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LIFE SCIENCE
MID-YEAR EXAM: PAPER 1
GRADE 12
22 MAY 2024

QUESTION PAPER

Time: 3 Hours

Total: 200 marks

Examiner: Mrs. T. Wallace

Moderator: Mrs. ML. Korb

Student Name and Surname:

Read these instructions carefully:

1. This paper consists of a question paper of **36** pages (including the Invigilator's Declaration and this cover page). Check that your exam paper is complete.
2. Read the information and questions carefully.
3. Answer ALL the questions on the question paper in the spaces provided.
4. **No typed scripts will be allowed.** They must be hand-written in blue or black ink.
5. It is in your own interest to write legibly and to present your work neatly.
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QUESTION 1**[80]**

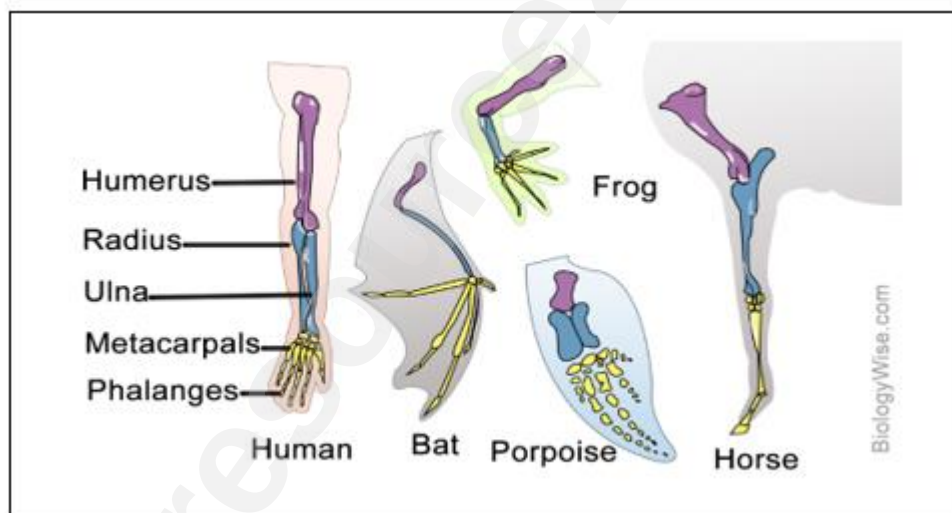
- 1.1 Select the term in **Column B** that best matches the description in **Column A**. Write the letter of the term in the corresponding space provided in the **ANSWER** column. Each letter may be used once only. (10)

Answer	Column A	Column B	
1.1.1	The person who recorded the first experimental evidence on the inheritance of traits.	A	Haploid
1.1.2	A process by which a chromatid breaks off during meiosis and joins to a different chromatid.	B	Phenotype
1.1.3	Medical expert who advises on the likelihood of offspring having an inherited disorder.	C	Hybrid
1.1.4	Picture of homologous chromosomes arranged in pairs to see their number, size and shape.	D	XXY
1.1.5	Having only one of each type of chromosome that is characteristic for a species.	E	Alfred Wallace
1.1.6	A chromosome that is not a sex chromosome.	F	Autosome
1.1.7	Genes at the same locus on 2 homologous chromosomes.	G	Crossing over
1.1.8	An organism's appearance resulting from its genetic information.	H	Allele
1.1.9	The part of a chromosome where crossing over takes place.	I	Genetic counsellor
1.1.10	Klinefelter's syndrome.	J	Karyotype
		K	Chiasma
		L	Gonosome

- 1.2 Ten multiple-choice questions are given below. Choose the most correct option in each question and write the **LETTER** of your choice in the space provided in the table below. (10)

Question	1.2.1	1.2.2	1.2.3	1.2.4	1.2.5
Answer					
Question	1.2.6	1.2.7	1.2.8	1.2.9	1.2.10
Answer					

- 1.2.1 The diagram below showing the bones of vertebrate forelimbs is an example of:



- A. Homologous structures.
 B. Analogous structures.
 C. Convergent evolution.
 D. Vestigial structures.
- Adapted from: Curro Hazeldean Prelim Paper 1 2022, Mrs M.Maartens*
- 1.2.2 Which statement best describes the pattern of extinction throughout biological history?

- A. The rate of extinction has steadily increased over the entire history of life
 B. The rate of extinction has steadily decreased over the entire history of life

- C. There has been very little extinction except during mass extinction events
- D. There has been a relatively constant turnover of species with occasional mass extinction events

1.2.3 The fossil record is not complete because:

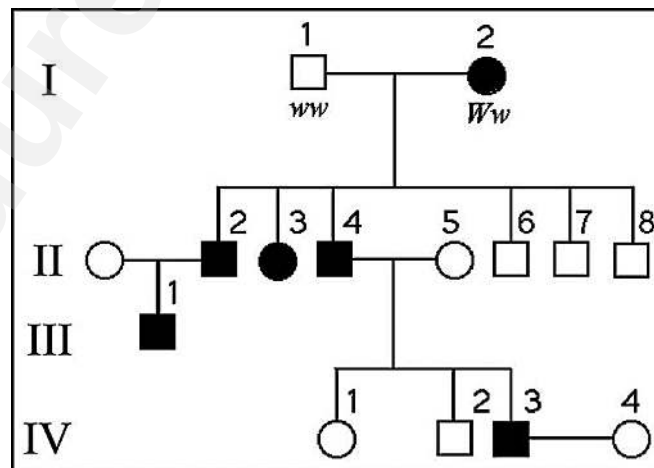
- A. Very few organisms were preserved as fossils
- B. Animals with hard parts are preserved more easily
- C. Geological processes may destroy fossils
- D. All of the above

1.2.4 Which type of sugar and bonds are found in a DNA molecule?

	Type of sugar	Bonds linking complementary bases
A	Deoxyribose	Hydrogen
B	Deoxyribose	Peptide
C	Ribose	Hydrogen
D	Ribose	Peptide

The following questions (1.2.5 to 1.2.7) are based on the information below:

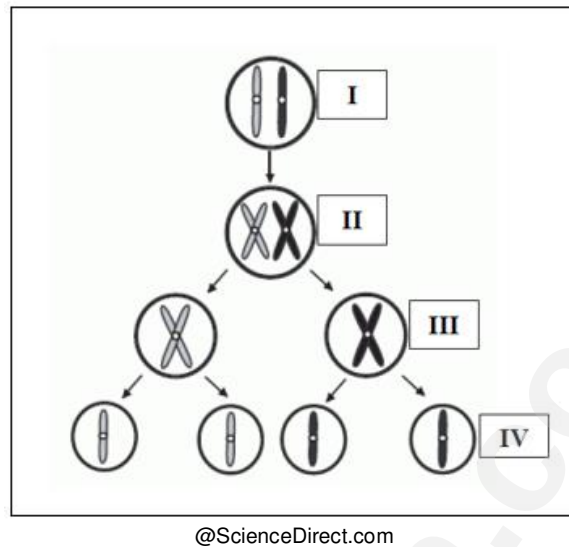
- “W” is for white fur, “w” is for brown fur for the rabbits.
- A square is male and a circle is female.
- A dark square or circle is white fur, and an empty circle or square is brown fur.



