



education

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**NATIONAL
SENIOR CERTIFICATE**

GRADE 12

LIFE SCIENCES P2

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MARKS: 150
TIME: 2½ hours

This question paper consists of 17 pages.

INSTRUCTIONS AND INFORMATION

Read the following instructions carefully before answering the questions.

1. Answer ALL the questions.
2. Write ALL the answers in the ANSWER BOOK.
3. Start the answers to EACH question at the top of a NEW page.
4. Number the answers correctly according to the numbering system used in this question paper.
5. Present your answers according to the instructions of each question.
6. Do ALL drawings in pencil and label them in blue or black ink.
7. Draw diagrams, flow charts or tables only when asked to do so.
8. The diagrams in this question paper are NOT necessarily drawn to scale.
9. Do NOT use graph paper.
10. You must use a non-programmable calculator, protractor and a compass where necessary.
11. Write neatly and legibly.

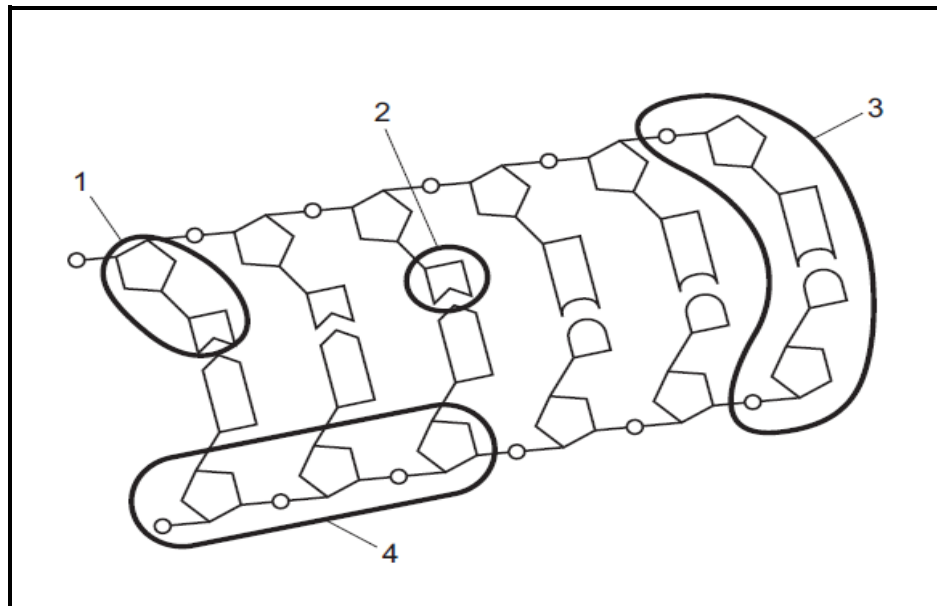
SECTION A**QUESTION 1**

1.1 Various options are provided as possible answers to the following questions. Choose the answer and write only the letter (A to D) next to the question number (1.1.1 to 1.1.9) in the ANSWER BOOK, for e.g 1.1.10 D.

1.1.1 The genotype of an organism is ...

- A a characteristic that can be seen.
- B the genetic composition of an organism.
- C a mapping of all the genes of an organism.
- D the position occupied by a gene on a chromosome.

1.1.2 The diagram below shows part of a DNA molecule.



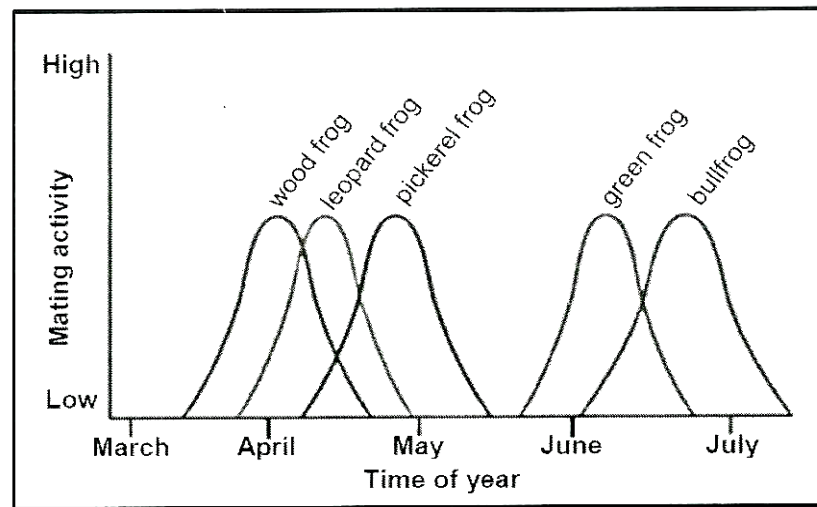
Which regions contain phosphate groups?

- A 1 and 2 only
 - B 1 and 4 only
 - C 3 and 4 only
 - D 2, 3 and 4 only
- 1.1.3 The inheritance of blood group AB is as a result of...
- A complete dominance.
 - B sex-linked inheritance.
 - C incomplete dominance.
 - D co-dominance.

