

Student Name:

**STAV**  
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**2002**

**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	6	6

**Directions to students**

**Materials**

Question and answer book of 20 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 2002**



**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**

Which definition best describes a gene?

- A. Three messenger RNA nucleotides that code for a specific amino acid.
- B. The number of nitrogenous bases in a nucleotide.
- C. A transfer-RNA nucleotide sequence specific for a particular amino acid.
- D. A sequence of nucleotides that directs the synthesis of a protein.

**Question 2**

One hundred white barley seedlings that had been grown in the dark were placed near a light source. After 48 hours, 78 turned green. Which statement best explains why some of the plants turned green?

- A. A white plant results only from a lack of light.
- B. A white plant results only from a homozygous genotype.
- C. The environment affects the expression of genes.
- D. Genes are not affected by environmental conditions.

**Question 3**

A cross between two mice with long tails and brown hair produced four kinds of offspring as listed below:

- Long tailed with brown hair.
- Long tailed with white hair.
- Short tailed with brown hair.
- Short tailed with white hair.

The genetic mechanism that best explains the results of this cross is:

- A. intermediate inheritance.
- B. gene linkage.
- C. independent assortment.
- D. crossing over.

**Question 4**

A pair of alleles of a gene are said to be co-dominant if:

- A. the heterozygous organism expresses both alleles in the phenotype.
- B. the alleles occur on different chromosomes.
- C. the phenotype follows a normal distribution.
- D. one allele influences the expression of the other in the phenotype.

**Question 5**

A botanist has a pea plant with purple flowers determined by a dominant allele P. How could he determine if the plant is homozygous PP or heterozygous Pp?

- A. Examine the plant's chromosomes under the microscope.
- B. Cross the plant with pure breeding purple plants.
- C. Perform a test cross: cross the plant with known heterozygous Pp.
- D. Perform a test cross: cross the plant with a white one that is homozygous recessive pp.

**Question 6**

In a certain species of mouse, grey fur (G) is dominant over white fur (g). If a homozygous grey mouse is crossed with a white mouse, the genotypes of the  $F_1$  generation will most likely be:

- A. 100% Gg
- B. 50% Gg and 50% gg
- C. 25% GG, 50% Gg and 25% gg
- D. 75% Gg and 25% gg

**Question 7**

Black colour in guinea pigs is dominant to white. When a pure breeding black guinea pig is crossed with a white one, what fraction of the  $F_2$  generation is expected to be heterozygous?

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

**Question 8**

The major difference between messenger RNA and transfer RNA molecules is:

- A. Messenger RNA molecules contain ribose, and transfer RNA molecules contain deoxyribose.
- B. Messenger RNA molecules function in carrying coded information to the ribosomes, and transfer RNA molecules function in carrying amino acids to the ribosomes.
- C. Messenger RNA molecules contain thymine, and transfer molecules contain uracil.
- D. Messenger RNA molecules function when they are double stranded, and transfer RNA molecules function when they are single-stranded.

**Question 9**

Restriction endonucleases are enzymes that:

- A. cut pieces of DNA at specific sites.
- B. always produce blunt ends.
- C. repair broken pieces of DNA.
- D. separate the strands of DNA for copying.

**Question 10**

The length of an amino acid chain being translated from mRNA is controlled by codons that code for “stop”. These are UAA and UAG. When one of these codons is reached the process is terminated. The DNA sequence below codes for part of a peptide.

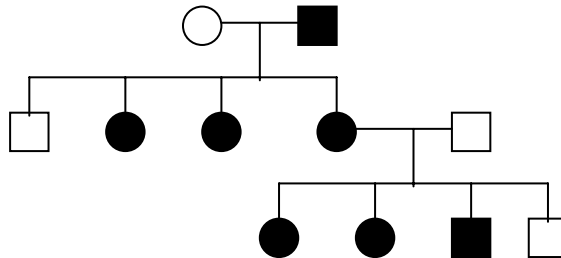
5' C A G T A T T C C A T G A 3'  
 1 2 3 4 5 6 7 8 9 10 11 12 13

The amino acid chain would be shorter than normal if:

- A. Base 5 is lost.
- B. Base 3 is replaced by T.
- C. Base 12 is replaced by A.
- D. A is added between bases 6 and 7.

