



Student Name:

# ***STAV*** ***Publishing*** **2001**

## **BIOLOGY**

### **Unit 4 Trial Examination**

**Total writing time: 1 hour 30 minutes**

### **QUESTION AND ANSWER BOOK**

#### **Structure of book**

| <i>Section</i> | <i>Number of marks allocated</i> | <i>Style of question</i> | <i>Number of questions</i> | <i>Number of questions to be answered</i> |
|----------------|----------------------------------|--------------------------|----------------------------|-------------------------------------------|
| A              | 25                               | Multiple choice          | 25                         | 25                                        |
| B              | 50                               | Written response         | 7                          | 7                                         |

#### **Directions to students**

##### **Materials**

Question and answer book of 18 pages with a detachable Multiple Choice Answer Sheet inside the front cover. You should have at least one pencil and an eraser.

##### **The task**

Please ensure that you write your **name** in the space provided on the cover of this book and in the space provided on the Multiple Choice Answer Sheet.

Answer **all** questions.

The marks for each question give an idea of how much time you should spend and how much information you should provide. There is a total of 75 marks available for this task.

Section A questions should be answered in pencil on the Multiple Choice Answer Sheet provided.

Section B questions should be answered in ink or ball point pen in the spaces provided in this book.

All written responses should be in English.

##### **At the end of the task**

Place the Multiple Choice Answer Sheet inside the front cover of this book.

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**NOVEMBER 2001**

# STAV Publishing

2001

## BIOLOGY

### Unit 4 Trial Examination

## MULTIPLE CHOICE ANSWER SHEET

STUDENT  
NAME:

#### INSTRUCTIONS:

#### USE PENCIL ONLY

- Write your name in the space provided above.
- Use a **PENCIL** for **ALL** entries.
- If you make a mistake, **ERASE** it – **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.
- Mark your answer by placing a **CROSS** through the letter of your choice.

|     |   |   |   |   |
|-----|---|---|---|---|
| 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 |

|     |   |   |   |   |
|-----|---|---|---|---|
| 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 |

**SECTION A - Multiple choice questions****Specific instructions for Section A**

This section consists of 25 questions. You should attempt **all** questions.

Each question has four possible correct answers. Only **one** answer for each question is correct. Select the answer that you believe is correct and indicate your choice on the multiple choice answer sheet by crossing the letter that corresponds with your choice of the correct answer.

If you wish to change an answer, erase it and cross your new choice of letter.

Each question is worth **one** mark. **No** mark will be given if more than one answer is completed for any question. Marks will **not** be deducted for incorrect answers.

**Question 1**

Two parents in a cross were found to produce the following gametes:

Male parent: DK, Dk, dK, dk

Female parent: DK, DK, DK, DK

The genotypes of the male and female parents would be:

- A DdKk and DdKk
- B DDKK and DdKk
- C DDKK and DDKK
- D DdKk and DDKK

**Question 2**

Two different sets of genes would be found in which of the following cells?

- A Two skin cells, one in each of a pair of identical twins.
- B Two skin cells in the same dog.
- C Two ova in the same elephant.
- D A liver cell and a skin cell in the same giraffe.

**Question 3**

In domestic cattle, meiosis forms four cells. Each cell contains:

- A one copy of each domestic cattle gene.
- B two copies of each domestic cattle gene.
- C four copies of each domestic cattle gene.
- D eight copies of each domestic cattle gene.

**Question 4**

Sophie had a snapdragon plant that she knew was pure breeding for the red allele of flower colour. She crossed this with a plant that was homozygous for the character, white flower. She was not surprised to find that all the flowers of the F<sub>1</sub> were pink. This is because she knew that:

- A the red pigment character is dominant.
- B the pink character is dominant.
- C the pink and red characters are co-dominant.
- D the white and red characters are co-dominant.

**Question 5**

Duchenne muscular dystrophy causes wastage of muscles. Its expression is recessive and the allele that causes it is found on the X chromosome. It affects mainly boys who die before 20 years of age. The disorder is rarely found in girls. This is because:

- A the allele is one of the few found on the Y chromosome.
- B an X-linked recessive allele must be homozygous for it to be expressed in female humans.
- C sex-linked characters can never be seen in female, only males.
- D a sex linked allele is never passed from mother to daughter.

