a bacteriophage.
- C. a bacterial chromosome.
- D. able to duplicate independently.

Question 14

A change in genetic make-up that results in a new characteristic which may be inherited is called a

- A. multiple allele.
- B. lethal factor.
- C. mutation.
- D. chromosome.

Question 15

Homologous structures in different animals are structures which

- A. have the same structure but different function.
- B. have similar function but different structure.
- C. have a common ancestry but may now have different functions.
- D. are essentially the same in all vertebrates.

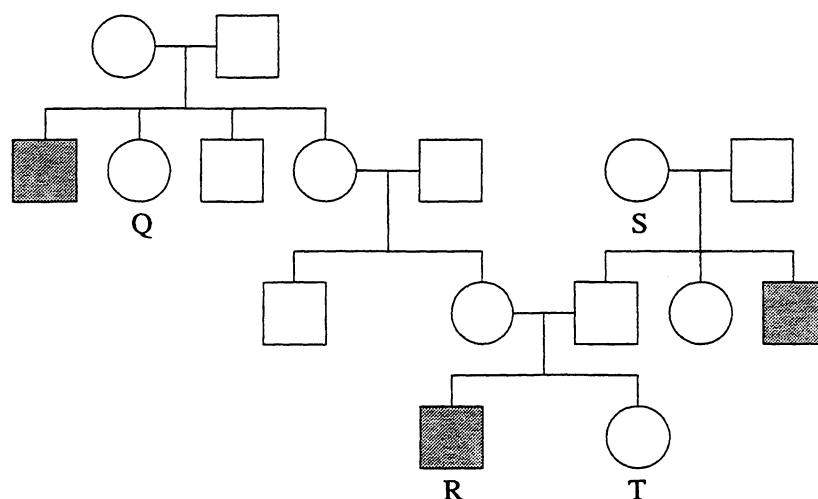
Question 16

Consider two genes in an organism. The genes are located on different chromosomes and each has two allelic forms. These may be represented by A and a, and R and r, respectively. You would expect to find offspring of only one phenotype in which of the following crosses?

- A. Homozygous recessive at both gene loci $\times$ heterozygous at one locus and homozygous at the other.
- B. Homozygous dominant at both gene loci $\times$ heterozygous at both gene loci.
- C. Heterozygous at both gene loci $\times$ heterozygous at both gene loci.
- D. Heterozygous at both gene loci $\times$ homozygous recessive at both gene loci.

Question 17

The human pedigree below shows the occurrence of an X-linked recessive condition in a family. Affected individuals are shaded.

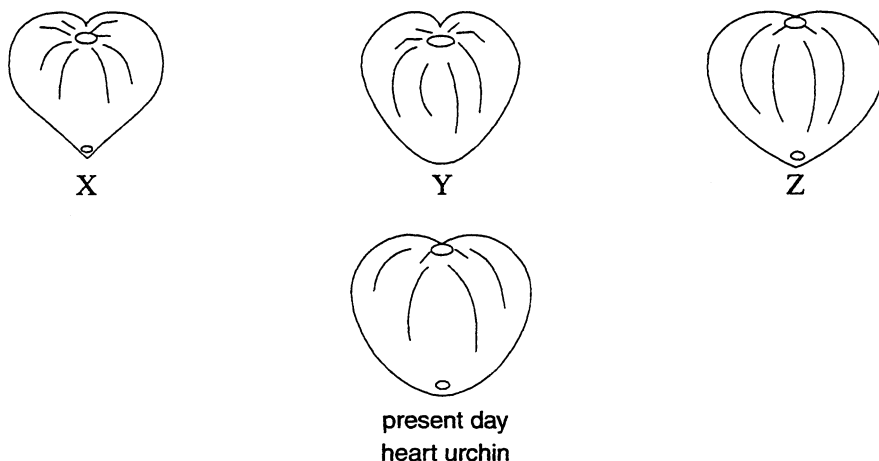


It is reasonable to conclude that

- A. individual R inherited the defective allele from his father.
- B. individual S is heterozygous for the condition.
- C. the first child to individual T has a one in four chance of having the condition.
- D. individual Q has no chance of being heterozygous for the condition.