1.1.4 A messenger RNA molecule contains 300 nitrogenous bases. The maximum number of amino acids that it can code for is ...

- A 300.
- B 150.
- C 30.
- D 100.

1.1.5 Scientists have investigated on the breeding habits of different species of frogs. Different frogs, which all belong to the genus *Lithobates*, are found in the same forest. The graph shows their mating activity.



Based on the information, what kind of reproductive isolation mechanism is most likely keeping the bullfrogs and wood frogs as separate species?

- A Geographic isolation through the presence of geographic barriers
- B Reproductive isolation through species specific courtship behaviour
- C Reproductive isolation through seasonal isolation
- D Reproductive isolation through the production of infertile offspring

- 1.1.6 The table below shows the number of differences in the amino acid sequence of the protein albumin in four species of primates.

Species of primates	Monkey	Gibbon	Gorilla	Human
Human	32	14	8	0
Gorilla	32	14	0	
Gibbon	32	0		
Monkey	0			

Which TWO species are likely to have separated most recently, according to the results on the table?

- A Humans and monkeys
 B Gorillas and gibbons
 C Gibbons and monkeys
 D Gorillas and humans
- 1.1.7 The list below contains steps taken during the replication of DNA. Place them in the correct order.
- Both strands act as templates
 - Complementary free nucleotides bind to each strand
 - DNA unwinds and hydrogen bonds break
 - Newly formed DNA molecules are identical to each other
- A 1,2,3,4
 B 2,3,1,4
 C 3,2,1,4
 D 3,1,2,4
- 1.1.8 Scientists recovered the body of an extinct woolly mammoth from frozen soil of Siberia. The DNA sequence of the woolly mammoth was very similar to the DNA sequence of the African elephant.
- A The woolly mammoth and the African elephant have a common ancestor.
 B The woolly mammoth is not related to the African elephant.
 C The woolly mammoth has the same number of chromosomes as the African elephant.
 D The woolly mammoth and the African elephant should be classified as the same species.

- 1.1.9 A trait that has a range of phenotypes is an example of ...
- A continuous variation.
 - B Lamarckism.
 - C Darwinism.
 - D discontinuous variation.
- (9 x 2) **(18)**

1.2 Give the correct **biological term** for each of the following descriptions. Write only the term next to the question numbers (1.2.1 to 1.2.9) in the ANSWER BOOK.

- 1.2.1 The process in which a genetically identical copy of an organism is created
- 1.2.2 The phenomenon where two homozygous individuals are crossed and the offspring display an intermediate form of the characteristics of the two parents
- 1.2.3 Opening in the skull through which the spinal cord enters
- 1.2.4 A diagram showing evolutionary relationships amongst different species
- 1.2.5 The theory that proposes that evolution does not always occur at a steady rate, but in a sudden burst after long periods of no change
- 1.2.6 Phase of meiosis during which the chromosome number halves
- 1.2.7 A phase in cell cycle during which a cell grows and replicates its genetic material
- 1.2.8 A cell condition in which the nucleus contains a full set of chromosomes
- 1.2.9 The area where the chromatids cross over and form breakage points