**Question 6**

A colony of honey bees, *Apis mellifera*, consists of a single queen, female workers and male drones. Each type of bee is the result of a different method of reproduction.

- A queen is produced when a sperm from a drone fertilises an ovum. The development of a queen is assisted by 'royal jelly', a mixture of essential nutrients.
- Female workers are produced when sperm from a drone fertilises an ovum, but no 'royal jelly' is fed to the pupae.
- A male is produced from an unfertilised ovum.

It is therefore true to say that:

- A male bees are diploid.
- B queen bees are haploid.
- C the number of chromosomes in female worker is different to that of a male drone.
- D the production of female workers requires meiosis but the production of male drones does not.

**Question 7**

DNA is made up of repeating units called:

- A glucose molecules.
- B purines.
- C nucleotides.
- D amino acids.

**Question 8**

The amount of Adenine in a DNA molecule is:

- A not known relative to the amount of cytosine.
- B less than the amount of cytosine.
- C the same as the amount of cytosine.
- D greater than the amount of cytosine in the same molecule.

**Question 9**

A particular protein consists of a chain of 25 amino acids. The **minimum** number of bases needed to code for the production of this protein is:

- A 25
- B 75
- C 50
- D 100

Questions 10 and 11 refer to the diagram on the right.

**Question 10**

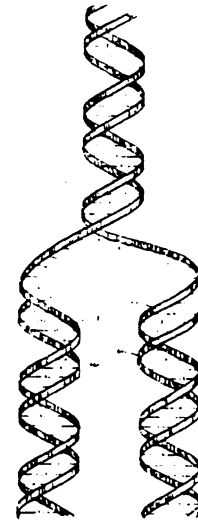
This diagram represents the process of:

- A transcription.
- B translation.
- C DNA replication.
- D RNA replication.

**Question 11**

The process depicted in the diagram takes place:

- A in the cytoplasm of the cell.
- B during mitosis only.
- C during meiosis only.
- D during both mitosis and meiosis.



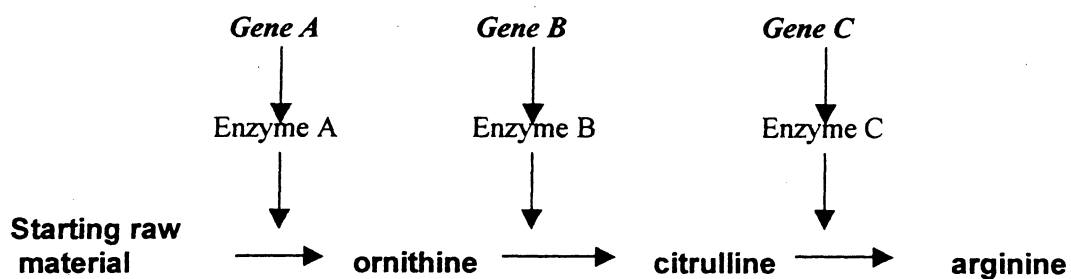
**Question 12**

Pigment production in humans is due in part to a gene that produces the pigment producing enzyme tyrosinase. Which of the following best describes the **sequence** of involvement in the production of tyrosinase in skin cells?

- A DNA → tRNA → ribosome → mRNA → pigment enzyme
- B Pigment enzyme → DNA → mRNA → ribosome → tRNA
- C DNA → mRNA → ribosome → tRNA → pigment enzyme
- D DNA → mRNA → ribosome → pigment enzyme → tRNA

Questions 13 and 14 refer to the following information.

Provided it is given a starting raw material, the pink mould *Neurospora* produces an amino acid according to the following steps:



**Question 13**

It is true to say that:

- A if gene A was inactivated the mould would survive if ornithine was added to the growth media.
- B if gene C missing the mould would survive if citrulline was added to the growth media.
- C if gene C was missing arginine would be formed directly from ornithine.
- D if the medium on which the mould normally grew was prepared without the starting raw material, the mould would survive if gene A, B and C were active.