Question 18

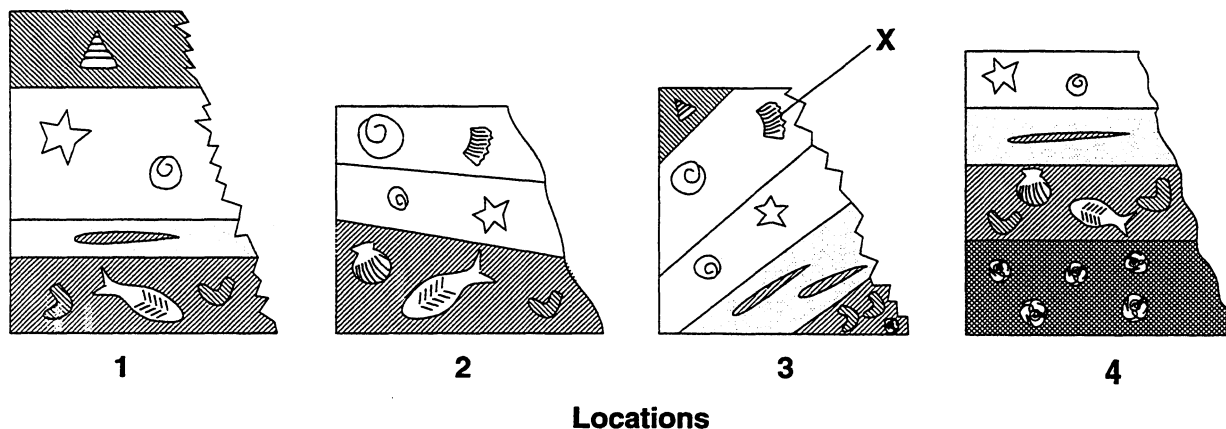
Fossils X, Y and Z were found in different strata of sedimentary rock and represent part of an evolutionary sequence. The present day heart urchin is also illustrated.



Which of the following is the most likely?

- A. Fossil Y and the present day urchin would be found in the same stratum.
- B. Fossil Z and the present day urchin could be bred together to produce vigorous fertile offspring.
- C. Urchin X is now extinct.
- D. Fossil X would be found in more recent rock than Y and Z.

The following diagram relates to Questions 19 and 20.



Question 19

The location in which the oldest fossils would be found is

- A. 1
- B. 2
- C. 3
- D. 4

Question 20

It is reasonable to conclude that

- A. the organism represented by fossil X never lived at location 1.
- B. erosion has not occurred at any location.
- C. the organisms which fossilised came from an arid environment.
- D. the organism represented by fossil X lived at location 1 but did not fossilise there.

Question 21

The source of new genetic variation in an individual is

- A. crossing over in meiosis.
- B. sexual reproduction.
- C. different environments.
- D. mutation.

Question 22

Parallel evolution

- A. is when related species develop similar characteristics in response to environmental pressure.
- B. explains the appearance of anteaters e.g. echidna, armadillo and armadillo.
- C. explains how two species eventually become one.
- D. is when unrelated species share the same characteristic.

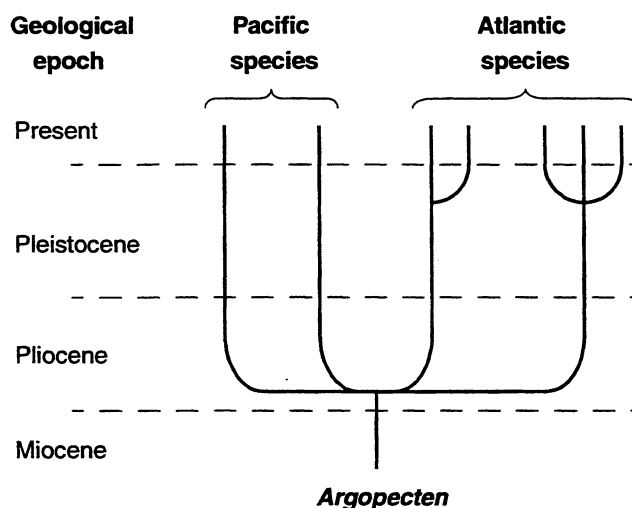
Question 23

Man can be distinguished from other primates by the possession of

- A. cerebral hemispheres.
- B. nails instead of claws.
- C. fully bipedal stance and gait.
- D. four-chambered heart.