@Numerade

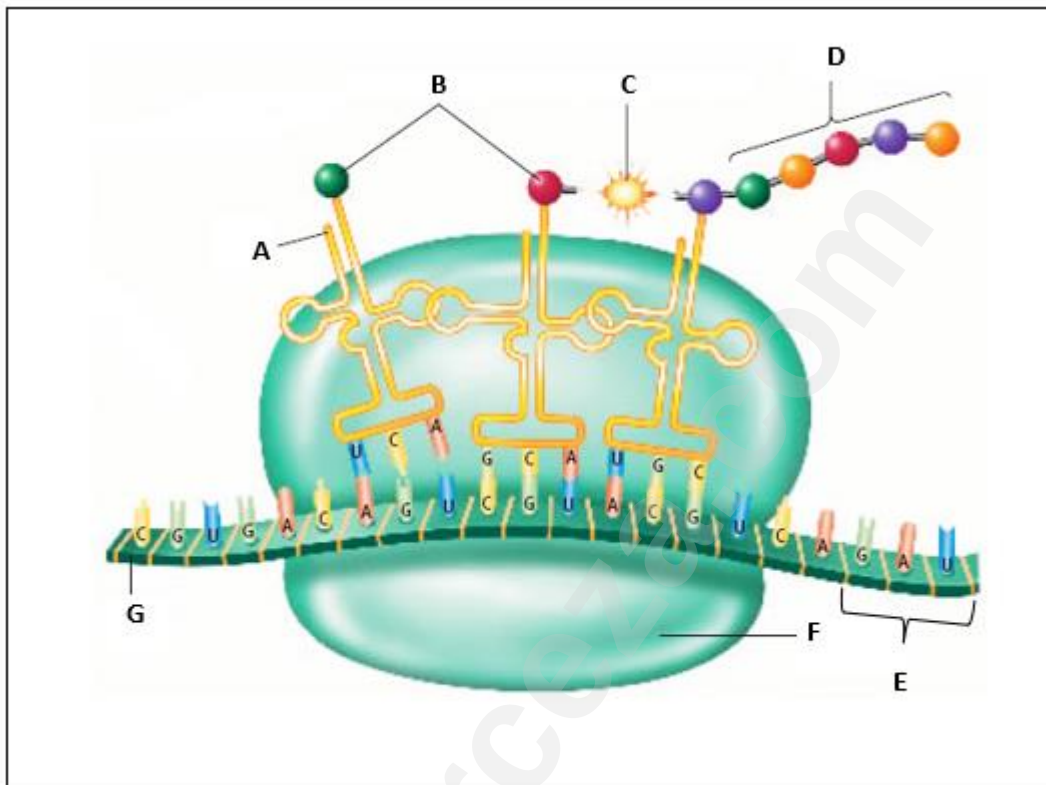
- 1.2.5 Which is the correct description of the parents (Level 1)?
- A. Homozygous dominant and homozygous recessive
 - B. Heterozygous and homozygous dominant
 - C. Heterozygous and homozygous recessive
 - D. Both heterozygous
- 1.2.6 What is the phenotype and genotype of rabbit number 3 in the second generation?
- A. Female brown, heterozygous
 - B. Male white, homozygous dominant
 - C. Female white, heterozygous
 - D. Male brown, homozygous recessive
- 1.2.7 What is the percentage chance that rabbit 3 in generation 4 is heterozygous?
- A. 25%
 - B. 75%
 - C. 0%
 - D. 50%
- 1.2.8 In each option, the first sequence is the original sequence of bases in the DNA strand and the second sequence is the same strand but mutated. Indicate which option is an example of an insertion point mutation.
- A. CCGTAGCC CCGTCGCC
 - B. CTTCGGTT CTTTCGGTT
 - C. GCTTCGGA GCTCGGA
 - D. CGGACCUG CGGACCAG

Questions 1.2.9 and 1.2.10 are based on the diagram below.



- 1.2.9 The four cells at the end of the process can best be described as ...
- A. four haploid gametes.
 - B. cells with the same chromosome number as the original cell.
 - C. four diploid gametes.
 - D. sperm cells.
- 1.2.10 The first cell/s showing that reduction division has occurred is/are numbered...
- A. I.
 - B. II.
 - C. III.
 - D. IV.

- 1.3 Study the following diagram. It shows a stage in the process of protein synthesis.



<https://classnotes123.com>

- 1.3.1 Which stage in protein synthesis is shown in the diagram? (1)

- 1.3.2 Where in the cell does this process occur? (1)

- 1.3.3 Identify the following molecules: (3)

D: _____

E: _____

F: _____

- 1.3.4 Identify part E: (1)

- 1.3.5 Fill in the table below. Give ONE difference in structure and ONE difference in function between molecule A and Deoxyribonucleic Acid. (4)

Difference in:	Molecule A	Deoxyribonucleic Acid
Structure		
Function		

- 1.3.6 The table below lists some of the amino acids. Alongside is a mRNA codon for each amino acid. The strand of DNA against which mRNA is transcribed is called the coding strand. Use Table 1 to answer the following questions.

Table 1: Amino Acids and mRNA Codons

Amino Acid	mRNA Codon
Serine	AGU
Aspartic Acid	GAC
Glutamine	GAG
Histidine	CAU
Leucine	CUA
Alanine	GCA
Lysine	AAA
Proline	CCU
Glycine	GGC

<https://ibiologia.com/codon/>

State the:

- a) tRNA anticodon for proline. (1)

- b) proline triplet on the DNA coding strand. (1)

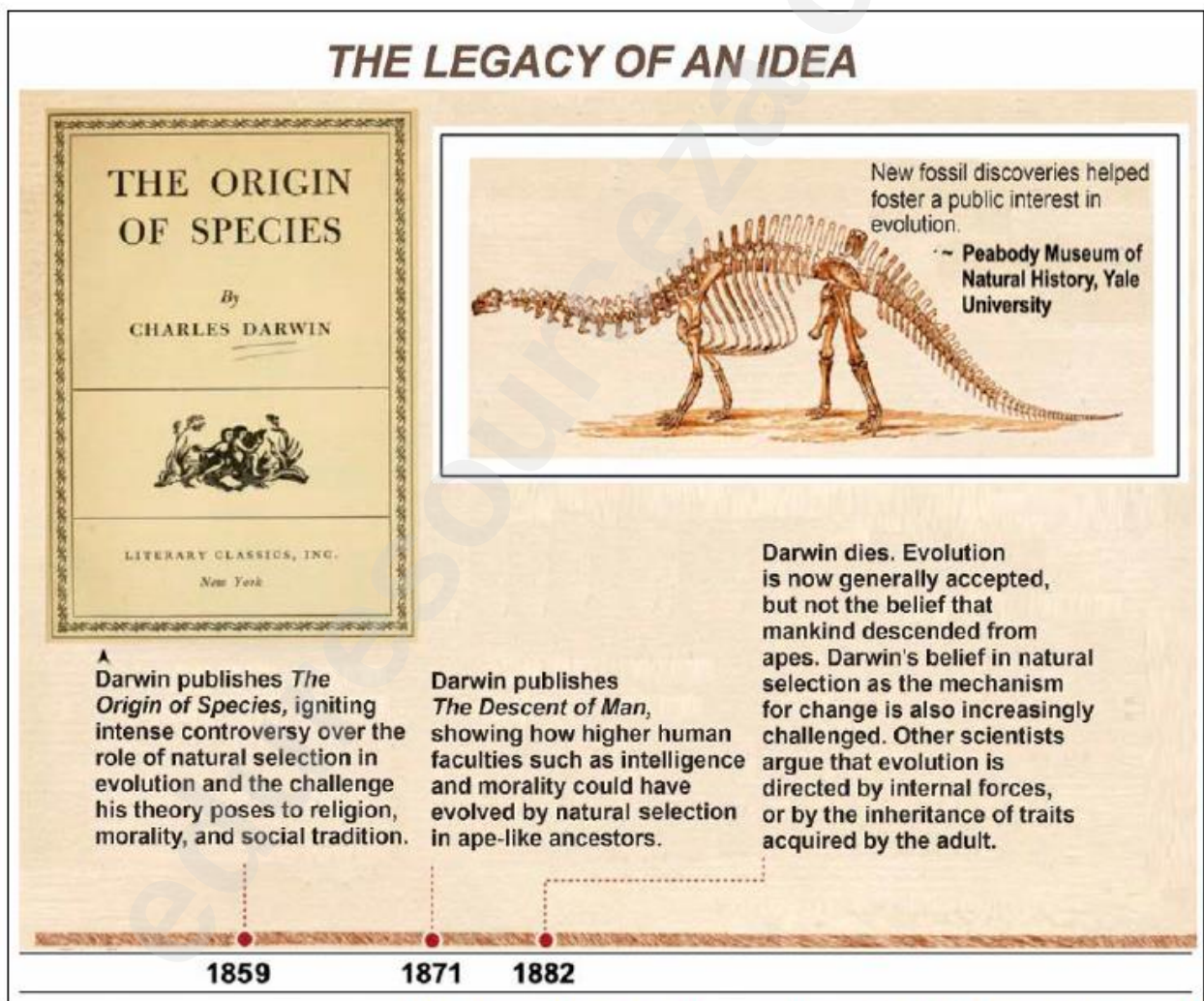
- c) amino acid carried by the tRNA anticodon GAU. (1)

- d) amino acids that are coded for by the following DNA bases: (2)

C T C: _____

C G T: _____

- 1.4 Study the infographic below that shows the timeline of the early ideas of the theory of evolution and answer the questions that follow.