**Question 11**

Examine the pedigree diagram below.



This inheritance of the trait shown in shaded individuals could be:

- A. autosomal recessive only.
- B. autosomal dominant only.
- C. autosomal dominant or Y linked dominant.
- D. X linked dominant or autosomal recessive.

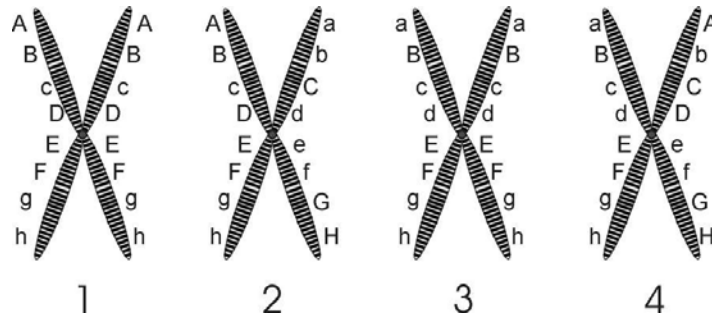
**Question 12**

Strawberries are plants that show the condition polyploidy. This means that:

- A. the plant has a chromosome number which is three or more times the haploid number.
- B. the plant has a chromosome number which is twice the haploid number.
- C. the plant shows continuous phenotypes.
- D. the plant can only reproduce asexually.

**Question 13**

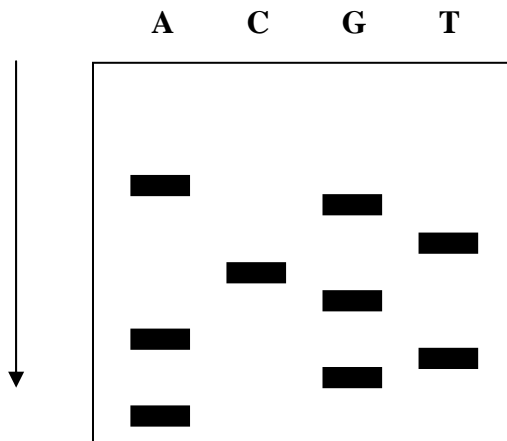
Which of the chromosomes below are homologous?



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

**Question 14**

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



The order of the bases in the DNA from this experiment is:

- A. AGTAGCTGA
- B. AGTCGATGA
- C. AAACGGGTT
- D. AGTACGGTA

**Question 15**

In birds, the sex chromosomes are Z and W. The male bird, or rooster, has two Z chromosomes and the female, or hen, has a Z and a W. A gene for feather colouring in chickens is situated on the Z chromosome but not on the W chromosome. This gene has two alleles, gold and brown. The gold allele is dominant to brown. A poultry farmer crossed a hen with a rooster that was pure breeding for feather colour. All the **male** offspring of this cross were gold and all the **females** were brown.

The parent birds were probably:

- A. a brown hen crossed with a gold rooster.
- B. a gold hen crossed with a brown rooster.
- C. a gold hen crossed with a gold rooster.
- D. a brown hen crossed with a brown rooster.