Question 24

During the Miocene period, a genus of scallop, *Argopecten*, lived in a variety of environments in the waters between North and South America. Later a strip of land, now known as the Isthmus of Panama, emerged separating the Atlantic and Pacific Oceans and dividing the population of *Argopecten*. On the Atlantic side of the isthmus the continental shelf is wide with many islands, lagoons and bays. On the Pacific side the continental shelf is narrow. The figure below shows when new species of the genus *Argopecten* began to appear in the fossil record and the possible relationship between these new species.



It is reasonable to suggest that

- A. environmental changes have caused variation to occur amongst *Argopectin* during the Pleistocene epoch.
- B. convergent evolution has occurred.
- C. the evolution of new species of *Argopecten* supports the idea that the isthmus emerged sometime during the Pliocene.
- D. the Atlantic species could interbreed and produce fertile offspring under natural conditions.

SECTION 2**Specific instructions for Section 2**

Section 2 consists of 8 questions. You should attempt all questions. The marks allotted to each question are shown at the end of the question. You should spend approximately 60 minutes answering this section of the paper.

Question 1

The sequence of amino acids in a protein molecule is controlled by the codons in an mRNA molecule.

- a. What is a codon?

1 mark

- b. The following table shows the genetic code for mRNA.

First Base	Second Base				Third Base
	U	C	A	G	
U	UUU } phenylalanine	UCU } serine	UAU } tyrosine	UGU } cysteine	U
	UUC } leucine	UCC } serine	UAC } tyrosine	UGC } cysteine	C
	UUA } leucine	UCA } serine	UAA } STOP	UGA } STOP	A
	UUG } leucine	UCG } serine	UAG } STOP	UGG } tryptophan	G
C	CUU } leucine	CCU } proline	CAU } histidine	CGU } arginine	U
	CUC } leucine	CCC } proline	CAC } histidine	CGC } arginine	C
	CUA } leucine	CCA } proline	CAA } glutamine	CGA } arginine	A
	CUG } leucine	CCG } proline	CAG } glutamine	CGG } arginine	G
A	AUU } isoleucine	ACU } threonine	AAU } asparagine	AGU } serine	U
	AUC } isoleucine	ACC } threonine	AAC } asparagine	AGC } serine	C
	AUA } isoleucine	ACA } threonine	AAA } lysine	AGA } arginine	A
	AUG } methionine	ACG } threonine	AAG } lysine	AGG } arginine	G
G	GUU } valine	GCU } alanine	GAU } aspartic acid	GGU } glycine	U
	GUC } valine	GCC } alanine	GAC } aspartic acid	GGC } glycine	C
	GUA } valine	GCA } alanine	GAA } glutamic acid	GGA } glycine	A
	GUG } valine	GCG } alanine	GAG } glutamic acid	GGG } glycine	G

The codons UAA, UAG and UGA are 'stop' signals and when one of these is reached no amino acid is added and the protein chain stops at this point.

What is the process by which the protein chain is produced?

1 mark

Consider part of a DNA molecule which controls the production of a chain of amino acids.

- c. What is the base sequence of the mRNA which would result from the piece of DNA shown below?
Enter your answer in the table below.

Base Number	1	2	3	4	5	6	7	8	9	10	11	12	13
DNA	C	A	G	T	A	T	T	C	C	A	T	G	A
mRNA													

1 mark

- d. Using the genetic code shown above and your answer to part c., show the amino acid sequence which results from the DNA segment.

1 mark

- e. If the base at position 1 is deleted, what is the new amino acid sequence of the polypeptide?

1 mark

- f. What would be a possible effect of this change on the function of the polypeptide?

1 mark

Genetic engineers are able to cut segments of DNA from one species and insert these segments into the genome of another species, using so-called 'genetic scissors'.

- g. What is another name for 'genetic scissors'?

1 mark

The cut segments are incorporated into the recipient DNA.

- h. What feature of DNA makes this possible?