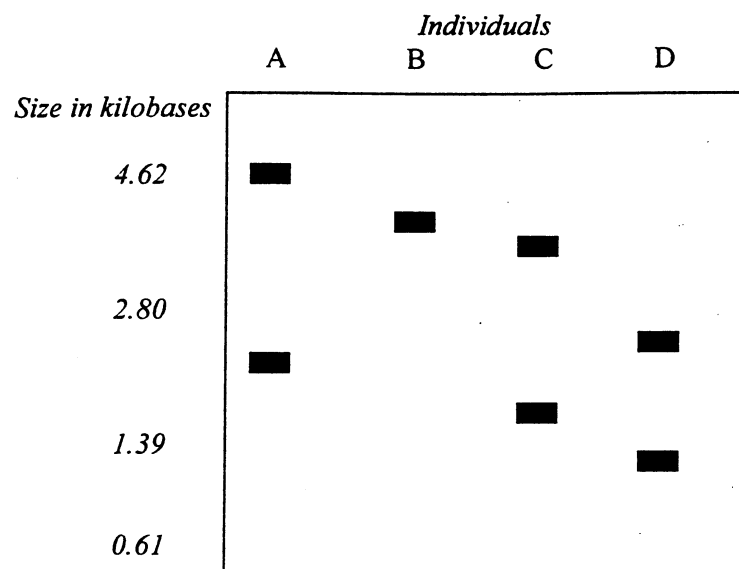
**Question 14**

If a mutation occurred in gene B preventing the formation of enzyme B, the substance(s) which would need to be present in the growth media for the mould to survive would be:

- A starting material + ornithine.
- B ornithine.
- C all four substances.
- D citrulline.

**Question 15**

Gel electrophoresis is a procedure used to separate fragments of DNA of different sizes and hence to establish a genetic profile of different individuals. Below is a diagram of a gel containing DNA fragments from 4 different individuals.



The direction of movement of the DNA fragments on the diagram is:

- A down the page because small pieces travel farther than big pieces.
- B down the page because big pieces travel farther than small pieces.
- C up the page because small pieces travel farther than big pieces.
- D up the page because big pieces travel farther than small pieces.

**Question 16**

\_\_\_\_\_ and \_\_\_\_\_ generate variation, while \_\_\_\_\_ results in adaptation to the environment.

- A Sexual recombination . . . natural selection... overproduction of offspring
- B Natural selection . . . mutation . . . sexual recombination
- C Genetic drift . . . natural selection . . . mutation
- D Mutation . . . sexual recombination . . . natural selection

**Question 17**

Critics like to point out that the theory of evolution is flawed because it is based on random changes - mutations. They say that a random change in an organism (or a car or a TV set) is likely to harm it, not make it function better. What logical statement could a defender of evolution make in reply to this criticism?

- A Mutation has little to do with evolution.
- B Fossils prove without a doubt that mutations drive evolution.
- C Mutations are not actually random.
- D Mutation is random, but natural selection is not.

**Question 18**

Which of the following would result in the evolutionary adaptation of a mouse population in the Snowy Mountains to its environment?

- A Mice with thicker fur best survive a cold winter.
- B Mice are most likely to mate with close neighbours.
- C A mutation for spotted fur occurs.
- D Half the mice are killed by an avalanche.

**Question 19**

A geneticist studied a grass population growing in an area of erratic rainfall. She found that plants with alleles for curled leaves reproduced better in dry years, but plants with alleles for flat leaves reproduced better in wet years. This situation would tend to:

- A lead to uniformity in the grass population.
- B lead to directional selection in the grass population.
- C preserve the variability in the grass population.
- D cause gene flow in the grass population.

**Question 20**

We know a lot about fossil crabs, snails, and corals, but not much about ancient seaweeds. Why do you suppose this is the case?

- A Autotrophs moved onto land, leaving only animals in the sea.
- B A mass extinction wiped out the seaweeds, but animals survived.
- C Animal life was much more abundant than seaweeds in ancient times.
- D Seaweeds were too soft to fossilize well.

**Question 21**

The oldest fossils usually:

- A have the longest half-lives.
- B are found in the deepest strata.
- C are found above younger fossils.
- D contain more radioactive isotopes than younger fossils.

**Question 22**

Gondwana:

- A is the theory that crustal plates can move relative to one another.
- B is the evolutionary history of a species, family, or phylum.
- C was a land mass that broke up to form the present-day Southern continents.
- D is the idea that all life on Earth is related.