[Adapted: <media.nationalgeographic.org> and <<https://openlibrary.org>>]

1.4.1 Provide the names of the following biologists:

a) He suggested that evolution occurred by the inheritance of acquired traits. (1)

b) He is the co-discoverer, along with Charles Darwin, of the theory of natural selection. (1)

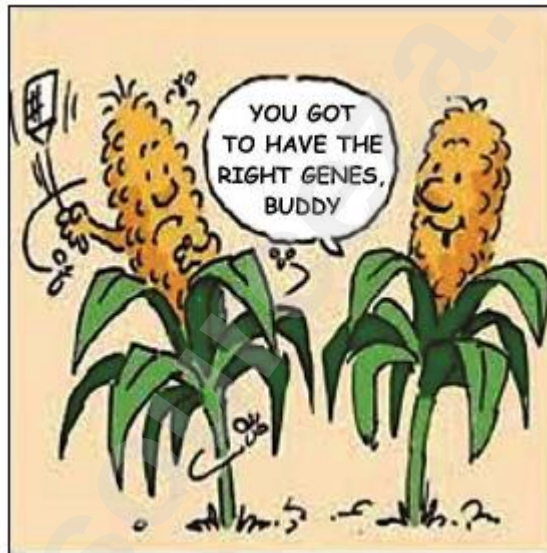
1.4.2 The ideas of evolution by Charles Darwin and other biologists were severely challenged at that time in history. Discuss reasons why people challenged their ideas. (4)

1.4.3 How does fossil evidence support the theory of evolution? (2)

- 1.5 Genetically Modified (GM) crops are now grown around the world. Since they were approved for commercial use in 1996, their production has increased dramatically. Very few products do not contain some form of GM ingredient.

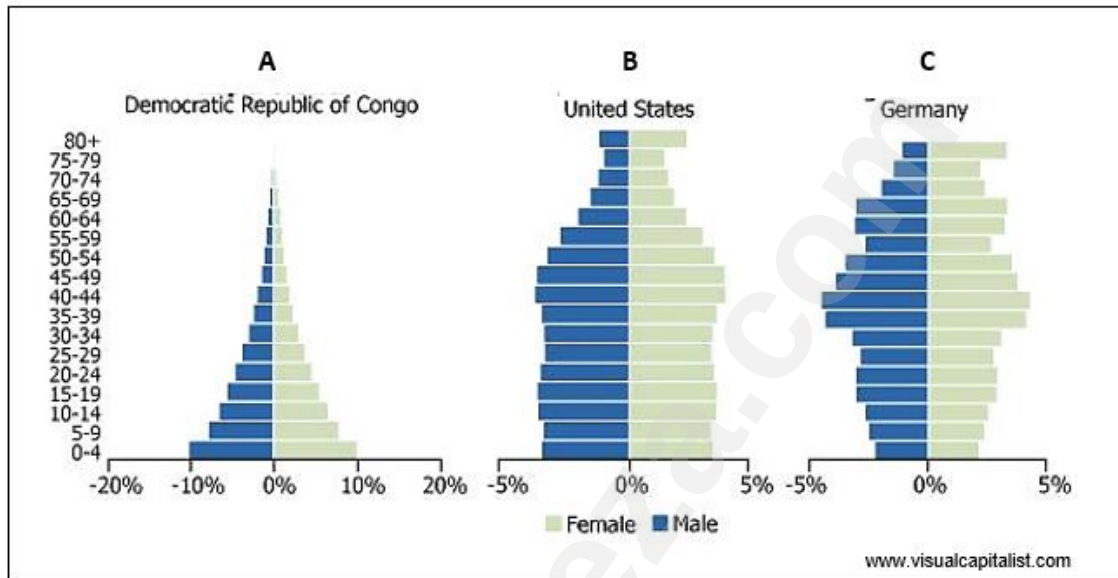
- 1.5.1 What is meant by the term "Genetically Modified crop"? (2)

- 1.5.2 The following cartoon shows one of the advantages of certain GM crops. Explain the message in this cartoon. (3)



[Source: <<http://www.seriouswonder.com>>]

- 1.6 Population growth is important for all countries to aid in future planning of budgets and facilities needed, like schooling, hospitals and care for the aged. Study the Population Pyramids below that is based on 2018 statistics and answer the questions that follow.



- 1.6.1 Name the types of population pyramids: A, B and C. (3)

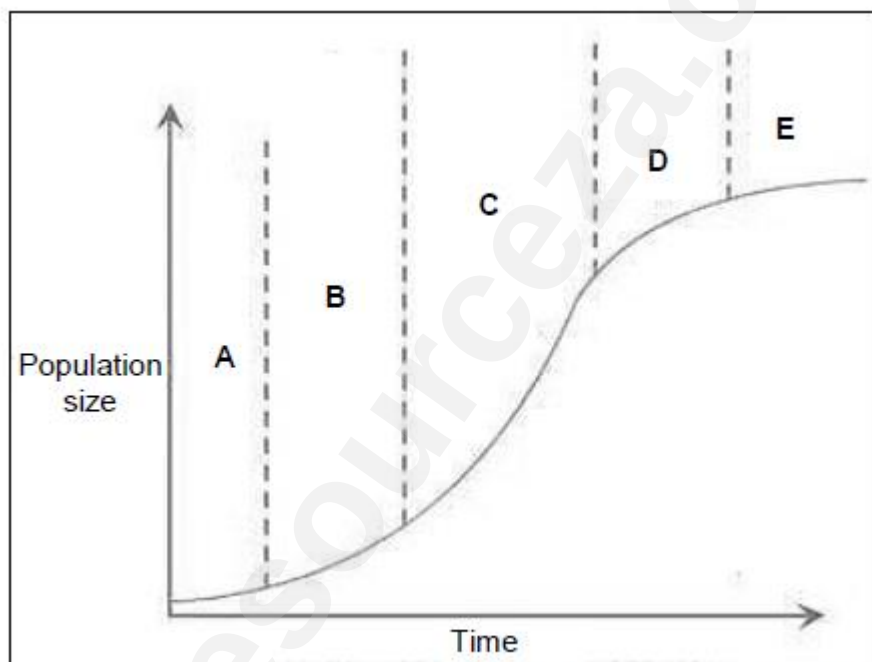
- 1.6.2 What percentage of the population of the Congo is below 10 years old? (1)

- 1.6.3 By looking at the population pyramid of Germany, state 2 problems that Germany will have in 2040. (2)

- 1.6.4 Give a reason why the United States and Germany have so many people above 80? (2)

- 1.6.5 Every country has an ecological footprint. More developed countries (MDC) have an ecological deficit. Explain what this means and what has caused it. (3)

- 1.7 The graph below shows the growth of a population of Impala over time.



[Adapted from: <http://www.tutorvista.com/>]

- 1.7.1 Is the population of impala at phase E stable or unstable? Explain. (2)

- 1.7.2 The data used to plot the graph was obtained using a sampling method of population estimation known as the Mark-Recapture Method. On one occasion, 530 impala were caught, tagged and released in the park. A few days later, a second capture was done and 480 impala were caught of which 80 had tags.

- a) In the block below, calculate an estimate of the population of impala at this time. (Show your working). (4)

- b) List THREE precautions that the rangers take when doing this population estimate in order to make the estimate scientifically valid. (3)

- 1.8 A newly approved crop is this apple from a Canadian biotech company that does not brown even after it's been sliced – these are called "Arctic Apples". It recently received FDA* approval. The agency said it is safe to eat, which means they may appear on supermarket shelves.

*FDA = Food & Drug Administration



[Adapted from: <<http://time.com/3840073/gmo-food-charts>>]

- 1.8.1 If you were a parent buying apples for your family, would you buy these GM apples? Justify your answer with TWO reasons. (2)

- 1.8.2 A scientist heard about the new GM Arctic Apples and he decided to do his own tests on the apples comparing them to "natural" apples. He took a "natural" apple and an Arctic Apple and cut each apple in half. Over the next two hours, he observed the percentage of the cut surface that turned brown and recorded it in a table every 15 minutes.

