

Trial Examination 2001

# VCE Biology Unit 4

## Written Examination 2

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 | Marks |
|-------------------|---------------------|------------------------------------|-------|
| A Multiple-choice | 25                  | 25                                 | 25    |
| B Short answer    | 5                   | 5                                  | 50    |

### Directions to students

#### Materials

Question and answer booklet of 16 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 A and Section B.

Answer **all** questions from Section A. Section A is worth 25 marks.

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

Answer **all** questions from Section B. Section B is worth 50 marks.

Section B questions should be answered in the spaces provided in this question and answer 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 question and answer booklet.

Students are advised that this is a trial examination only and cannot in any way guarantee the content or the format of the 2001 VCE Biology end-of-year examination.

## SECTION A

### Specific Instructions for Section A

Section A consists of 25 multiple-choice 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 square 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.

### Question 1



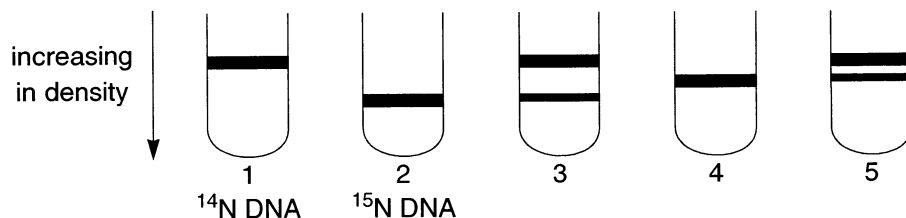
The diagram above represents a chromosome in

- A. a non-dividing cell.
- B. a mitotic cell at metaphase.
- C. a cell at anaphase I of meiosis.
- D. a cell at anaphase of mitosis.

*Questions 2 and 3 refer to the following information.*

Nitrogen atoms exist in two isotopic forms, heavy  $^{15}\text{N}$  and light  $^{14}\text{N}$ . A scientist took a number of bacterial cells in which the DNA consisted of the heavy form of nitrogen alone ( $^{15}\text{N}$ -DNA).

The cells were then placed in a culture medium containing only  $^{14}\text{N}$ . Samples of cells were removed from the culture medium after various times of incubation. The DNA molecules were extracted from the cells and analysed for the presence of  $^{14}\text{N}$  and  $^{15}\text{N}$ . Pure samples of  $^{14}\text{N}$  and  $^{15}\text{N}$  each produce a single band as shown in tubes 1 and 2 respectively.



### Question 2

DNA sampled from cells after one cell cycle would produce

- A. two bands as shown in tube 3.
- B. two bands as shown in tube 5.
- C. one band as shown in tube 4.
- D. one band as shown in tube 2.

**Question 3**

DNA from cells sampled after a large number of cell cycles would produce

- A. one band as shown in tube 2.
- B. two bands as shown in tube 3.
- C. two bands as shown in tube 5.
- D. one band as shown in tube 4.

**Question 4**

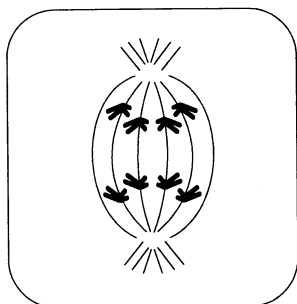
Crossing over and recombination in meiosis occur during

- A. second prophase.
- B. first prophase.
- C. second metaphase.
- D. first telophase.

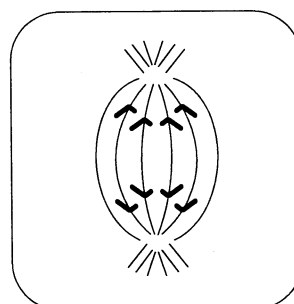
**Question 5**

Which of the following diagrams best represents a cell during anaphase I of meiosis?

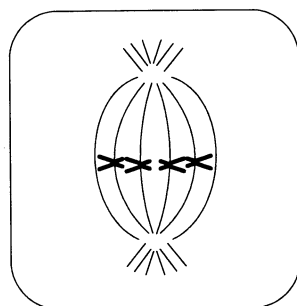
A.



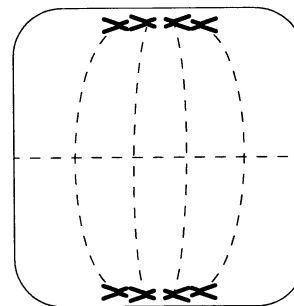
B.