1 mark

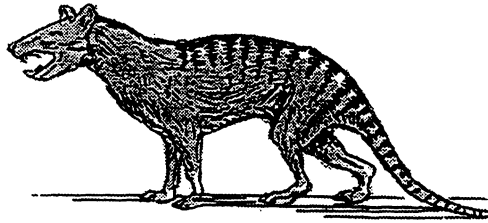
- i. Give one similarity between genetic engineering and artificial selection.

1 mark

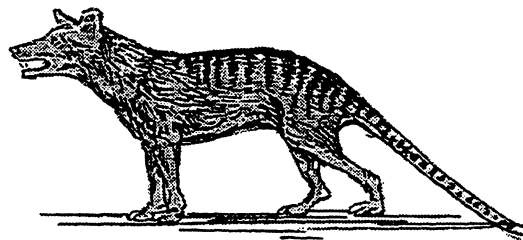
Total 9 marks

Question 2

Biologists who have compared the feet of the Thylacine (Tasmanian tiger) to *Borhyaena* (a long extinct South American marsupial) suspect that the Thylacine evolved from this 45 million year old line of marsupial carnivores.

Borhyaena

Thylacine



However, recombinant DNA technology has thrown a new light on this relationship. It has been established that DNA can be used as a measure of genetic distance between species that come from a common ancestor. The technique used to determine the Thylacine's classification was DNA hybridisation.

The technique of DNA hybridisation uses heat to separate the two strands in the DNA molecules of the two species being compared. The DNA of each species will now be single-stranded. The single strands from each of these two species are then mixed together. The single strands of the different species will join together or hybridise if their bases are complementary. The amount of hybridisation can be measured. The more closely related the two species are, the greater the hybridisation of the DNA.

- a. i. In DNA hybridisation, what is meant by saying 'the strands will join together if their bases are complementary'?

1 mark

- ii. What inference can be made about the relationship between the Thylacine and *Borhyaena* if hybridisation occurs?

1 mark

- b. Scientists have suggested that it could be possible to clone a Thylacine from preserved specimens.
- i. What assumption must be made about the DNA from these specimen if cloning were to be successful?

1 mark

- ii. What cellular proces would make a copy?

1 mark

The DNA for these two animals was extracted from fossils and hybridised. It was shown that the Thylacine was in fact more closely related to the small Australian carnivorous marsupials, despite its greater anatomical similarity to *Borhyaena*.

- c. If a hybridisation test was to be performed on single strands of DNA from a small Australian carnivorous marsupial, would you expect the DNA to match exactly? Explain your answer.

1 mark

- d. Why do you think the Thylacine and *Borhyaena* were incorrectly thought to be so closely related?

1 mark

- e. If the Thylacine and *Borhyaena* could be brought into the same area, would they be able to interbreed?