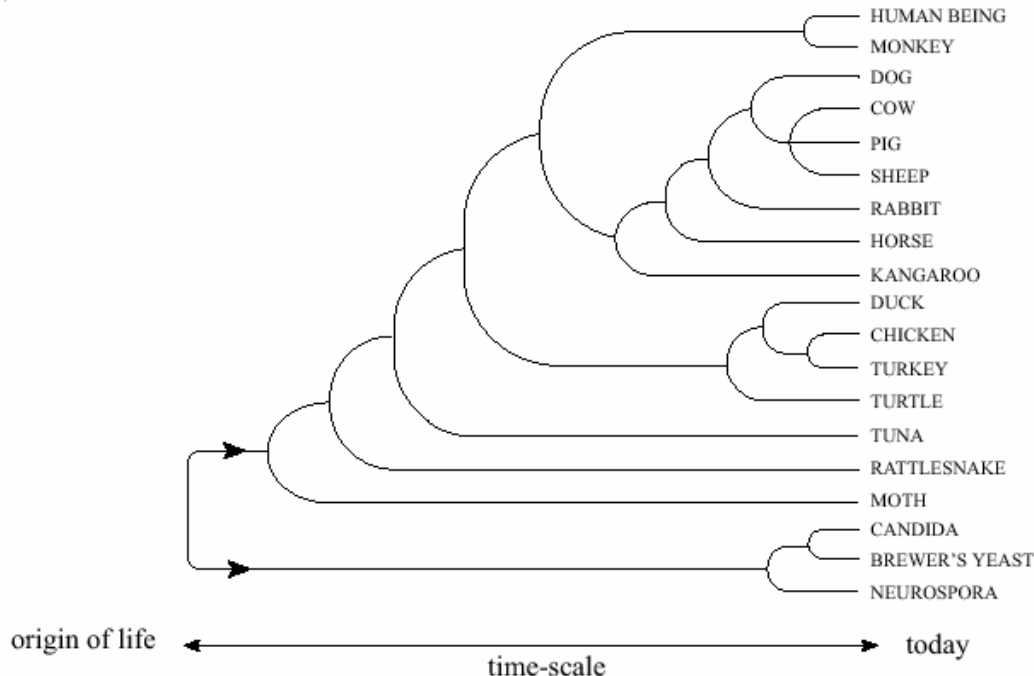
**Question 16**

Which of the following processes is **least** likely to alter the allele frequencies in the gene pool of a population within one generation?

- A. Natural selection on the basis of phenotypes.
- B. Independent assortment of homologous chromosomes during meiosis.
- C. Migration of individuals into and out of the population.
- D. Mutation during DNA replication.

**Question 17**

Cytochrome C is a mitochondrial protein involved in the process of cellular respiration. By comparing the amino acid differences in the cytochrome C evolutionary relationships between species can be determined. The diagram below shows the relationships that this method reveals.



Which pair of organisms would be expected to show the greatest similarity in DNA base sequences in their mitochondrial genes coding for cytochrome C?

- A. Duck and turkey.
- B. Rabbit and horse.
- C. Turkey and turtle.
- D. Candida and brewer's yeast.

**Question 18**

A flounder is a fish that lies on the sandy bottom of the sea floor. When young, the flounder has eyes on each side of its head, like other fish. But as the fish matures one eye moves around the head (or sometimes through it) so that the adult has both eyes on the side of the head that is not in the sand. In terms of evolution, this is an example of :

- A. Lamarckism; the fish has adapted to its environment as it matured.
- B. non-disjunction; the fish has an unusual number of chromosomes and so is deformed.
- C. natural selection; the fish species has an adaptation that helps it survive.
- D. Darwinism; the fittest fish survive.

**Questions 19 and 20 relate to the following information.**

The bacterium *Staphylococcus aureus* is normally harmless in healthy people. However, in people who are ill or have weakened immune systems *S. aureus* can cause severe infections. This often occurs when people are patients in hospitals. Generally antibiotics can control *S.aureus* infections. But several strains of *S. aureus* that are not killed by any of the common antibiotics have recently been detected in hospitals.

**Question 19**

The best biological explanation for the appearance of antibiotic resistant *S. aureus* in hospitals is probably that:

- A. antibiotics that are becoming weaker with overuse.
- B. people who insist on an antibiotic prescription even if they have a viral disease.
- C. the widespread use of antibiotics in hospitals.
- D. mutations in *S. aureus* that now make the bacterium immune to all antibiotics.

**Question 20**

The development of the antibiotic resistant *S. aureus* in hospitals is an example of:

- A. bacterial selection.
- B. immunological selection.
- C. natural selection.
- D. artificial selection.