Time (min)	"Natural" Apple (% brown)	Arctic Apple (% brown)
0	0	0
15	4	0
30	10	0
45	15	0
60	15	0
75	25	5
90	40	5
105	50	5
120	50	5

[Examiner's hypothetical data]

- a) State the independent variable in this experiment. (2)

- b) State the dependent variable in this experiment. (2)

- c) Did his observations support the claims made by the producers of the Arctic Apple? Explain. (2)

- d) Identify TWO fixed variables. (2)

- e) How could the scientist have made sure his results were more reliable? (2)

[80]

QUESTION 2**[40]**

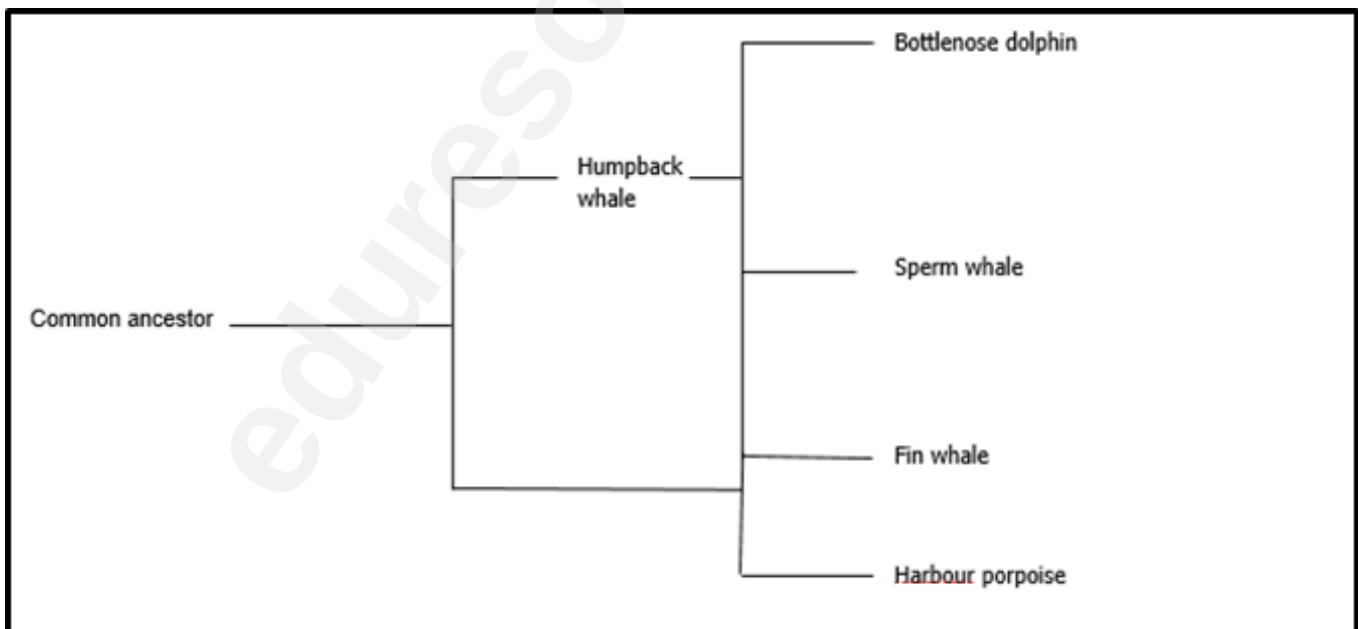
- 2.1 The following table shows the percentage genetic similarity of a small section of the piece of DNA between different species of the mammalian order Cetacea (which includes whales, dolphins and porpoises).

	Fin whale	Humpback whale	Sperm whale	Bottlenose dolphin	Harbour porpoise
Fin whale	100				
Humpback whale	81	100			
Sperm whale	48	48	100		
Bottlenose dolphin	43	43	41	100	
Harbour porpoise	40	45	45	48	100

<https://www.researchgate.net/cetaceans>

- 2.1.1 According to the table, which two species are most distantly related? (2)
Explain the reason for your choice.

- 2.1.2 The following figure shows a phylogenetic tree of relationships between the species of Cetaceans shown in the table above. This tree was constructed using some of the physical characteristics that some of these mammals share.

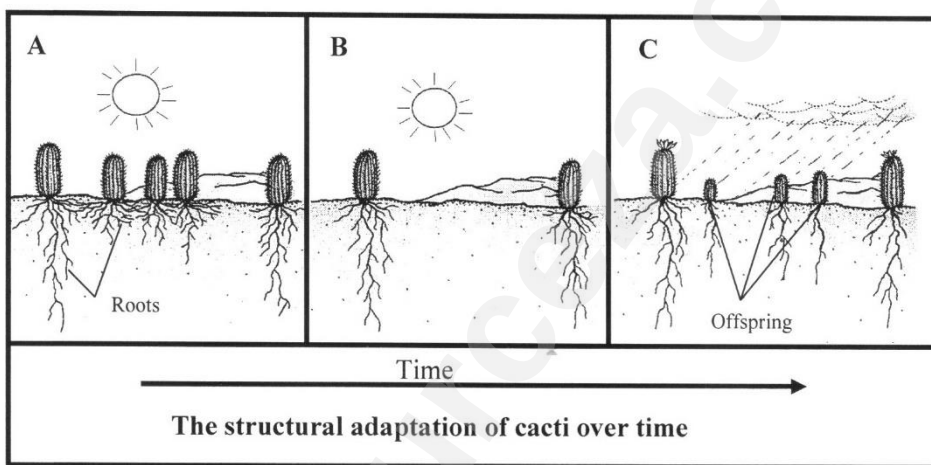


<https://www.researchgate.net/cetaceans>

- a) What is meant by a 'common ancestor'? (2)

- b) According to the phylogenetic tree, what is the most recent common ancestor of the bottlenose dolphin and the sperm whale? (1)

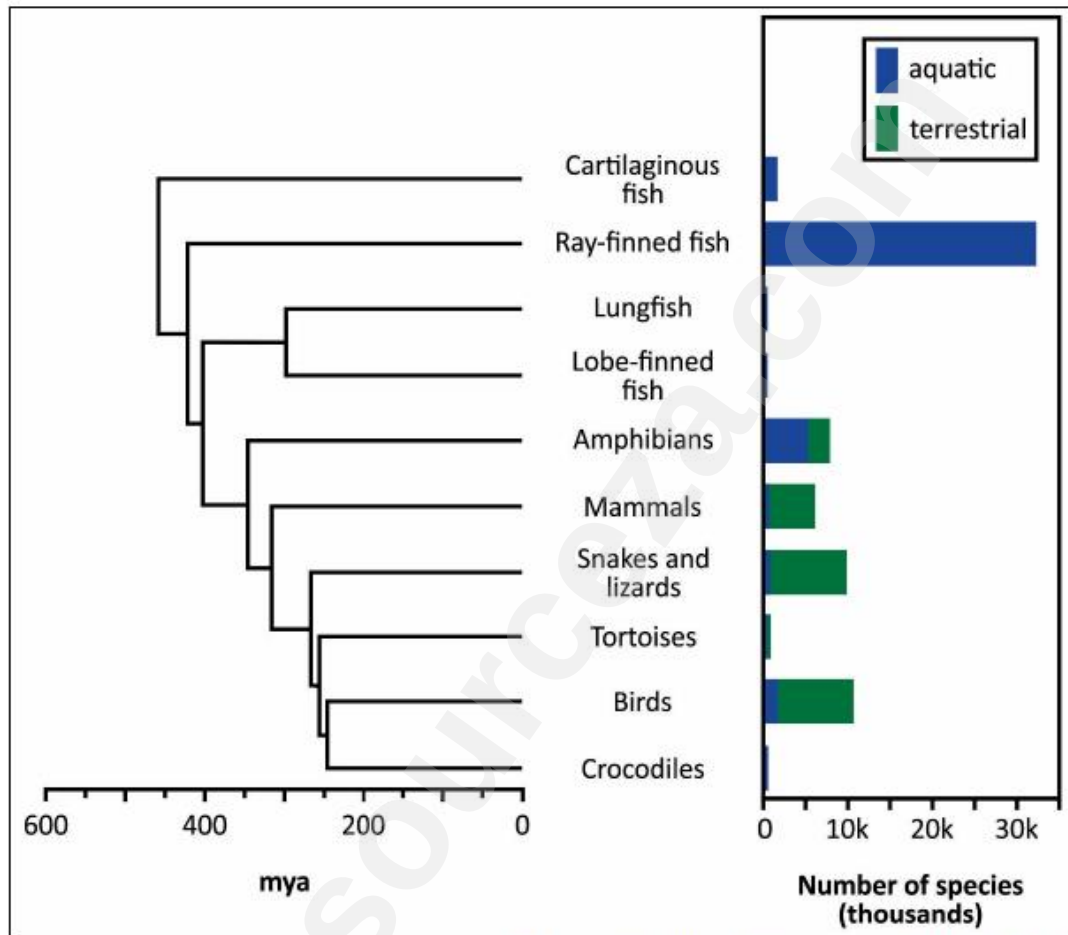
- 2.2 Study the three diagrams (A, B and C) below that show a system used to explain evolution.



- 2.2.1 From a comparison of pictures A and B, name the feature of the cacti that has enabled them to survive long periods of hot, dry weather conditions. (1)

- 2.2.2 The mechanism put forward by Darwin to explain his theory of evolution was Natural Selection. Use the diagrams above to explain this theory. (5)

- 2.3 Study the diagram of the phylogenetic tree of some vertebrates. Included in the diagram is the number of species in each vertebrate group as well as the number of species that live in aquatic (water) and in terrestrial (land) environments.