1 mark

Total 7 marks

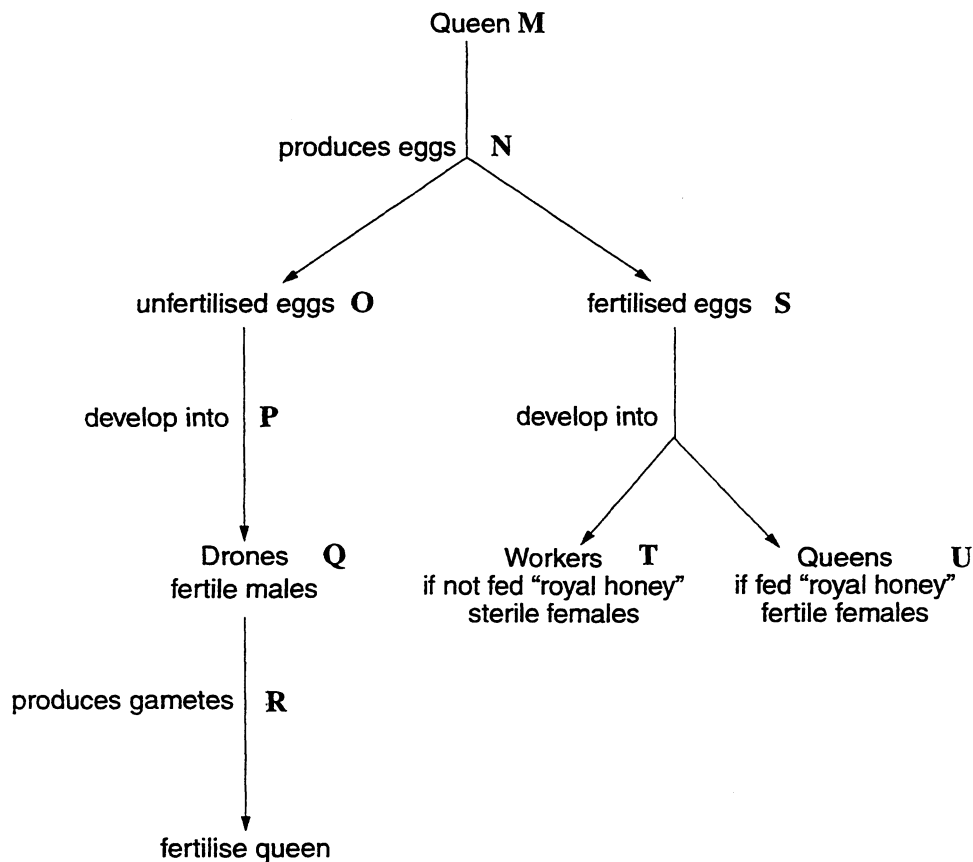
Question 3

State an advantage of asexual reproduction to a species. Explain and give an example.

Total 2 marks

Question 4

The diagram below shows stages in the reproductive cycle of bees.



- a. Name the processes labelled N, P and R in the diagram.

- i. N _____
 ii. P _____
 iii. R _____

1½ marks

- b. For each of the stages listed in the table below, indicate whether the bee is haploid or diploid. Indicate your answer by placing a tick in the appropriate column. Stage M is done for you.

Stage	Haploid	Diploid
M		✓
O		
Q		
S		
T		
U		

2½ marks

Total 4 marks

Question 5

Many characteristics of the tomato plant, *Lycopersicon esculentum*, have been studied by geneticists. Characteristics due to single genes are easily observed and the plants grow readily. Plant height and leaf shape are two easily observable characteristics.

Tall cut-leaved tomato plants were crossed with dwarf potato-leaved plants, resulting in the F_1 generation being all tall cut-leaved plants. These were then allowed to cross with each other.

- a. i. Using the allele symbols given below, show the genotype and phenotype of the parental plants.

Height gene: T = tall

t = dwarf

Leaf shape gene: L = cut-leaved

l = potato-leaved

1 mark

- ii. What is an allele?

1 mark

- b. What is the genotype and phenotype of the F_1 plants?

1 mark

- c. Assuming that the two genes are not linked, what phenotypes and in what ratio would you expect offspring to be if the F_1 plants were crossed. Show your working.

2 marks

Total 5 marks

Question 6

Genes found on the same chromosome are said to be linked. Four genes A, B, C and D have been identified as occurring on Chromosome 11 in humans. The table below shows the recombination frequency observed between these genes.

A - C	20
B - C	5
B - A	15
A - D	2
B - D	13

- a. Does Mendel's 2nd law 'the principle of segregation' hold true in the above situation? Explain your answer.

2 marks

- b. Draw a gene map in the space below showing the position of genes A to D on a chromosome and their distance apart.

2 marks

- c. i. What event leads to recombination?

1 mark

- ii. When does it occur?

1 mark

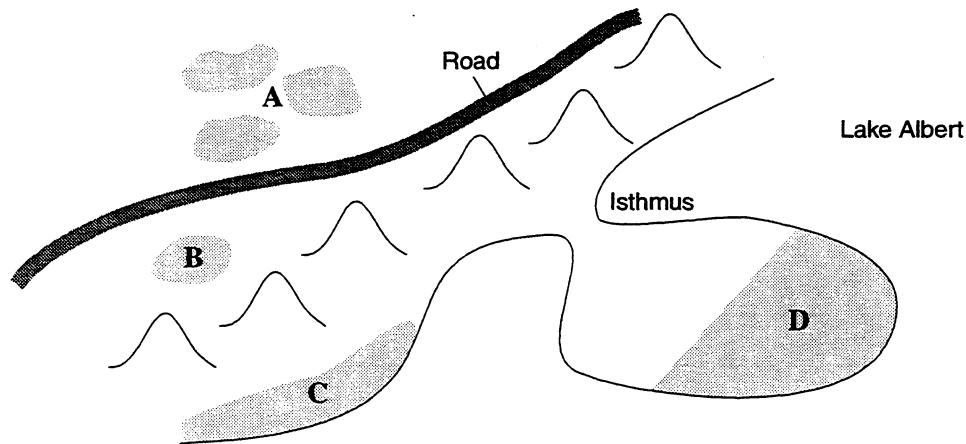
- iii. What advantage to a species is recombination? Explain your answer.