**Question 21**

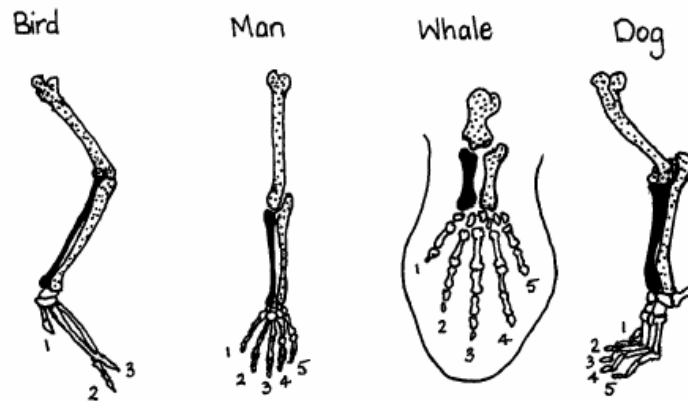
The Australian Marsupial mole (*Notoryctes* species) and the African Golden Mole (*Amblysomus* species) are extremely similar in size, shape and life-style. Although they are both mammals, the Australian species is a marsupial and the African is placental. It is many millions of years since these species shared a common ancestor. These animals are an example of:

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



**Question 22**

The bone structures of the pentadactyl limbs of four species of mammals are shown below.



These pentadactyl limbs are taken by scientists as an example of:

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

**Questions 23 and 24 refer to the following information**

In the first paragraph of his revolutionary book, "The Origin of Species" Charles Darwin writes: "... if we reflect on the vast diversity of the plants and animals which have been cultivated, ... and which have varied ... , we are driven to conclude that this great variability is due to our domestic productions having been raised under conditions of life not so uniform as, and somewhat different from, those to which the parent species had been exposed under nature."

Darwin then went on to explain in detail his observations of breeding pigeons. He described how the fancy pigeons, popular in England at that time, had been produced from the common rock dove that to this day exists in big cities around the world.

**Question 23**

Charles Darwin is pointing out in this paragraph that:

- A. humans had been influencing phenotypes of cultivated plants and animals even in Darwin's time.
- B. by changing the environment in which plants and animals are raised the species may no longer closely resemble their parent species.
- C. species can be seen to change, sometimes in only a few generations.
- D. all of the above things are true.

**Question 24**

The development of the fancy pigeon breeds from the rock dove is an example of:

- A. natural selection.
- B. selective breeding
- C. man interfering with nature.
- D. pigeons being bred to amuse Victorian ladies.

**Question 25 refers to the following information.**

The diagram below shows the Stratigraphic ranges and origins of some major groups of animals and plants. The vertical lines represent the evolutionary Periods when each species' fossils could be expected to be found.

PERIOD	ANIMALS						PLANTS					
Quaternary												
Tertiary												
Cretaceous												
Jurassic												
Triassic												
Permian												
Pennsylvanian												
Mississippian												
Devonian												
Silurian												
Ordovician												
Cambrian												

**Question 25**

A paleontologist digging in rocks that are known to be from the early Permian period might find fossils of the following types of organisms

- A. animals with shells, amphibians, reptiles, ginkos, pines, ferns, horsetail rushes and club mosses.
- B. fishes, amphibians, reptiles, mammals, horsetail rushes, ferns and pines.
- C. reptiles and pines only.
- D. animals with shells, fishes, amphibians, reptiles, club mosses, horsetail rushes, ferns and pines.

**END OF SECTION A**

**SECTION B - Short Answer Questions**

**Specific instructions for Section B**

This section consists of **6** 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**

Many inherited diseases are due to structural abnormalities in the chromosomes. In chromosomal translocations a segment of one chromosome may break off and attach itself to another non-homologous chromosome.