C.



D.



Questions 6 and 7 refer to the following information.

There is a group of chickens called frizzle fowl. Their feathers are so brittle and curly that they wear off, leaving the birds naked at times. When frizzles are mated to normal birds, neither parental type is represented in the  $F_1$  generation. Instead one finds a third kind of fowl called mild frizzle. The  $F_2$  generation exhibits the following ratio:

|              |    |
|--------------|----|
| Frizzle fowl | 23 |
| Mild frizzle | 50 |
| Normal       | 20 |
| Total        | 93 |

**Question 6**

The frizzle gene exhibits

- A. the monohybrid ratio.
- B. recombination.
- C. independent assortment.
- D. incomplete dominance.

**Question 7**

When the mild frizzle fowls produced above are mated, one would expect the following offspring

- A. Frizzle fowl: normal 3 : 1
- B. Frizzle fowl: mild frizzle 3 : 1
- C. Frizzle fowl: normal: mild frizzle 1 : 2 : 1
- D. Frizzle fowl: mild frizzle: normal 1 : 2 : 1

**Question 8**

In *Drosophila*, the normal eye colour is red and the gene is found on the X chromosome. In 1910, T.H. Morgan discovered a mutation which causes white eyes. This mutant allele is recessive to the normal red eye colour. When red-eyed homozygous females are crossed to white-eyed males, then in the offspring

- A. all the sons have white eyes and all the daughters have red eyes.
- B. 50% of the daughters have red eyes and 50% have white eyes.
- C. all daughters have white eyes and all sons have red eyes.
- D. all the sons and daughters have red eyes.

*Questions 9 and 10 refer to the following information.*

In rabbits, spotted coat (D) is dominant to solid colour (d).

### Question 9

A cross that would show whether a spotted individual is heterozygous for coat colour would be

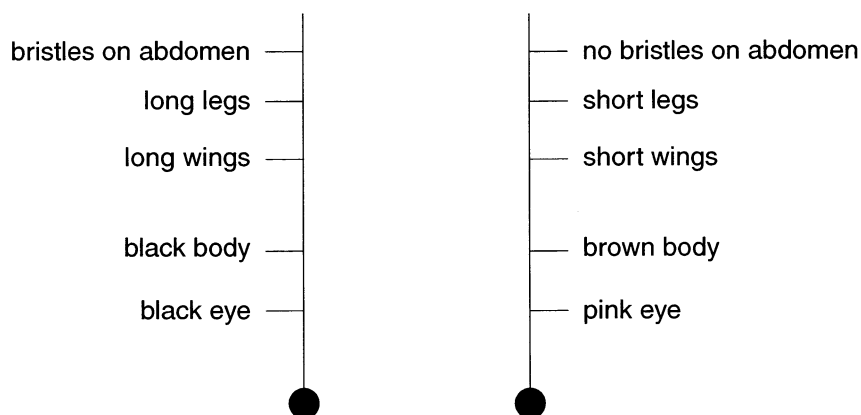
- A  $DD \times DD$
- B  $Dd \times dd$
- C  $dd \times dd$
- D  $DD \times Dd$

### Question 10

When two rabbits with spotted coats were mated, they produced some offspring with spotted coats and some with solid colour. It is reasonable to conclude that

- A. all the offspring with spotted coats have the same genotype.
- B. neither of the parents are heterozygous.
- C. no offspring could be homozygous for spotted coat.
- D. all the offspring with solid colour are homozygous.

*Questions 11 and 12 refer to the following information.*



The above chromosomes show five gene loci in relation to the centromere.

### Question 11

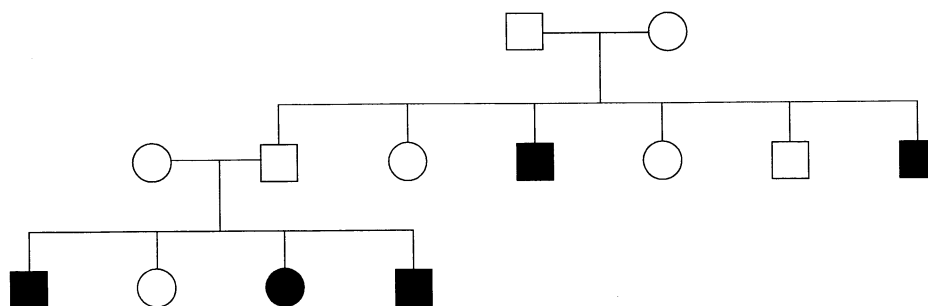
Which of the following pairs of alleles would not show linkage?