**Question 23**

The fauna and flora of Australia are very different from those of the rest of the world. Why might this be true?

- A The climate of Australia is unlike that of any other place in the world.
- B Australia was never in close proximity to the other continents.
- C They have become different by convergent evolution.
- D Australia has been isolated for about 50 million years.

**Question 24**

What evidence most strongly suggests that an impact by an asteroid or meteorite may have caused the extinction of the dinosaurs?

- A Fossils indicate that most dinosaurs were looking up when they died.
- B Fossils show that dinosaurs suffered from cold and starvation.
- C Sedimentary rocks contain a layer of iridium, a mineral that is uncommon on Earth.
- D The dinosaurs disappeared rather abruptly, virtually overnight.

**Question 25**

The wings of birds and insects have the same function, but they do not have the same evolutionary origin. Bird and insect wings are:

- A analogous.
- B taxonomic.
- C phylogenetic.
- D homologous.

**END OF SECTION A**

**SECTION B - Short answer questions****Specific instructions for Section B**

This section consists of 7 questions. There are 50 marks in total for this section. Write your responses in the spaces provided. You should attempt **all** questions. Please write your responses in **blue or black ink**.

**Question 1**

The ABO blood grouping system depends on three alleles of one gene. The  $I^A$  and  $I^B$  alleles control the production of the A and B antigens respectively which are attached to the red blood cell membrane. The third allele,  $i$ , does not lead to the production of any antigen.

- a List all of the alleles that are possible in the genotype of a person who is blood Group A.

(1 mark)

A couple have a baby girl but the husband suspects that she may have been mixed up in the hospital with another baby girl. The child has Group B blood. The husband is Group O. The mother is Group A.

- b On the basis of the information about the blood groups of the people concerned, is it possible for the baby girl to be the daughter of the two parents listed? Explain your answer.

(2 marks)

- c The two parents have two more children a year apart. The first of these (their second child) is male and Group O. What is the probability that their third child will be:

male? \_\_\_\_\_

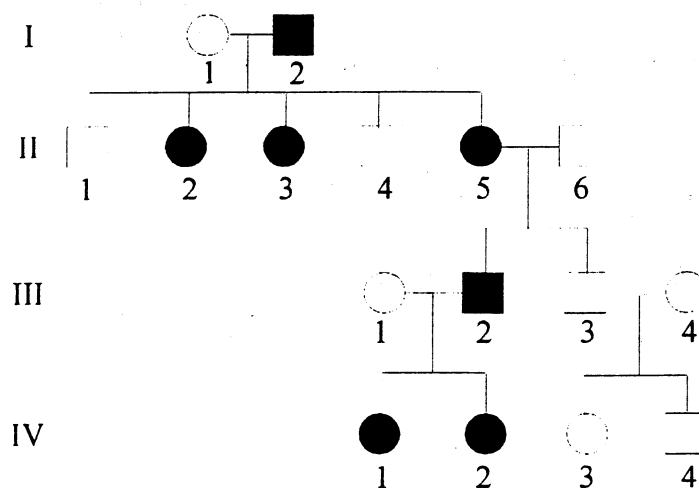
Group O? \_\_\_\_\_

(2 marks)

**Total 5 marks**

**Question 2**

The pedigree below shows the data of a family that is affected by vitamin D-resistant rickets. The trait is dominant and the gene is X-linked. The allele that causes the disease is written as  $X^R$ .



- a Consider the person II-3. Is this person male or female, affected, unaffected or a carrier?

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(1 mark)

- b What is the genotype of person II-2?

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(1 mark)

- c If person II-2 has children with an affected partner, what are the possible genotypes and phenotypes of the children?

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(2 marks)

**Total 4 marks**

**Question 3**

Foxes, *Vulpes vulpes*, have a gene that controls coat colour that has three alleles. These are  $W^S$ , which codes for silver coat,  $W^P$ , which codes for platinum coat and  $W^W$ , which codes for white face and silver coat.

The genotypes  $W^W W^W$ ,  $W^P W^P$ ,  $W^W W^P$  are all lethal. An embryo that has one of these genotypes dies before birth.