**a** What are non-homologous chromosomes?

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(1 mark)

**b** During what process is translocation most likely to occur? Give a reason for your answer.

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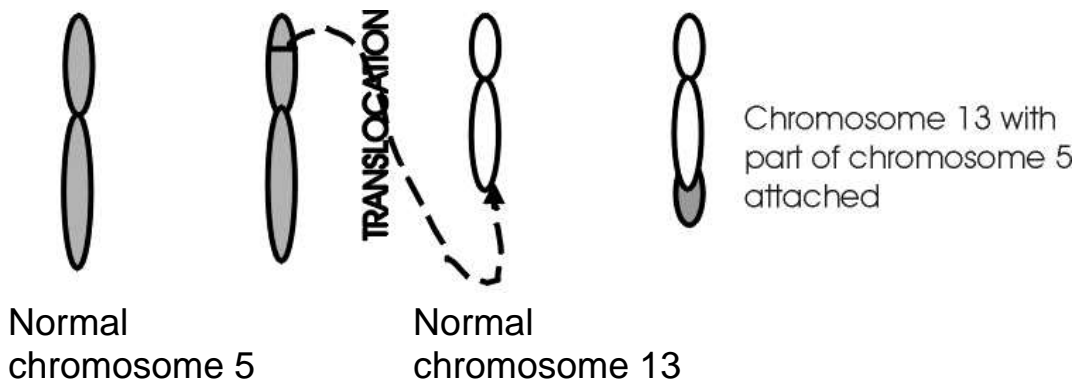
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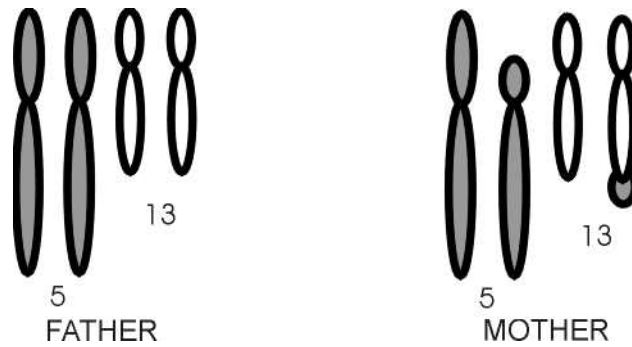
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(2 marks)

One such inherited condition is called Cri du Chat syndrome (Cry of the cat). This syndrome is characterised by mental retardation, a smaller than normal head and a strange cry like a meowing cat due to a weakness and under development of the upper part of the larynx. The condition is due to a translocation of part of the short arm of chromosome 5 as shown in the diagram below.



A man who is normal for chromosomes 5 and 13 marries a woman with translocation of part of chromosome 5 to chromosome 13.



**c** In the boxes below, draw the combinations of chromosomes 5 and 13 that might be found in the gametes formed by the mother and the father.

<i>Possible gametes of the father</i>	<i>Possible gametes of the mother</i>

(2 marks)

Children who inherit the translocated chromosome 13 are phenotypically normal, in spite of the duplication of some of their genetic information. Those children who inherit the deleted chromosome 5 have Cri du Chat syndrome.

**d** What is meant by the term phenotypically normal?

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(1 mark)

**e** What is the probability of the couple above having a child with Cri du Chat syndrome?

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(1 mark)

- f** The couple described above have two children. A boy with Cri du Chat, and a girl with a duplication. Using the boxes below draw the chromosome 5 and 13 genotypes of these children. Label each box in the spaces provided.


(2 marks)

- g** A laboratory procedure can be used to detect if a child has a chromosome duplication. Name this procedure.

\_\_\_\_\_

(1 mark)

- h** Briefly describe the procedure named above.

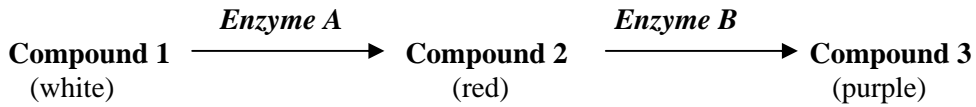
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

(2 marks)

**Total 12 marks**

**Question 2**

Colour pigment in plants is under genetic control. Two genes, A and B, are involved. The following diagram represents a pigment-producing pathway in a plant.