- A. black body and long wings.
- B. long legs and bristles on abdomen.
- C. black body and short wings.
- D. short wings and pink eye colour.

### Question 12

Crossing over would occur most frequently between the gene loci for

- A. body colour and leg length.
- B. eye colour and bristles on the abdomen.
- C. body colour and wing length.
- D. wing length and eye colour.

**Question 13**

The best explanation for the inheritance pattern displayed is

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

**Question 14**

In order for a human male child to be conceived under natural conditions, which of the following combinations of chromosomes must be present in the paternal gamete?

- A. 22 non-homologous autosomes and one X chromosome.
- B. 22 non-homologous autosomes and one Y chromosome.
- C. 22 autosomes, an X and a Y chromosome.
- D. 44 autosomes and 2 sex chromosomes.

**Question 15**

A wine maker selected two of his finest grape varieties and cross bred them to form a new variety of grapes for a particular type of wine he wished to produce. This is an example of

- A. artificial selection.
- B. natural selection.
- C. genetic fitness.
- D. recombination.

**Question 16**

Selection acts on

- A. mainly the genotype, but also the phenotype.
- B. the genotype only.
- C. the phenotype and genotype only.
- D. the phenotype only.

**Question 17**

From a distance a whale and shark look much the same. This is a result of

- A. their close phylogenetic origin.
- B. convergent evolution.
- C. adaptive radiation.
- D. sharing the same ecological niche.

**Question 18**

Evolution occurred in the Peppered moth (*Biston betularia*) population in England during the industrial revolution because

- A. birds ate obvious moths.
- B. soot covered the trees.
- C. a new favourable mutant moth arose.
- D. lichen, which hid moths, were killed.

**Question 19**

Many of the plants that humans depend on for food, such as potatoes and bread wheat, have more than two complete sets of chromosomes in each of their cells. The term used to describe such a species is

- A. polygenic.
- B. recombinant.
- C. polyploid.
- D. replicated.

**Question 20**

Some parts of the United States have small, fairly isolated populations. In one of these areas a benign condition which results in the skin having a bluish colour is quite common. This has been traced back to one individual who arrived in the area in the early 19th century. This is an example of

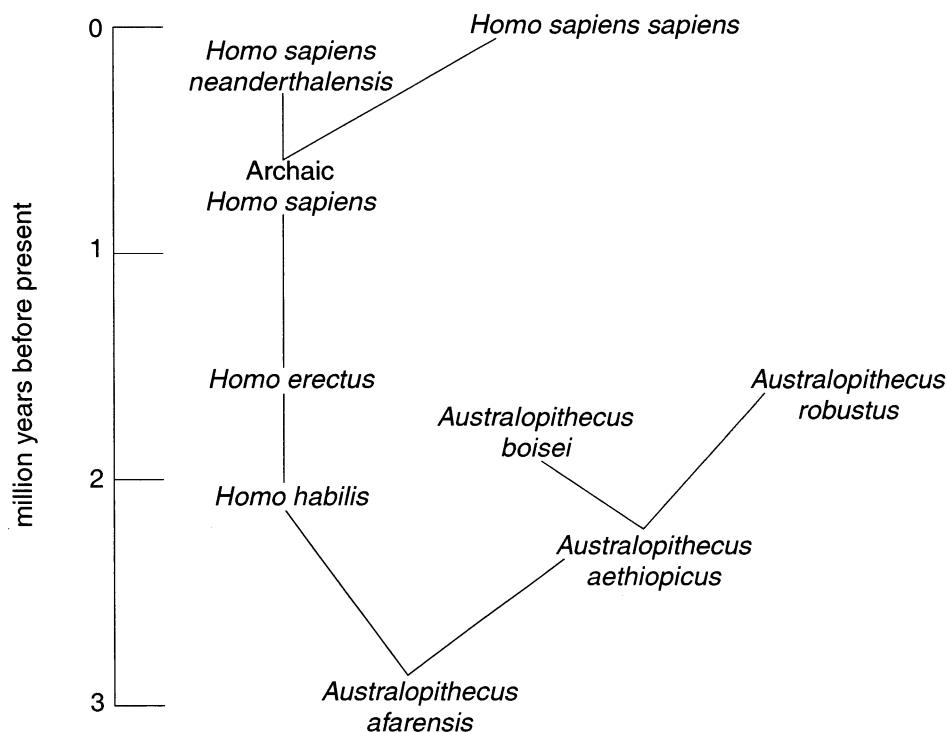
- A. genetic drift.
- B. gene flow.
- C. gene pool.
- D. genetic distance.