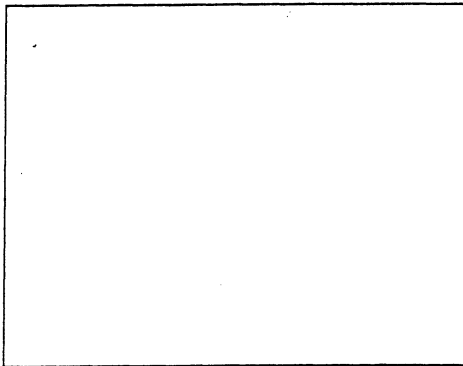
- a** What are two possible heterozygous genotypes of adult foxes?

Genotype 1: \_\_\_\_\_

Genotype 2: \_\_\_\_\_

(2 marks)

- b** Assume that the two foxes whose genotypes you have specified in part **a** mate. The female gives birth to 6 live cubs. How many of each genotype is likely in the litter? Explain your answer fully.



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(3 marks)

**Total 5 marks**

**Question 4**

DNA is the universal molecule that forms the major component of chromosomes. The structure of DNA, shown at the right, is sometimes described as a “twisted ladder”.

- a** The “rungs” of the ladder of DNA are made up of specific base pairs. Name these specific base pairs.

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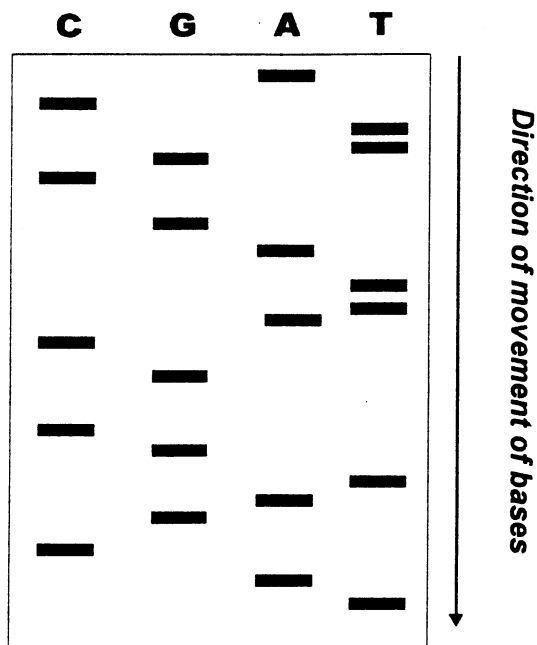
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(2 marks)



The order of the bases in DNA can be determined using a DNA sequencer. The specific piece of DNA to be analysed is treated with modified bases and then run on an electrophoresis gel. The bases are removed from the DNA sequentially and they run down the gel in the order that they are removed.

The following diagram shows the result of sequencing part of a gene.



- b Write down the order of the bases in the DNA from this experiment.

(1 mark)

- c What mRNA would be formed if this piece of DNA was the code?

(1 mark)

mRNA leaves the nucleus for the process of protein synthesis.

- d Where in the cell does protein synthesis occur?

(1 mark)

- e Describe the steps in the process of protein synthesis. You should use a labelled diagram to assist your answer.

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(3 marks)

- f Use the data table provided below to give the amino acid sequence that the mRNA in part c would code for.

(1 mark)

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

Changes can occur in the DNA molecule. One type of change is called a point mutation.

- g** Using data from the Table above, give an example of a point mutation and outline a possible effect this could have on the protein product formed.

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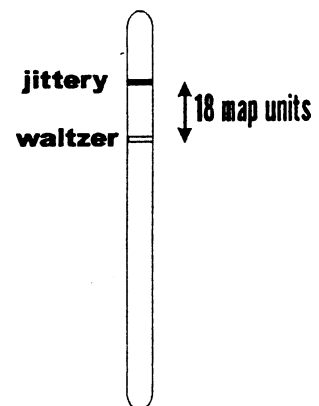
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(2 marks)

**Total 11 marks**

### Question 5

There are two genes for two different nervous disorders in mice, waltzer (**w**) and jittery (**j**), which are 18 map units apart on chromosome 10, as shown on the diagram at the right. These are both recessive conditions to their alternative forms which are phenotypically normal (**W**) and (**J**). Both genes are expressed independently.