The alleles **A** and **B** produce functional enzymes but the alleles **a** and **b** do not. Plants that are heterozygous are able to produce enough enzyme to catalyse the reaction that produces the pigment.

The plants with the following genotypes were crossed.

$$\text{AaBb} \times \text{AaBb}$$

**a** List the genotypes of the gametes of the plants above.

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(1mark)

**b** What are all the possible genotypes of the offspring? Show your working.

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(2 marks)

**c** What **colours** would you expect among the offspring, and in what proportion? Show your working.

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(3 marks)

**Total 6 marks**

**Question 3.**

Several human adult onset neurodegenerative disorders are known to be due to expansion of CAG repeats in particular chromosomes.

**a** What do the letters C A G stand for?

C \_\_\_\_\_

A \_\_\_\_\_

G \_\_\_\_\_

(1 mark)

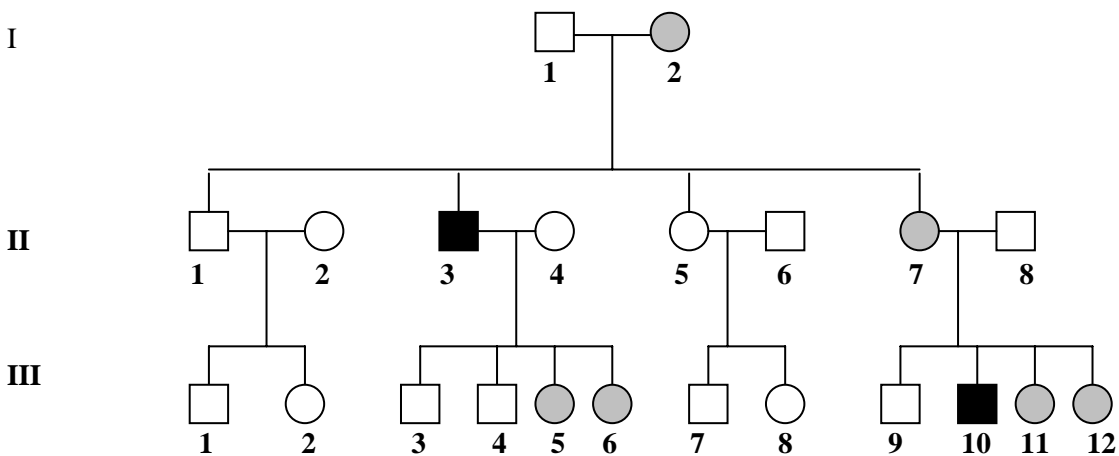
One particular neurological disease, Kennedy Disease, is characterised by 40–62 CAG repeats in the first exon of the gene that codes for an Androgen receptor protein.

**b** What is an exon?

\_\_\_\_\_  
\_\_\_\_\_

(1 mark)

Below is a family pedigree for Kennedy Disease. Individuals shaded black have the condition and those that are shaded grey do not show any symptoms but are carriers.



**c** Using the information in the pedigree, and your knowledge of biology, explain the mode of inheritance of Kennedy Disease.

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

(2 marks)

In order to diagnose if a patient has this condition, DNA from a region of the gene containing the CAG repeats is cut and a PCR reaction is used on the DNA sample.