**Question 21**

Which of the following are not features of primates?

- A. Relatively large brain and stereoscopic vision.
- B. Opposable thumb and touch sensitive fingers.
- C. Stereoscopic vision and most with upright stance.
- D. Mainly tree-living and have an opposable thumb.

## Question 22



From the information presented, about 1.6 million years ago there may have been at least three hominid species existing in Africa. These would have been

- A. *A. aethiopicus*, *H. habilis*, *H. neanderthalensis*.
- B. Archaic *H. sapiens*, *H. erectus*, *H. habilis*.
- C. *H. erectus*, *A. robustus*, *A. boisei*.
- D. *A. aethiopicus*, *A. boisei*, *H. habilis*.

## Question 23

DNA hybridisation techniques may be used to estimate the genetic distance (time since divergence from a common ancestor) between two or more species. Which of the following statements is correct?

- A. The higher the degree of bonding between hybridised strands, the closer the relationship between the species.
- B. The lower the  $T_m$  (melting temperature) of the hybridised strand, the closer the relationship.
- C. The higher the degree of complementarity, the greater the genetic distance.
- D. The lower the degree of base pairing, the smaller the divergence from ancestral forms.

## Question 24

Two species of the *Ammospermophilus* squirrel are geographically isolated from each other by the Grand Canyon. The white-tailed antelope squirrel (*A. leucurus*) lives in the desert north of the Canyon and Harris's antelope squirrel (*A. harrisi*) inhabits the area south of the canyon. Speciation is most likely to have occurred within the *Ammospermophilus* squirrels because

- A. the *A. leucurus* species gave rise to the *A. harrisi* species through adaptive radiation.
- B. a mutation arose which prevented interbreeding, forcing the affected individual to colonise a new niche.
- C. the environmental pressures specific to each end of the canyon favoured different variations in phenotype.
- D. the inheritance of acquired characteristics has caused divergent evolution.



**Question 25**

The comparison of anatomical structures in different species, such as the comparison of the bones that make up a bat's wing with the bones that make up a whale's fin, help to establish evolutionary relationships. This is an example of

- A. comparative biochemistry.
- B. comparison of analogous structures.
- C. comparison of homologous structures.
- D. comparative embryology.

**END OF SECTION A  
TURN OVER**

**SECTION B****Specific Instructions for Section B**

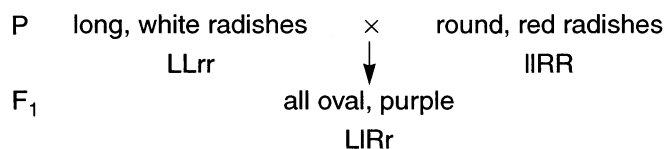
Section B consists of 5 short answer questions numbered 1 to 5; you must answer all of these questions. This section is worth 50 marks. You should spend approximately 60 minutes answering this section of the paper.

The marks allotted to each question are shown at the end of each question.

Questions must be answered in the spaces provided in this booklet.

**Question 1**

Radishes may be long, round or oval and they may be red, white or purple. The following cross was performed



- a. What type of dominance is displayed by the oval and purple phenotypes?

1 mark

- b. If pure breeding round, red individuals are crossed with the F<sub>1</sub> oval, purple individuals, predict the phenotypes and their ratios.

3 marks

- c. Two F<sub>1</sub> individuals were then crossed. Identify the phenotypes and their frequencies in the F<sub>2</sub> generation.

2 marks

Total 6 marks

**Question 2**

Mitochondrial DNA (mtDNA) is a single circular chromosome. Several human diseases are known to be caused by mutations in mtDNA. This results in defects in mitochondrial ATP production. To identify the defect, the mtDNA of both normal and diseased individuals is cut with a chemical in one place.