2 marks

Total 8 marks

Question 7

The map below shows the distribution of different populations of frogs A to D. All species are geographically isolated and there is variation present between the groups.



- a. What is a possible consequence of being geographically isolated?

1 mark

Biologists studying the different populations found that populations A and B when brought together successfully produced offspring, yet when population C was introduced no breeding occurred. Physically there were no differences between these populations.

- b. Suggest an explanation for no breeding occurring with C.

1 mark

When populations C and D were compared, frogs in population C were found to be similar in size and shape to those in population D. However, frogs in population C had dark lines down their backs. The biologists hypothesised that the stripes were an adaptation.

- c. Define the term adaptation.

2 marks

It is thought that all the frogs originated from a common ancestor.

- d. i. What is the biological term given to the development of populations that can not interbreed?

1 mark

- ii. What process brought this about?

1 mark

Total 6 marks

Question 8

In the Gulf of Carpentaria on Australia's northern coast, Bentinck Island and Mornington Island are situated about 30 km apart and 25 km from the mainland. Each is occupied by a tribe of Aborigines. The material culture of the two groups is identical, although there are some variations in their languages and traditions. Listed below in percentage terms are the frequencies of the blood groups in the ABO system in each gene pool recorded in 1960.

Aboriginal population	Number tested	Blood group – Frequencies		
		A	B	O
Bentinck Island	42	0	43	57
Mornington Island	67	15	0	85
Australian mainland	536	10-50	0	50-90

- a. Define the term gene pool.

1 mark

- b. From the above information, what evidence is there that gene flow has not occurred between the two Aboriginal populations? Explain your answer.

2 marks

- c. What is the likely foundation population for

- i. Bentinck Island?

- ii. Mornington Island?

2 marks

- d. Assuming that no interbreeding occurred between Bentinck Islanders and any other population, account for the existence of a child with blood type A, born to Bentinck Island parents. Explain your answer.

2 marks

- e. As the populations on Mornington and Bentinck Island can now readily interbreed, a biologist suggested that in a very short time (20 years) the proportion of blood groups on each island would be similar. Explain whether you agree or disagree.

2 marks

- f. In the Aboriginal tribes there is variation in their languages and traditions. What biological term, unique to humans, describes a population's way of life?

1 mark

Total 10 marks

END OF QUESTION AND ANSWER BOOKLET

Trial Examination 2000

VCE Biology Unit 4

Written Examination

Section 1 answer sheet

Student's Name: _____

Teacher's Name: _____

Instructions

Use a **pencil** for **all** entries. If you make a mistake, **erase** the incorrect answer – **do not** cross it out. Marks will **not** be deducted for incorrect answers.

No mark will be given if more than **one** answer is completed for any question.

All answers must be completed like **this** example:

A	☒	C	D
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Use pencil only

ONE ANSWER PER LINE

1	A	B	C	D
2	A	B	C	D
3	A	B	C	D
4	A	B	C	D
5	A	B	C	D
6	A	B	C	D
7	A	B	C	D
8	A	B	C	D
9	A	B	C	D
10	A	B	C	D
11	A	B	C	D
12	A	B	C	D

ONE ANSWER PER LINE

13	A	B	C	D
14	A	B	C	D
15	A	B	C	D
16	A	B	C	D
17	A	B	C	D
18	A	B	C	D
19	A	B	C	D
20	A	B	C	D
21	A	B	C	D
22	A	B	C	D
23	A	B	C	D
24	A	B	C	D