- a** What term is given to gene loci on the same chromosome?

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(1 mark)

- b** If a group of mice, pure breeding for both normal genes was crossed with a group of mice that had both of the nervous conditions of waltzer and jittery, what phenotypes would you expect in the  $F_1$  generation?

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(1 mark)

- c** Using drawings based on the diagram above, show the formation of all possible gametes produced from the mice in this  $F_1$  generation.

(3 marks)

- d A number of the  $F_1$  generation were mated with the group of mice which had both the nervous conditions of waltzer and jittery. What are the possible **phenotypes** of the  $F_2$  generation?

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(2 marks)

Some of the offspring from the  $F_2$  generation above are referred to as **recombinants**.

- e What are recombinants?

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(1 mark)

- f Using the information at the start of the question and your knowledge of Biology, explain what percentage of the offspring in the  $F_2$  generation would be expected to be recombinants.

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(2 marks)

**Total 10 marks**

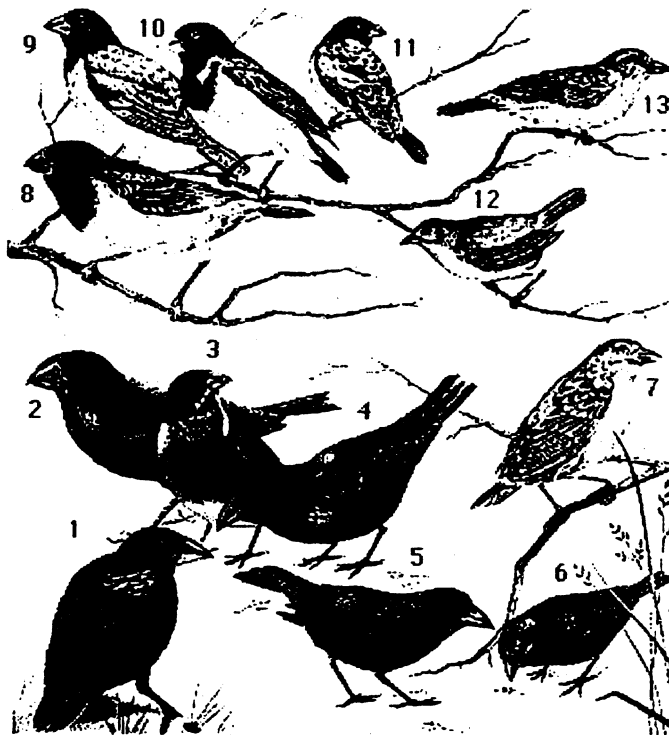
**Question 6**

The finches of the Galapagos Islands are famous for their role in Charles Darwin's development of the idea of evolution by natural selection. There are currently 13 species of finches in these volcanic islands in the Pacific Ocean. There are 12 major islands in the Galapagos archipelago and many smaller islands and rocky outcrops. On some islands two or three species of finch exist together, on other islands only one type of finch is found. The figure below shows these birds.

***Darwin's finches.***

The finches numbered 1-7 are ground finches. They seek their food on the ground or in low shrubs.

Those numbered 8-13 are tree finches. They live primarily on insects caught in the trees.



Charles Darwin suggested that these finches all evolved from a very small number of birds that came from South America, some 900 km to the East of the Galapagos Islands.

- a What term is used to describe a small population that arrives at a new destination and begins to breed?

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(1 mark)

- b Explain why some islands are able to support several species of finch.

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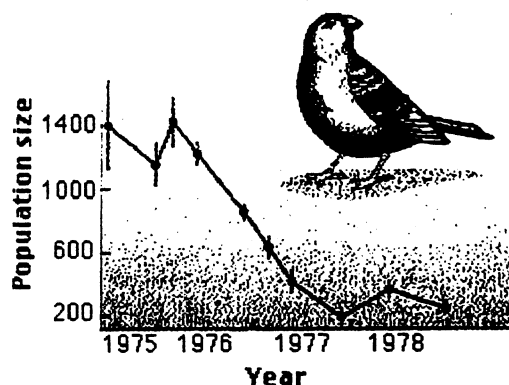
(2 marks)

Since Darwin's time, these birds have continued to provide a case study of how a single species reaching the Galapagos from Central or South America could, over a few million years, give rise to the 13 species that live there today.