- a. What is the name given to these chemicals?

1 mark

- b. When identifying the mtDNA changes, the polymerase chain reaction, PCR, is used on the sample of mtDNA. What is the purpose of PCR?

1 mark

- c. The process of synthesis of electron transport proteins involves copying DNA to RNA. What is this process called?

1 mark

- d. The anticodons for the three consecutive amino acids are

UUA UCG CAU

- i. Write the codons for these amino acids.

- ii. Write the DNA sequence on the mtDNA corresponding to these codons.

1 + 1 = 2 marks

- e. If the first two bases are removed from the mtDNA sequence, what effect may this have on the protein produced?

2 marks

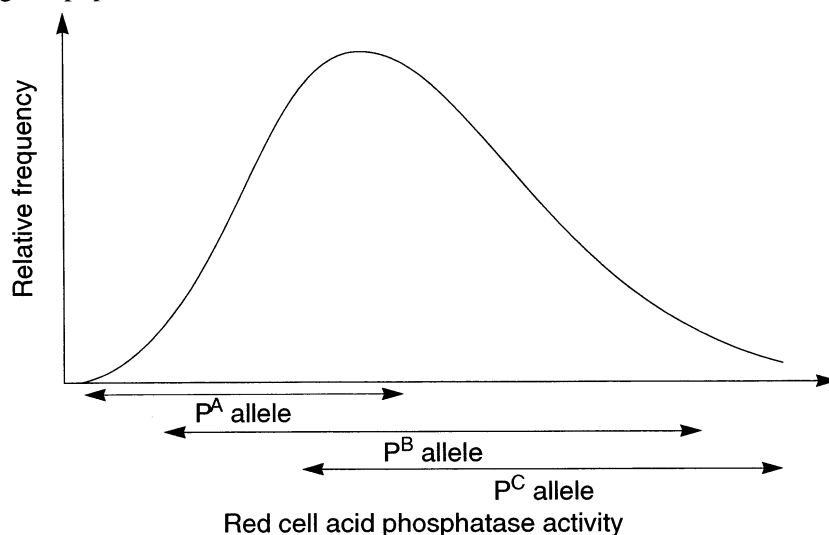
- f. Now that human mtDNA has been sequenced, the study of mtDNA of other genetically less well studied organisms is relatively simple using a human gene as a probe to find the corresponding gene on mtDNA of the other organism. Briefly explain how this process would work.

4 marks

Total 11 marks

**Question 3**

Acid phosphatase is an enzyme found in human red blood cells which removes or transfers phosphate groups. It is encoded by the acid phosphatase gene. Below is a graph of the distribution of red cell phosphatase activities in an English population.



- a. What type of variation is illustrated by this distribution?

1 mark

- b. Acid phosphatase is produced at one locus and a number of phenotypes are observed. What would give rise to these different phenotypes?

1 mark

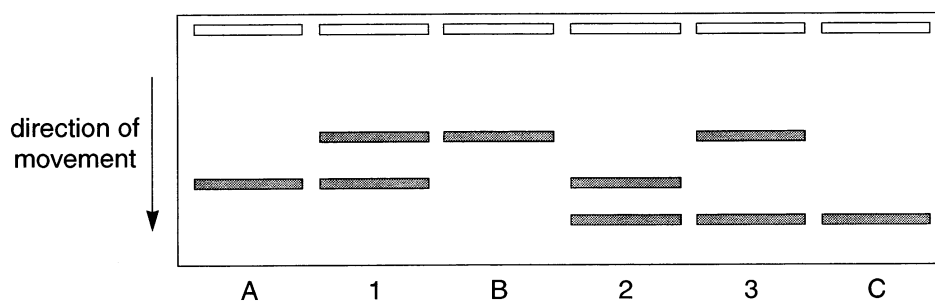
- c. If this gene has three alleles,  $P^A$ ,  $P^B$ ,  $P^C$ , list all possible genotypes.

1 mark

- d. These variants of acid phosphatase genes are electrophoretically distinct from each other. What is the cause of this distinction?