[Adapted: <<https://www.semanticscholar.org>>]

- 2.3.1 Refer to the diagram shown on the previous page and state whether the statements (a) to (f) are true (T) or false (F).

a) The earliest vertebrates lived in an aquatic environment. (1)

b) Mammals have the greatest number of terrestrial species. (1)

c) There are 10 000 bird species. (1)

d) The lobe-finned fish diverged from the lungfish around 290 mya. (1)

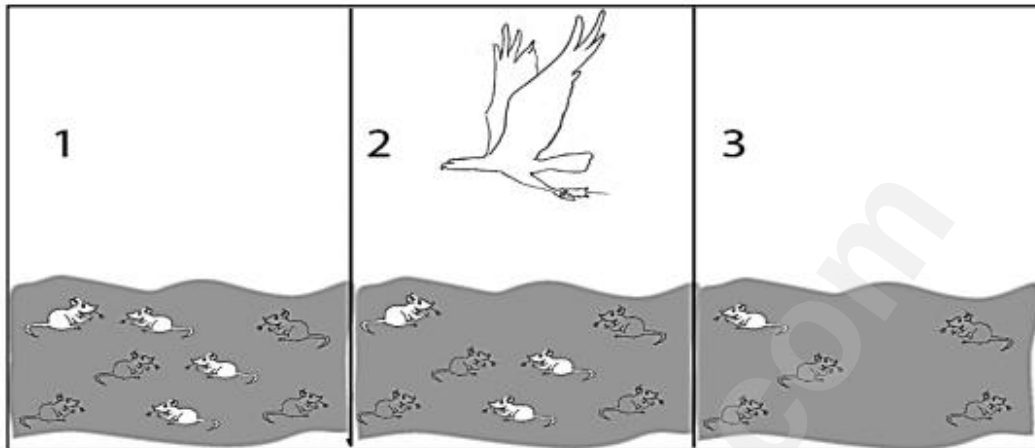
e) Tortoises are more closely related to birds than to crocodiles. (1)

f) Amphibians have been present for 400 million years. (1)

2.3.2 Explain TWO lines of evidence that scientists can use to determine the evolutionary relatedness of the different groups of vertebrates. (4)

2.4 Doctors are now prescribing fewer antibiotics to reduce the evolution of antibiotic-resistant bacteria. Using the example of antibiotic-resistant bacteria, discuss how the theory of evolution can aid in understanding and solving this public health problem. (5)

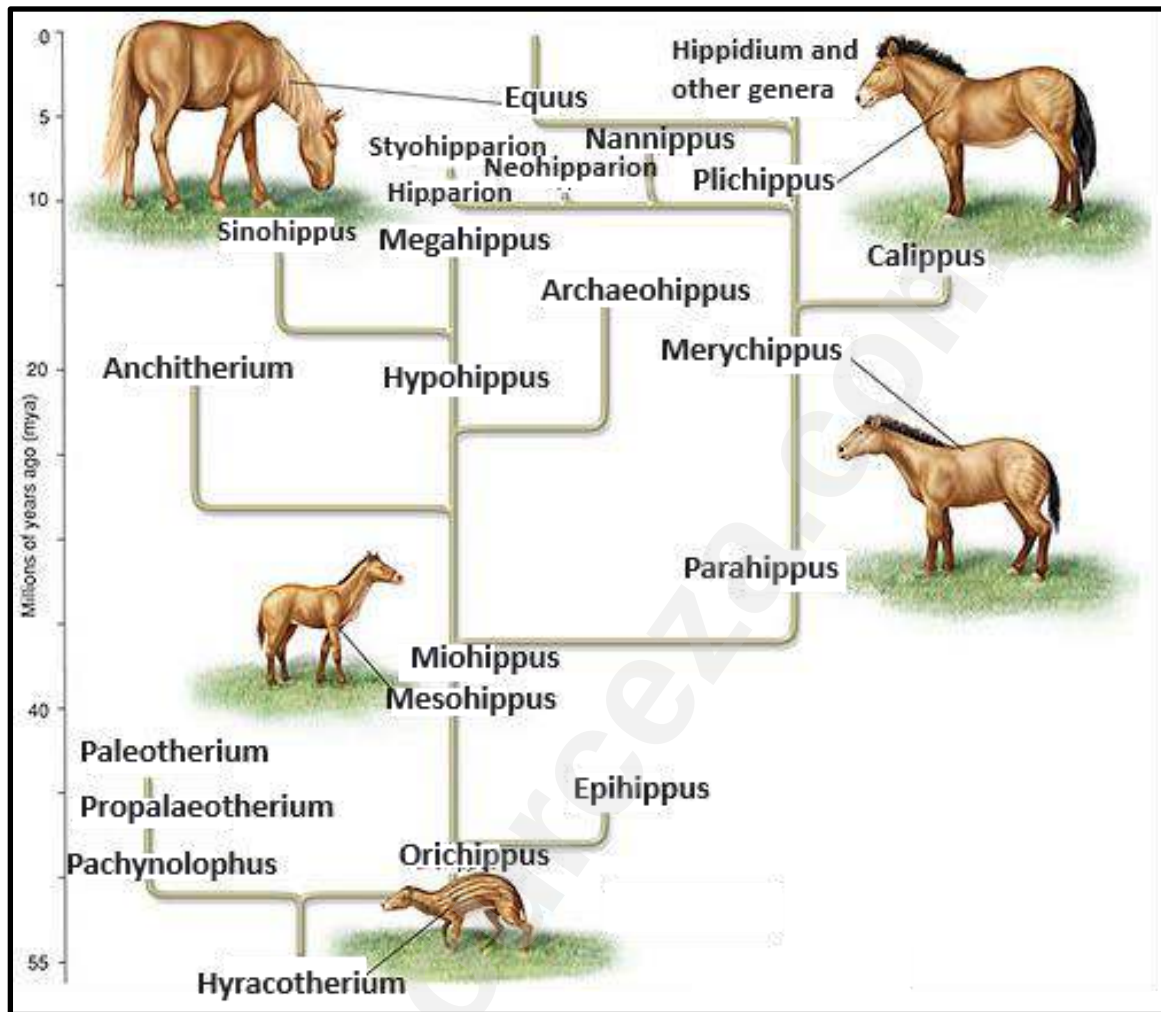
- 2.5 Study the sequence of diagrams below (sequenced in time order) and answer the questions that follow:



[Adapted from the University of California, Los Angeles, *Life Sciences 1: Demonstration Manual*]

- 2.5.1 Explain the term 'survival of the fittest' in relation to the example given above. (4)

2.6 A phylogenetic tree showing the evolution of the horse is shown below.



Adapted from: Curro Hazeldean Prelim Paper 1 2022

2.6.1 How would Lamarck have explained the physical changes seen in horse evolution, from Hyracotherium to modern Equus? (4)

2.6.2 Which horse genus is the last common ancestor of Hippidium and modern horses? (1)

- 2.6.3 Describe the selective pressures that influenced horse evolution over the 55mya shown in the cladogram. (3)

- 2.6.4 Explain the meaning of the hypothesis of 'Lamarckism'. (2)

[40]

QUESTION 3**[40]**

- 3.1 Read the information on Mucopolysaccharidosis / Hunter Syndrome below and use it and your own knowledge to answer the questions that follow it.

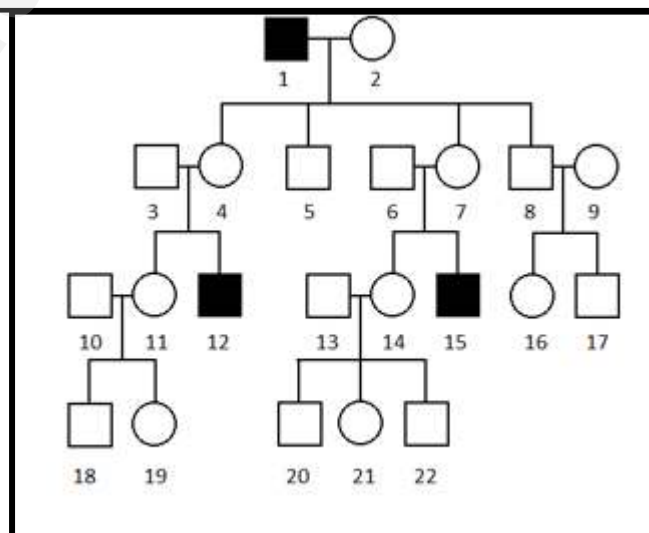
Mucopolysaccharidosis type II (MPS II), also known as Hunter syndrome, occurs almost exclusively in males. It is a condition that affects many different parts of the body. It is a progressively debilitating disorder. However, the rate of progression varies among affected individuals.