Finch number 3 in the diagram is *Geospiza fortis*, the medium ground finch that is found on the island of Daphne Major, a tiny member of the Galapagos Islands.

From 1975 through to 1978, a severe drought struck the islands, with virtually no rainfall for over a year. This caused a severe decline in the production of the seeds that formed the major part of the diet of *Geospiza fortis*. The graph shows the total population of *Geospiza fortis* on Daphne Major during these years.

One of the plants to survive the drought produces seeds in large, tough fruits that are virtually impossible for birds with a beak smaller than 10.5 mm to eat.



- c From the graph, what was the population of *Geospiza fortis* at the start of measurements and at the end of measurements?

At the start \_\_\_\_\_

At the end \_\_\_\_\_

(1 mark)

During 1976 and 1977 dead and living finches were collected and their beaks were measured. Living finches were tagged and released back on the island. The Table below gives the results the scientists obtained.

|            | Average beak length (mm) |
|------------|--------------------------|
| Dead birds | 10.68                    |
| Survivors  | 11.07                    |

- d Explain what had happened to influence the beak size of the surviving finches.

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(3 marks)

In the years between 1978 and 1988 the rainfall returned to normal levels in the Galapagos and the plant populations grew to the numbers found before the 1970s drought. The scientists returned to the island of Daphne Major in 1989 and measured the beaks of the finches again.

- e What do you predict might have happened to the average beak size of the *Geospiza fortis* by 1988? Explain your answer.

Prediction: \_\_\_\_\_

Explanation: \_\_\_\_\_

(2 marks)

**Total 9 marks**

### Question 7

In 1999, scientists announced the discovery of a complete hand and arm of the hominid *Australopithecus* - the first discovery of its kind. The fossil bones are likely to yield dramatic new details about the anatomy and behaviour of this distant relative to modern humans.



It should also tell us something about how our own hands and arms evolved.

The remains were found in a cave at Sterkfontein, South Africa, by Dr Ron Clarke and his assistants who have been working on the site for several years.

This latest discovery probably comes from the same individual but the palaeoanthropologists are having to recover the hominid part by part because the different sections of the specimen have become separated in rock movements that have occurred over time.

In the paper, Dr Clarke says his team looked at the rocks in the cave to get a more accurate date for when the skeletal remains were laid down. This palaeomagnetic analysis shows the creature must have died at least 3.3 million years ago.

- a Why would scientists look at the age of the rocks, rather than use radioactive Carbon ( $^{14}\text{C}$ ) to estimate the age of the fossils?

(1 mark)

The arrangement of bones appears to show a left arm that is stretched above the head with the fingers clenched. The hand bones of the skeleton are of similar length to those of modern humans but the thumb is much more powerfully constructed, and the finger bones are curved like those of apes.

- b** Explain what the presence of curved fingers and a powerful thumb suggests about the way of life of *Australopithecus*.

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(2 marks)

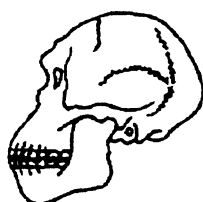
It is not thought that human lineage goes directly back to *Australopithecus* - it is more probable that we shared a common ancestor.

- c** What type of evolution could lead to the development of both *Australopithecus* and our own species from a common ancestor?

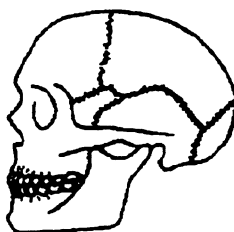
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(1 mark)

Skulls are also useful in helping to work out evolutionary relationships. The figure below shows drawings of skulls from three different hominids.



**Australopithecus**



**Modern Man**



**Neanderthal Man**

- d** Name one feature of these skulls that could be used to establish an evolutionary trend and use it to explain the order in which you think these species appeared on Earth.

Feature: \_\_\_\_\_

Order (oldest to most recent): \_\_\_\_\_

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(2 marks)

**Total 6 marks**

**Section B Total 50 marks**

**Examination Total 75 marks**

**END OF QUESTION AND ANSWER BOOKLET**