1 mark

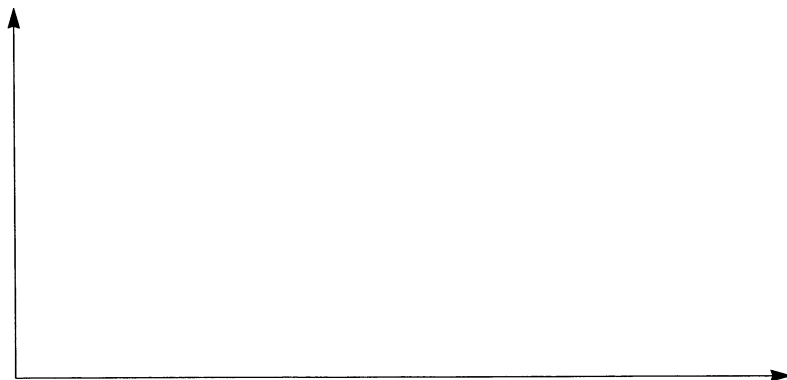
- e. Below is a gel of these different genes.



Identify the alleles present at point 2.

1 mark

- f. At a future date, there was a new environmental pressure which selected against the  $P^B$  allele. Using the axes below, indicate how you would expect the distribution of acid phosphatase activity to appear after a large number of generations.



2 marks

- g. How would you determine whether this environmental pressure has resulted in two distinct species?

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2 marks

Total 9 marks

**Question 4**

The inherited ability of a mosquito to resist insecticide is found to be controlled by a single gene which has two alleles:  $R_1$  for resistance and  $R_2$  for susceptibility. Two strains of mosquito have been monitored for resistance to a standard dose of insecticide. Strain A is highly susceptible, strain B is highly resistant. The following table gives mortality after various periods of exposure to the insecticide (all the data is in arbitrary units).

| Exposure period<br>% Mortality |                | 1   | 2    | 3    | 4    | 5    | 6    | 7    | 8    | 9    | 10   |
|--------------------------------|----------------|-----|------|------|------|------|------|------|------|------|------|
| Strain A                       |                | 6.8 | 71   | 94.1 | –    | –    | –    | –    | –    | –    | –    |
| Strain B                       |                | 0   | 0    | 0    | 0    | 0    | 0    | 2.1  | 9.5  | 70.2 | 92.5 |
| A × B                          | F <sub>1</sub> | 0   | 0    | 0    | 1.6  | 6.6  | 80.1 | 93.6 | –    | –    | –    |
|                                | F <sub>2</sub> | 6.6 | 20.3 | 20.4 | 20.5 | 20.7 | 71.0 | 77.0 | 78.0 | 80.2 | 92.6 |

- a. How do insecticide resistant genes arise?

\_\_\_\_\_

1 mark

- b. What is the dominance relationship of these alleles? Explain.

\_\_\_\_\_

\_\_\_\_\_

2 marks

- c. Account for the figures for the F<sub>2</sub> generation susceptibility.

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

3 marks

- d. What phenotypes and in what proportions would be expected from a cross between the F<sub>1</sub> and strain A?

\_\_\_\_\_

\_\_\_\_\_

2 marks

- e. If insecticide is found in the environment, over time what do you expect to happen?

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

4 marks

Total 12 marks

**Question 5**

Antarctic polar dinosaur fossils have been found in the south coast of Victoria. These date to the early Cretaceous period (105–120 million years ago), when Victoria was well within the Antarctic Circle. The average temperature was between 0°C and 10°C and it was dark for three months of the year.

- a. How is geological time measured absolutely and how do we establish this time?

1 mark

- b. What conditions were necessary for the preservation of these fossils?

2 marks

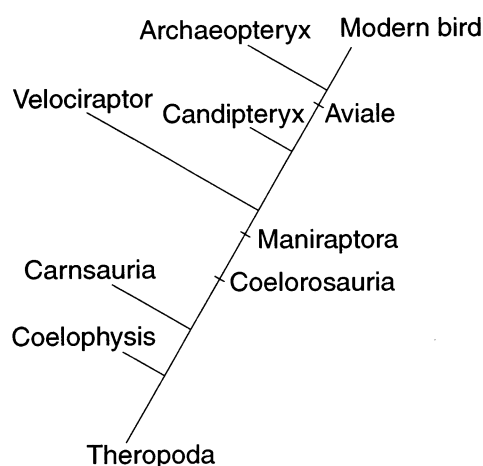
- c. Account for the observation that the Victorian *hypsilophodontid* species had very large eyes compared with those of other parts of the world.