At birth, individuals with MPS II do not display any features of the condition. Between ages two and four years, they develop full lips, large rounded cheeks, a broad nose, and an enlarged tongue. The vocal cords also enlarge, which results in a deep, hoarse voice. Narrowing of the airway causes frequent upper respiratory infections and short pauses in breathing during sleep (sleep apnea). As the disorder progresses, individuals need medical assistance to keep their airway open.

Many other organs and tissues are affected by MPS II. Individuals with this disorder often have a large head, a build-up of fluid in the brain, and an enlarged liver and spleen. Most people with this disorder develop hearing loss and have recurrent ear infections. Narrowing of the spinal canal in the neck can compress and damage the spinal cord. The heart is also significantly affected by MPS II, and many individuals develop heart valve problems. Heart valve abnormalities can cause the heart to become enlarged and can eventually lead to heart failure.

There are two types of MPS II, called the severe and mild types. While both types affect many different organs and tissues as described above, people with severe MPS II also experience a decline in intellectual function and a more rapid disease progression. Individuals with the severe form begin to lose basic functional skills (developmentally regress) between the ages of six and eight. The life expectancy of these individuals is 10 to 20 years. Individuals with mild MPS II also have a shortened lifespan, but they typically live into adulthood and their intelligence is not affected. Heart disease and airway obstruction are major causes of death in people with both types of MPS II.

Hunter syndrome is a condition that is inherited in an X-linked pattern. The gene associated with this condition is located on the X chromosome, which is one of the two sex chromosomes. In males, one copy of the gene in each cell is sufficient to cause the condition whereas a female must be homozygous for Hunter syndrome to have the disorder. A characteristic of X-linked inheritance is that fathers cannot pass X-linked traits to their sons.



- 3.1.1 Give the correct scientific term for a sex chromosome. (1)

- 3.1.2 Draw an annotated genetic diagram to explain the last sentence in the text - 'a characteristic of X-linked inheritance is that fathers cannot pass X-linked traits to their sons'. (6)

- 3.1.3 Questions (a) to (e) below refers to the showing of the inheritance of Hunter syndrome in a family.

- a) Is the allele for this condition dominant or recessive? Use one piece of information from the text to justify your answer and use information from the pedigree to illustrate your answer. (4)

- b) Neither of the parents of individual 1 possessed the gene for Hunter syndrome. Explain what must have occurred for individual 1 to have the gene (1)

- c) Using the numbers allocated to each individual on the pedigree, give the number of each of the females in this pedigree who are definitely carriers of the allele for Hunter syndrome. (2)

- d) Individual 15 married a female who was homozygous normal. They had two boys and one girl.

- i) Use a genetic diagram or a Punnett square to show this cross. Ensure that you stipulate the symbols that you are going to use before you begin the diagram. (6)

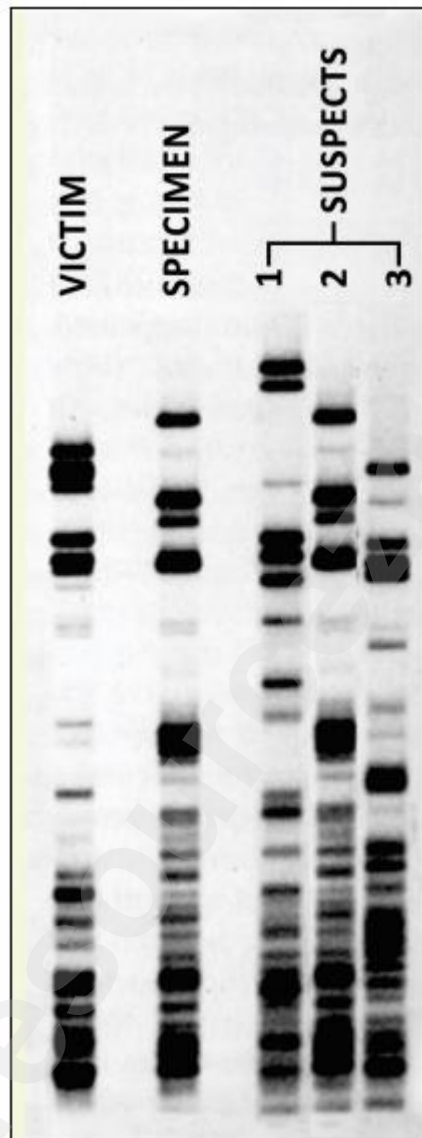


- ii) What is the chance of either of their sons inheriting the disorder? (1)

- iii) What is the chance that their daughter would be a carrier of the disorder? (1)

- e) Considering information in the text and the pedigree diagram do you feel that the type of MPS II in this family is the severe or the mild type? Justify your answer. (3)

- 3.2 At a crime scene, a forensic scientist found a small specimen of blood which was not from the victim. DNA was also extracted from the blood samples of the victim and three suspects and the DNA profiles were produced and can be seen below.



[<www.berkeley.edu>]

- 3.2.1 Identify the suspect that most likely committed the crime. (1)

- 3.2.2 The forensic scientist only found a small specimen of blood.

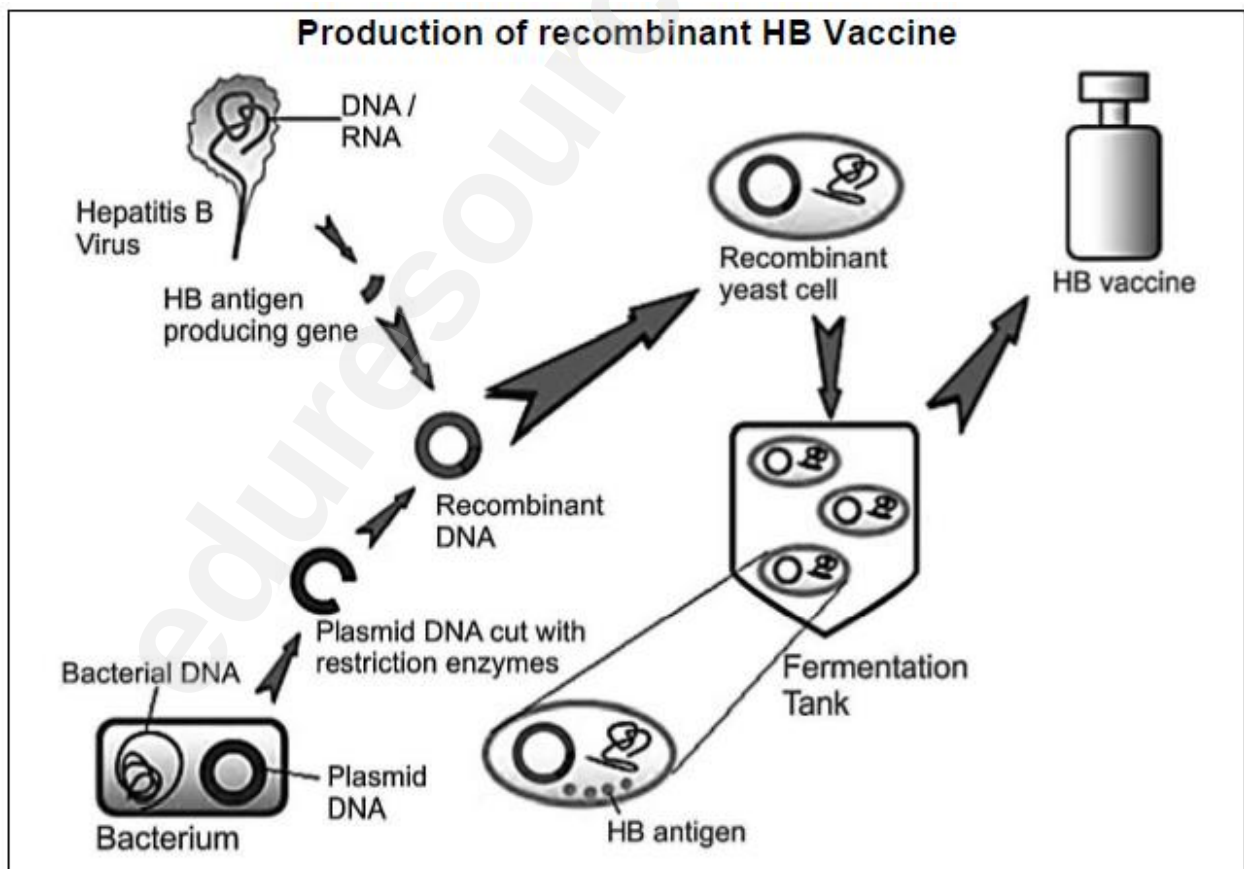
- a) What procedure does the forensic scientist perform to ensure there is enough DNA for analysis? (1)

b) Which cells in the blood sample would be used to obtain DNA? (1)

3.2.3 Suggest TWO reasons why using only a DNA profile in identifying the person who committed the crime may not be reliable. (2)

3.2.4 Name one other use for a DNA profile. (1)

3.3 Recombinant DNA Technology has revolutionised the biomedical world. Study the diagram below, which shows how biotechnology has been used to produce a vaccine that is given to all babies.