**d** What do the letters PCR stand for and what is the purpose of the reaction?

PCR stands for \_\_\_\_\_

Purpose \_\_\_\_\_

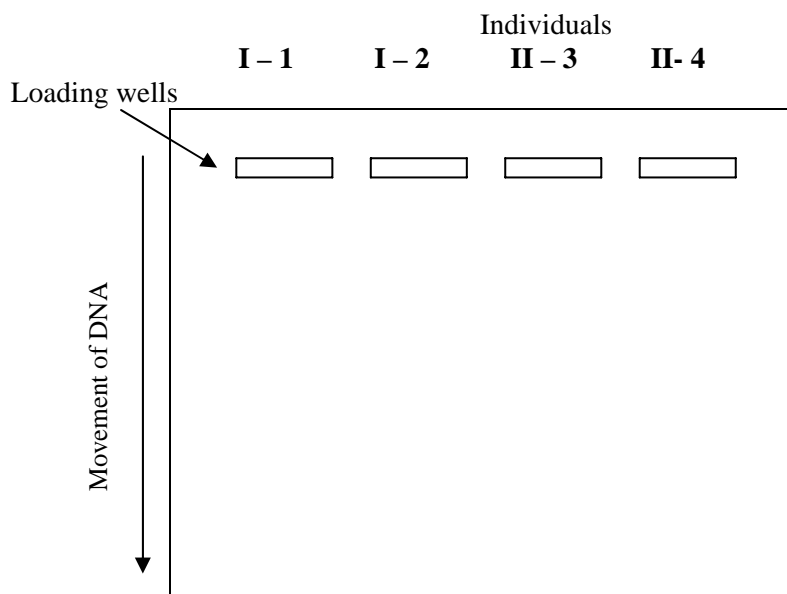
\_\_\_\_\_

(2 marks)

In patients with this disease the region in the gene containing repeated CAG is approximately twice the size of that found in normal people.

Below is a diagram of a gel electrophoresis for DNA analysis for some members of the family shown in the pedigree diagram on the previous page.

**e** Using the information given draw the DNA bands expected for the individuals



(3 marks)

**Total 9 marks**



**Question 4**

Analysis of human mitochondrial DNA (mtDNA) suggests that we are all almost identical in this DNA. Mitochondria are passed from generation to generation via the fertilized ovum.

- a** Is the DNA in mitochondria diploid or haploid?

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(1 mark)

Population geneticists explain the fact that all of the human mtDNA is very similar as a chance event. Out of a population of perhaps several thousand early human women, only one woman's mitochondrial genes were passed on.

- b** What is the name given to such a chance event?

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(1 mark)

Disasters such as earthquakes, floods or fires may reduce the size of a species' population drastically, killing victims randomly. Such an event, a few thousand years ago, is thought to have reduced the population of cheetahs to only a few individuals.

- c** Explain how this event might still be measured in the total gene pool of living cheetahs.

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(2 marks)

- d** Explain how this event is still likely to lead to the extinction of cheetahs, even though it occurred thousands of years ago.

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(2 marks)