2 marks

- d. When bone stops growing because the metabolic rate is lowered due to lack of food or water, other environmental stress, or a period of hibernation, there are bands which indicate when this happened. The *hypsilophodontid* species in Victoria do not show any banding. What does this imply?

1 mark

The following figure shows the evolutionary relationship between a group of dinosaurs.



- e. Which group is most closely related to the modern birds?

1 mark

- f. Which of the *Velociraptor* and the *Maniraptora* is most likely to be an ancestor of *Archaeopteryx*? Explain your answer.

1 mark

- g.** Approximately 65 million years ago the Cretaceous extinction occurred. This resulted in the death of most of the dinosaurs. In general terms, describe the effect this mass extinction had on the evolution of surviving species and new species.

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4 marks

Total 12 marks

**END OF QUESTION AND ANSWER BOOKLET**





Trial Examination 2001

# VCE Biology Unit 4

Suggested Solutions

**SECTION A**

- |       |       |       |       |       |
|-------|-------|-------|-------|-------|
| 1. D  | 2. C  | 3. C  | 4. B  | 5. A  |
| 6. D  | 7. D  | 8. D  | 9. B  | 10. D |
| 11. C | 12. B | 13. A | 14. B | 15. A |
| 16. D | 17. B | 18. A | 19. C | 20. A |
| 21. C | 22. C | 23. A | 24. C | 25. C |

**SECTION B****Question 1**

a. incomplete dominance for shape and colour. 1 mark

b. Parents:  $II RR \times LI Rr$  1 mark

$F_1$  genotype:  $LI RR, LI Rr, II RR, II Rr$  1 mark

1 : 1 : 1 : 1

$F_1$  phenotype:  $\frac{1}{4}$  oval, red;  $\frac{1}{4}$  oval, purple;  $\frac{1}{4}$  round, red;  $\frac{1}{4}$  round, purple 1 mark

c.  $LI Rr \times LI Rr$

|    | LR    | IR    | Lr    | lr    |
|----|-------|-------|-------|-------|
| LR | LLRR  | LIRR  | LLRr  | LI Rr |
| IR | LIRR  | II RR | LI Rr | II Rr |
| Lr | LLRr  | LI Rr | LLrr  | Llrr  |
| lr | LI Rr | II Rr | Llrr  | llrr  |

1 mark

| long, red | oval, red | long, purple | oval, purple | round, red | round, purple | long, white | oval, white | round, white |
|-----------|-----------|--------------|--------------|------------|---------------|-------------|-------------|--------------|
| 1         | 2         | 2            | 4            | 1          | 2             | 1           | 2           | 1            |

1 mark

**Question 2**

a. endonuclease or restriction enzyme 1 mark

b. PCR - increases (or 'amplifies') the number of copies of the particular piece of DNA 1 mark