[Source: <www.ied.edu.hk/biotech>]

3.3.1 Name the enzyme used to join the gene from the HB virus into the bacterial plasmid. (1)

3.3.2 What is meant by the term "Recombinant DNA"? (2)

3.3.3 Identify six critical steps in this biotechnological process. (6)

[40]

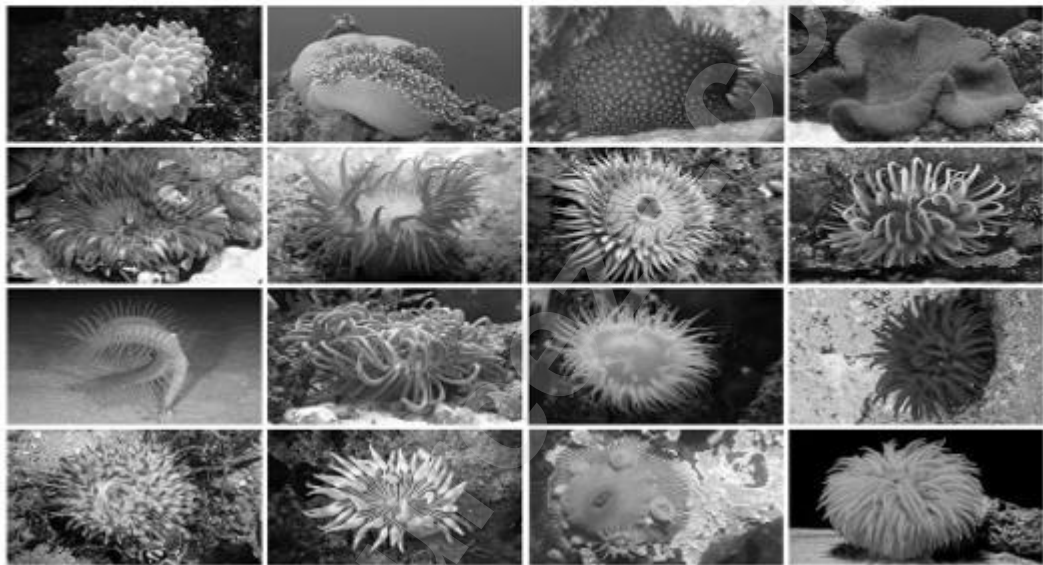
QUESTION 4**[40]**

4.1 Study the information below and answer the questions that follow.

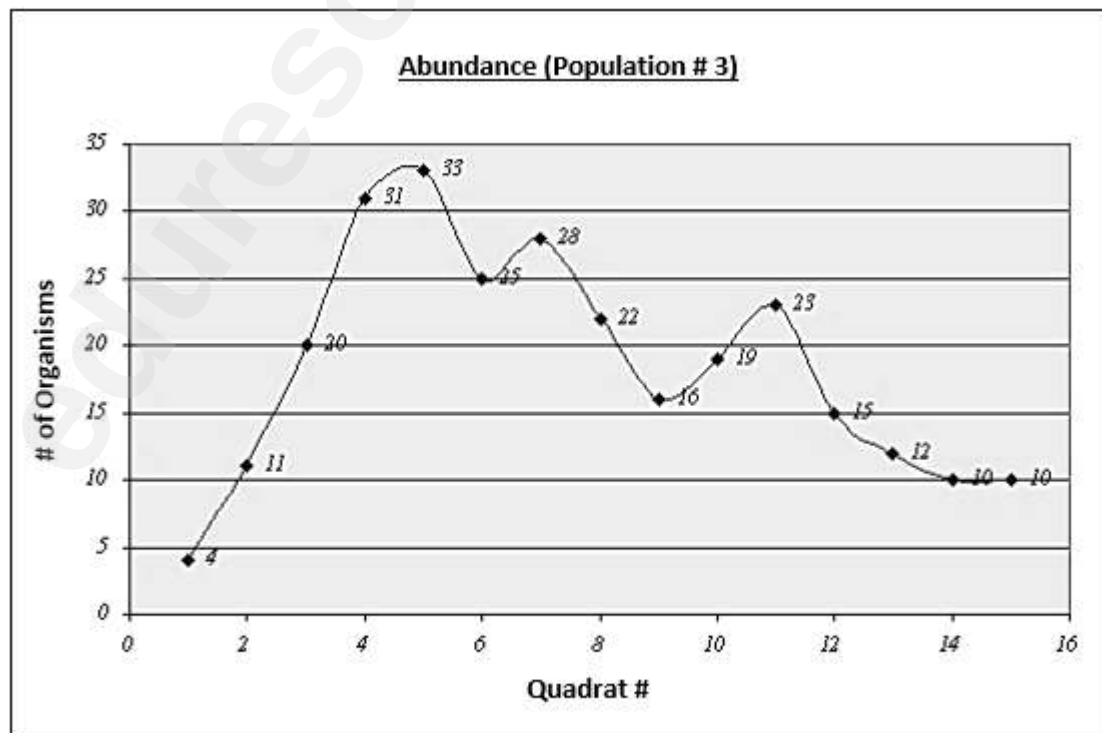
Quadrat sampling was used to measure the population size of sea anemones on a rocky shore. The graphs below show the results obtained from this investigation.

- The quadrats used were 1m x 1m.
- # = number of the sample site, of organisms, of quadrat, etc.

Sea Anemones

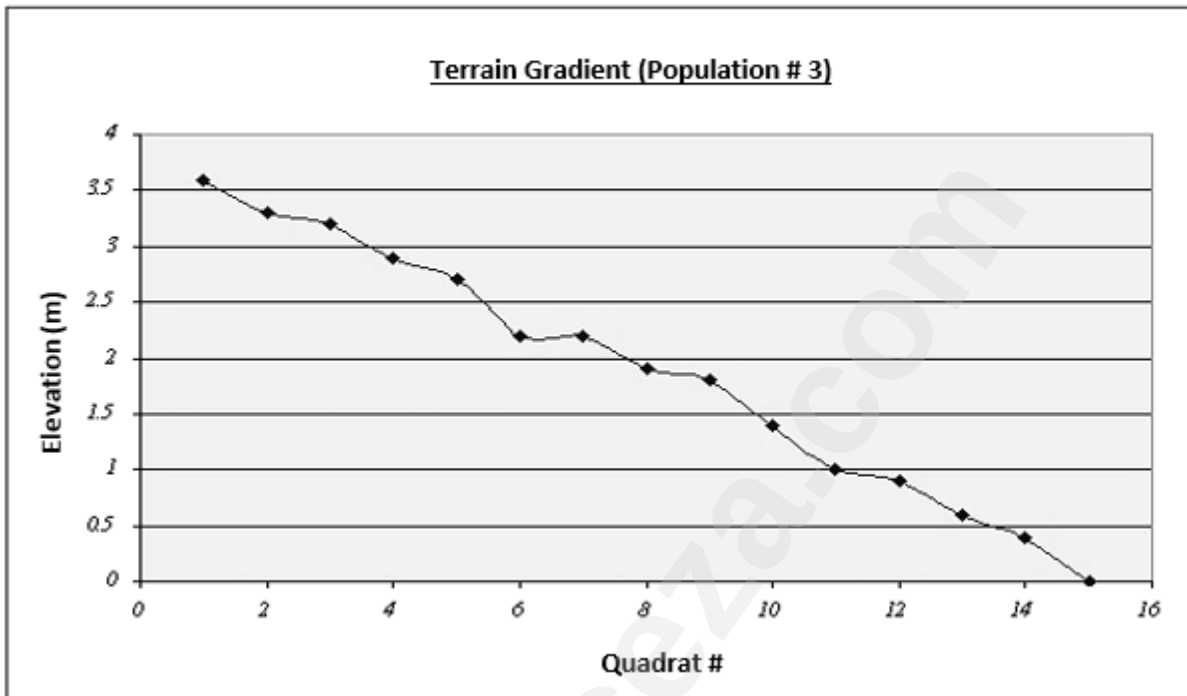


<http://i.imgur.com/zlp8dVy.jpg> Date of access 28/04/2019



<http://www.racerocks.com/racerock/research/santiago/santiago.htm>

Graph 2: The height above low tide (elevation in metres) that the quadrat was placed.