**Total 6 marks**

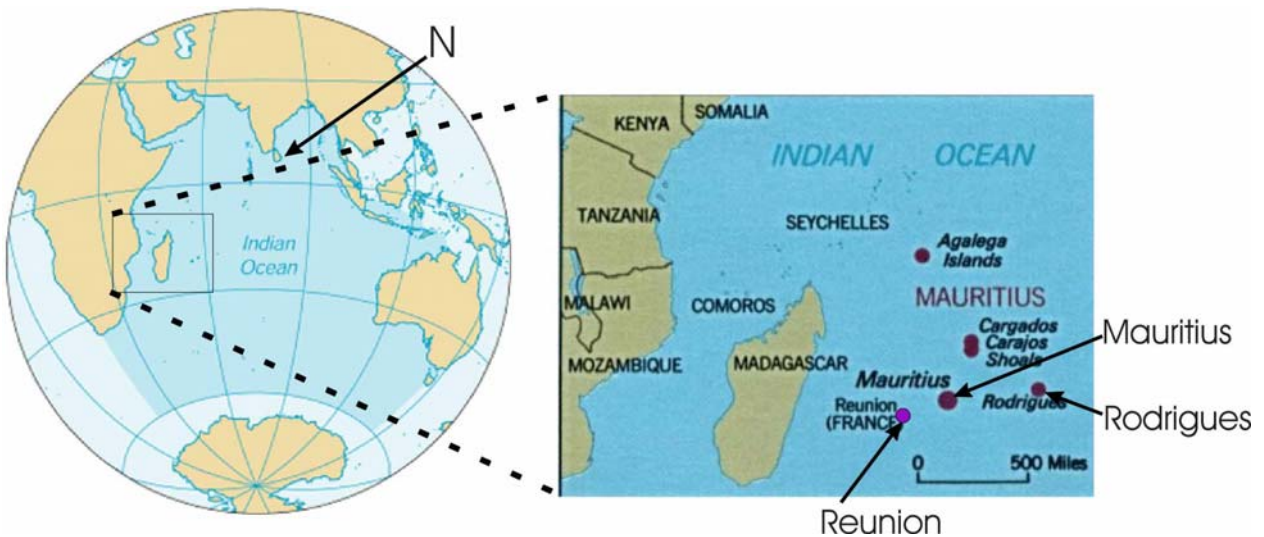
**Question 5**

The Dodo, *Raphus cucullatus*, was a large, flightless bird that was once found in great numbers on the Island of Mauritius in the Indian Ocean. Solitaire Birds, similar birds of different species, also lived on the Islands of Rodrigues and Reunion. For many years scientists thought that the pigeon-like ancestors of each of these island bird species came from Africa at least 25 million years ago.

Figure 1 shows an artist's impression of the Dodo and Figure 2 is a map of the Indian Ocean showing the location of Mauritius and neighboring islands.



**Figure 1:** Artist's impression of a Dodo



**Figure 2:** Indian Ocean, showing positions of Mauritius and some other Islands.

**a** Suggest how the ancestor of the Dodo could have moved from Africa to Mauritius.

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(1 mark)

Sailors that landed on Mauritius as long ago as 1507 described the Dodo as a stupid, fat, flightless bird about the size of a cat.

- b** Explain clearly how a bird the size of a pigeon could have evolved into the Dodo described by the ancient sailors.

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(4 marks)

The Solitaire birds that were described on the islands of Rodrigues, (*Pezophaps solitaries*), and Reunion (*Raphus solitarius*) were similar to the Dodo in size and life-style but are assigned different species names. This is an example of the effect of geographical isolation on speciation.

- c** How does geographical isolation result in the formation of different species?

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(2 marks)

The Dodo and both of the species of Solitaire birds became extinct before 1800.

- d** Describe one way that humans might have contributed to the extinction of these bird species.

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(1 marks)

Recently, researchers at the University of Oxford, UK, have reported on the analysis of DNA from preserved specimens of the Dodo and old bones of the Rodrigues Solitaire bird. They compared the DNA with that of another 35 kinds of living pigeons and doves.

Their analysis shows that the Dodo and the solitaire bird were close relatives, with their nearest living relative the Nicobar pigeon, *Claienas nicobarica*, from the Nicobar Islands. The location of the Nicobar Islands is marked with the letter **N** in Figure 2. Other closely related living species are found in South-East Asia. The crowned pigeons of New Guinea are also closely related to these extinct birds.

- e** In view of this new information, where do you think that the common ancestor of the Dodo and Solitaire birds came from? Justify your answer.

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(2 marks)

**Total 10 marks**

**Question 6**

In researching the evolution of our species, *Homo sapiens*, many lines of evidence have been investigated. The fossil record is important, as it provides physical material for comparison of sizes and positions of structures. Unfortunately, however, the fossil record is incomplete and many transitional fossils, which would provide valuable evidence, are yet to be discovered.

**a** Describe the conditions necessary for a fossil of an ancestral hominid to form.

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(2 marks)

**b** What does the term **transitional fossil** mean?

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(1 mark)

The fossil record is also valuable as it allows scientists to determine the ages of the fossils and so establish time-line relationships between them. Both relative and absolute dating techniques are useful in this respect.

**c** Explain the difference between relative dating of fossils and absolute dating of fossils.

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(2 marks)

*Australopithecus afarensis* is an extinct species that is thought to be an ancestor of our own species. Fossils of this species are found in Africa and have been widely studied. These studies indicate that the species may have lived partly in trees and partly walking upright on the African grasslands.

**d** What term is used to describe an animal that walks on only two feet?

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(1 mark)

**e** Describe one advantage of being able to walk upright for considerable distances.

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(1 mark)

**Total 7 marks**

**END OF EXAMINATION**