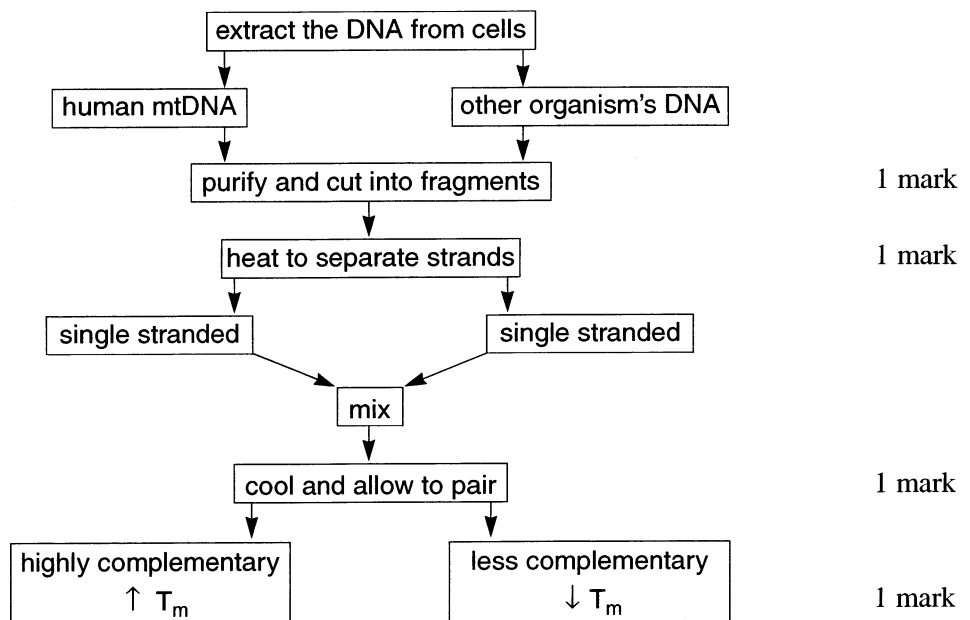
c. transcription 1 mark

d. i. AAU AGC GUA 1 mark

ii. TTA TCG CAT 1 mark

e. There would be no start codon, therefore no protein would be produced. 1 mark

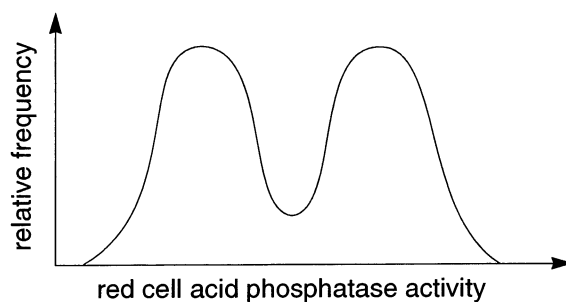
f.



Or any other reasonable answer, e.g. probe could be artificially synthesised.

### Question 3

- a. continuous variation 1 mark
- b. multiple alleles 1 mark
- c.  $P^A P^A$   $P^B P^B$   $P^C P^C$   $P^A P^B$   $P^A P^C$   $P^B P^C$  1 mark
- d. different lengths of alleles 1 mark
- e.  $P^C$  and  $P^A$  1 mark
- f.



correct shape 1 mark  
labelling of axes 1 mark

- g. If the populations could interbreed under natural conditions to produce fertile offspring they are the same species. 1 mark  
1 mark

### Question 4

- a. mutation 1 mark
- b. codominance 1 mark  
All of the  $F_1$  individuals have susceptibility which falls between the parental strains 1 mark
- c.  $F_2$  shows three classes of resistance:  
Highly susceptible (similar to strain A)  $R_2 R_2$   
Intermediate resistance (like the  $F_1$  individuals)  $R_1 R_2$   
Highly resistant (similar to strain B)  $R_1 R_1$ . Individuals die after prolonged exposure to insecticide. 3 marks

d.  $F_1 = R_1R_2$ , Strain A =  $R_2R_2$

|              |          |                  |         |
|--------------|----------|------------------|---------|
| $R_1R_2$     | $\times$ | $R_2R_2$         |         |
| 50% $R_1R_2$ | :        | 50% $R_2R_2$     |         |
| Intermediate |          | Highly resistant | 2 marks |

- e. The exposure to insecticide is a selection pressure. 1 mark  
 Those resistant will survive and reproduce more than the susceptible individuals. 1 mark  
 Over time the number of resistant individuals will increase as a percentage of the population. 1 mark  
 The susceptible allele will decrease in the population, but will probably not be eliminated. 1 mark

### Question 5

- a. radioisotopic dating 1 mark
- b. Any two of:  
 • Presence of bony or hard structures, or impression of organism  
 • Rapid burial and minimal disturbance  
 • Anaerobic conditions  
 • Cold conditions 2 marks
- c. Large eyes let in more light in the dark conditions. 1 mark  
 Therefore larger eyes increase vision and so increase chances of survival and reproduction. 1 mark
- d. Bone didn't stop growing  
 therefore they were active all year round (did not hibernate in winter). 1 mark
- e. Aviale 1 mark
- f. *Maniraptora*  
 This is in the line of descent to the modern birds, being the common ancestor of both *Velociraptor* and *Archaeopteryx*, whereas *Velociraptor* is a different branch. 1 mark
- g. Many ecological niches became available, 1 mark  
 and surviving species filled available niches. 1 mark  
 Different selective pressures existed after the extinction 1 mark  
 so different species evolved. 1 mark

# VCE Biology Unit 4

## Section A 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 | B | C | D |
|---|---|---|---|

### 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 |
| 13 | A | B | C | D |

#### ONE ANSWER PER LINE

|    |   |   |   |   |
|----|---|---|---|---|
| 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 |
| 25 | A | B | C | D |