- 4.1.1 State two reasons why quadrats are used to assess the population numbers of sea anemones. (2)

- 4.1.2 Which quadrat at site number 3 had the greatest number of sea anemones? (Graph1). (2)

- 4.1.3 What is the average population density of sea anemones at site number 3 (population #3) in graph 1? Show your working. (3)

- 4.1.4 Graph 2 shows the height of the quadrats above low tide. Quadrat #15 was placed at sea level. Which quadrat was placed 1 meter above the low tide level? (1)

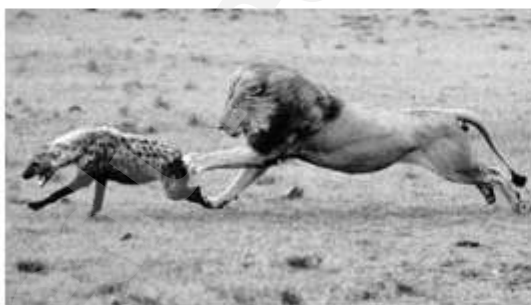
- 4.1.5 At which level above low tide were most sea anemones found? (2)

- 4.2 Read the following information and then answer the questions below.

The **lion** (*Panthera leo*) is one of the five big cats in the genus *Panthera*. The commonly used term **African lion** collectively denotes the several subspecies found in Africa. With some males exceeding 250 kg in weight, it is the second-largest living cat after the tiger. Wild lions currently exist in sub-Saharan Africa and in Asia. They are listed as Vulnerable on the IUCN Red Data List. Lions and spotted hyenas occupy the same ecological niche, in the areas where they coexist. They are sworn enemies, and the lions will kill hyenas or drive them out of their territory whenever they clash.



Resident male lions regularly mark their territory by spraying vegetation with urine and by scuff-marking. Roaring serves to advertise territories, to communicate with other pride members, and to demonstrate aggression toward enemy lions.



Lions typically live in a pride made up of one male, four to five females who usually hunt together, and four to five cubs. Up to two subordinate males may stay with the pride, but most males leave at age two and become nomadic.

Females are mainly responsible for the care of the young. Females nurse their young but will also nurse the young of their female relatives in the pride if litters are born close together.

Adult lions have no predators but are vulnerable to humans, starvation, and attacks from other lions. Infanticide is an important contributor to cub mortality and cub mortality increases when prey is scarce.

There are about 25 000 African lions left in the wild and the general population trend is in decline.

<http://www.iucnredlist.org/search> - 2015 <https://en.wikipedia.org/wiki/Lion>

4.2.1 Which TWO parameters for keeping lion numbers at the carrying capacity are referred to in the text? (2)

4.2.2 What does; ...”occupy the same ecological niche” ... mean? (2)

4.2.3 One of the causes of infanticide occurs when the male intentionally kills cubs that try and feed with him. This is a survival strategy. In your opinion, what is the logic behind this behaviour? (2)

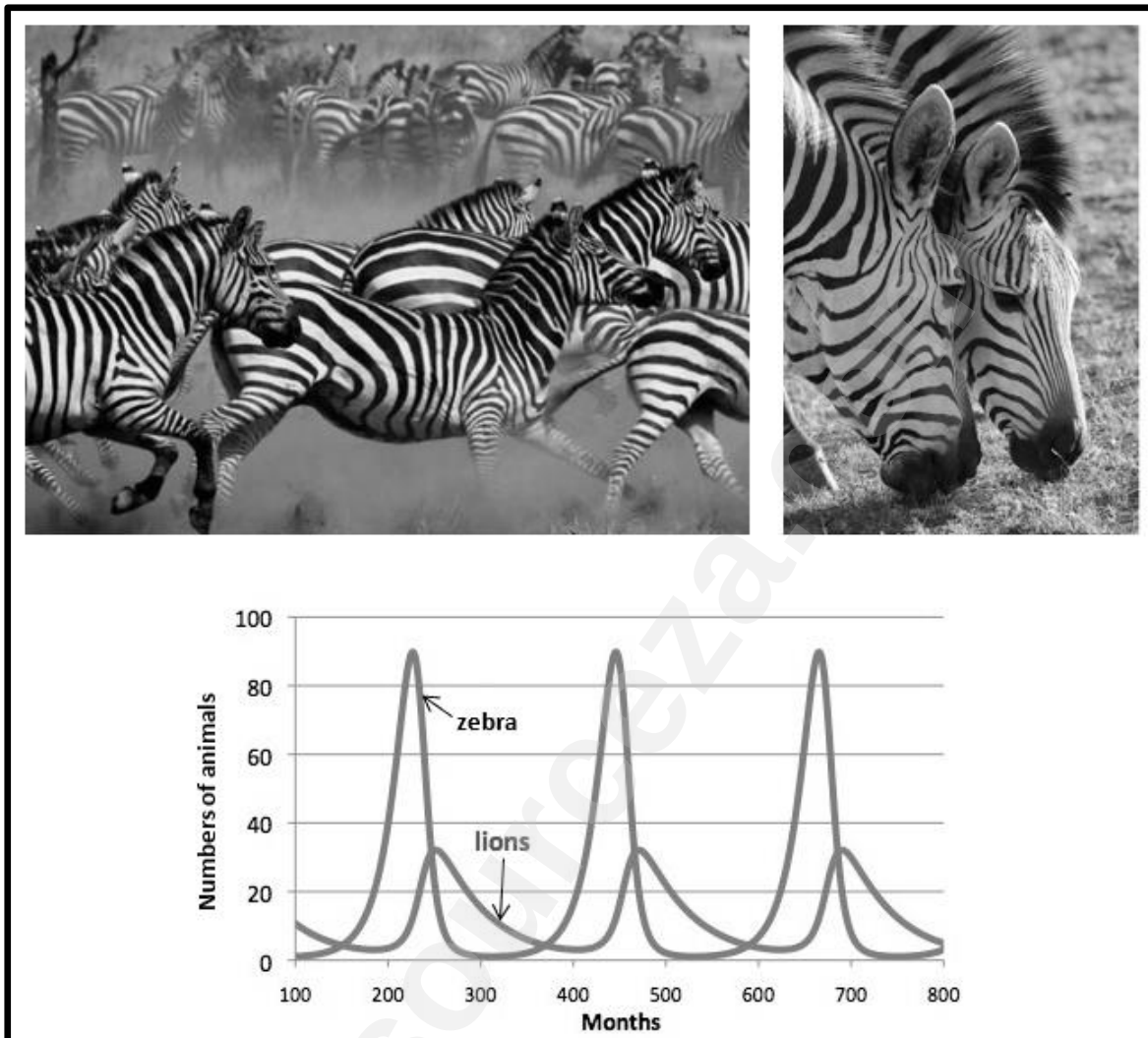
4.2.4 List two other strategies (besides that described in 4.2.3) that lions have to ensure that the pride gets enough food. (2)

4.2.5 Explain the type of competition that occurs between lions and hyenas (1)

4.2.6 Describe three limiting factors that regulate the growth of the hyena population. (3)

4.2.7 State what the effect would be if the hyena population exceeded the carrying capacity. (2)

4.3 Study the following information and answer the questions relating to it:



4.3.1 What relationship is shown in the graph above? (1)

4.3.2 Explain the changing shape of the lion curve in relation to the zebra curve. (4)

- 4.3.3 Do you think the zebra population represented in the above graph can sustain the maximum size of the lion population? Give TWO reasons for your answer. (2)

- 4.3.4 Zebras have distinctive black and white stripes and move around in herds, which is a very good safety mechanism to avoid predation. Explain this statement with reference to lions hunting them. (2)

- 4.3.5 Zebras are often found grazing together with impala and wildebeest. What is this form of coexistence called? (1)

- 4.3.6 Explain how the number of lions could be effectively determined on this game farm. (2)

4.4 Study the information below and answer the questions.

Intense Tropical **Cyclone Idai** was one of the worst tropical cyclones on record to affect Africa and the Southern Hemisphere. The long-lived storm caused catastrophic damage in Mozambique, Zimbabwe, and Malawi, leaving more than 1 300 people dead and many more missing. The photograph below shows the effect of the cyclone on the environment in Malawi.



<http://floodlist.com/wp-content/uploads/2019/03/flooding-shire-river-malawi-march-2019-Govt-of-Malawi.jpg>
https://en.wikipedia.org/wiki/Cyclone_Idai

4.4.1 Describe the type **and** steps of succession that will occur after this flood has receded. (4)

Adapted from: Curro Hazeldean Prelim Paper 1 2022, Mrs M.Maartens

[40]

Grand Total: 200 marks