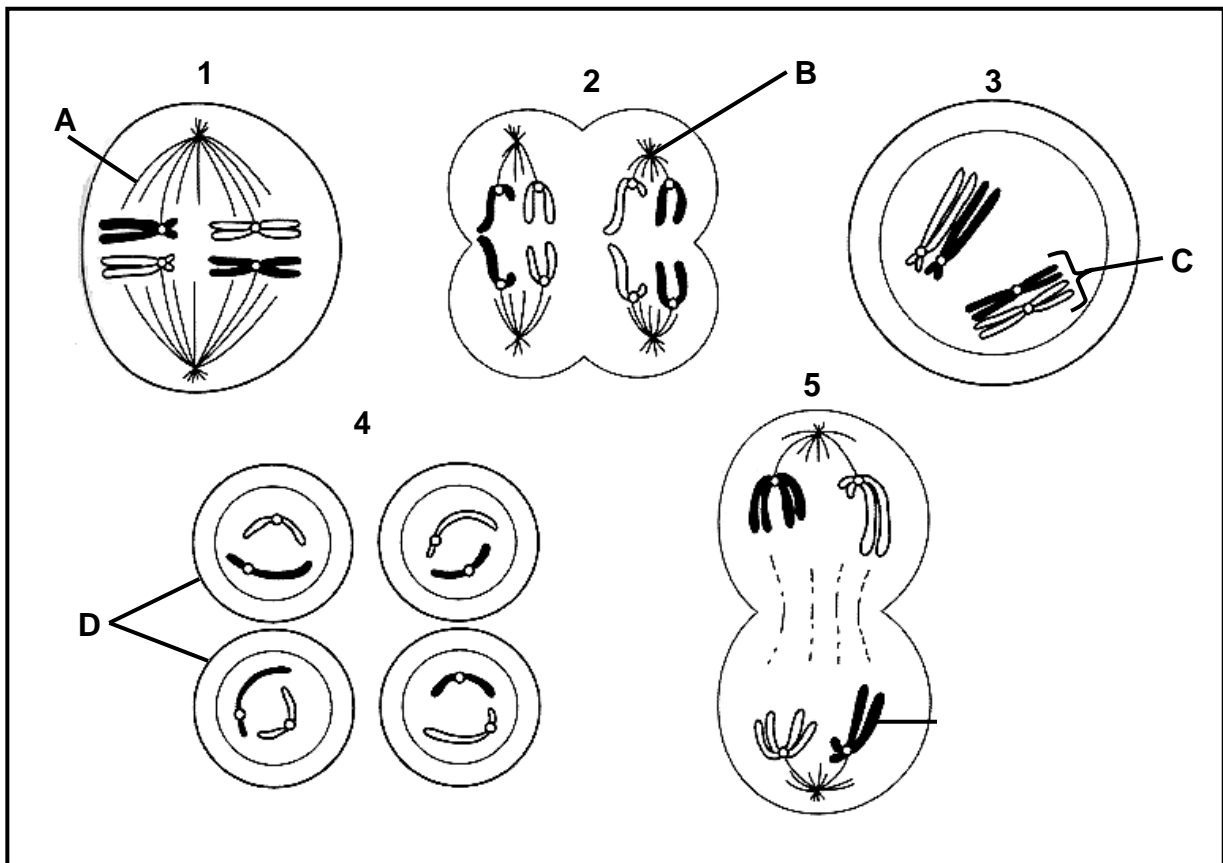
(9 x 1) **(9)**

1.3 Indicate whether each of the statements in COLUMN I apply to **A ONLY**, **B ONLY**, **BOTH A AND B** or **NONE** of the items in COLUMN II. Write **A only**, **B only**, **both A and B**, or **none** next to the question numbers (1.3.1 to 1.3.3) in the ANSWER BOOK.

COLUMN I		COLUMN II
1.3.1	A specific pattern of bands that represents a unique sequence of nucleotides that resemble bar codes	A: DNA replication B: DNA profile
1.3.2	The allele that produces its characteristic phenotype when in a homozygous or heterozygous state	A: Recessive B: Dominant
1.3.3	Organisms have an inherent/internal drive to change	A: Lamarck B: Darwin

(3 x 2) (6)

1.4 The diagrams below show cells dividing during meiosis.



1.4.1 Identify the parts labelled **A** to **D**. (4)

1.4.2 Identify the phase represented in:

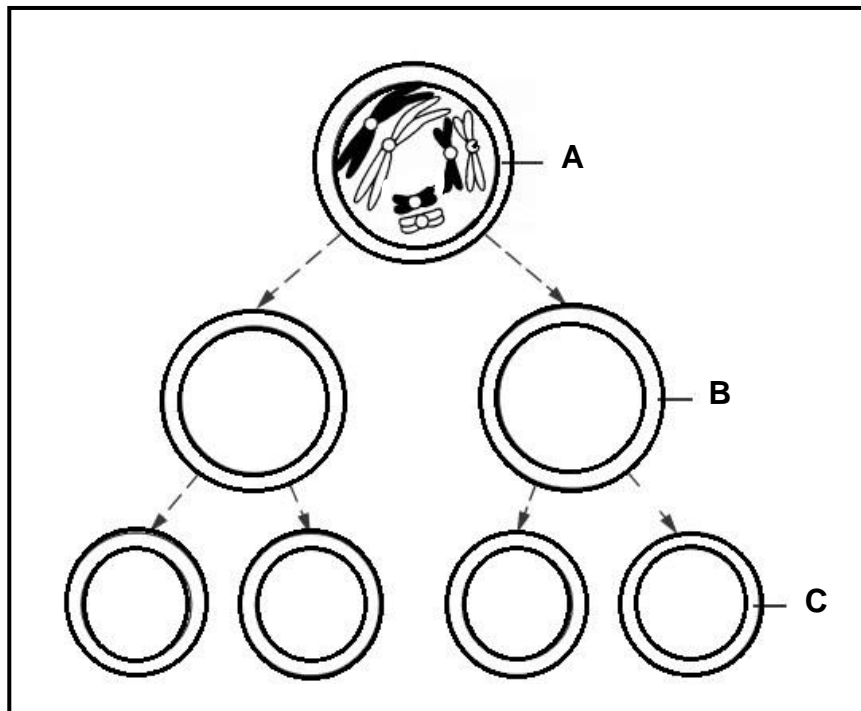
(a) Diagram 1 (1)

(b) Diagram 2 (1)

1.4.3 Use the numbers of the diagrams to give the correct sequence in which the phases occur. (2)

(8)

1.5 The diagram below shows an animal cell undergoing meiosis.



1.5.1 State the number of chromosomes in cell ...

(a) **A.**

(1)

(b) **B.**

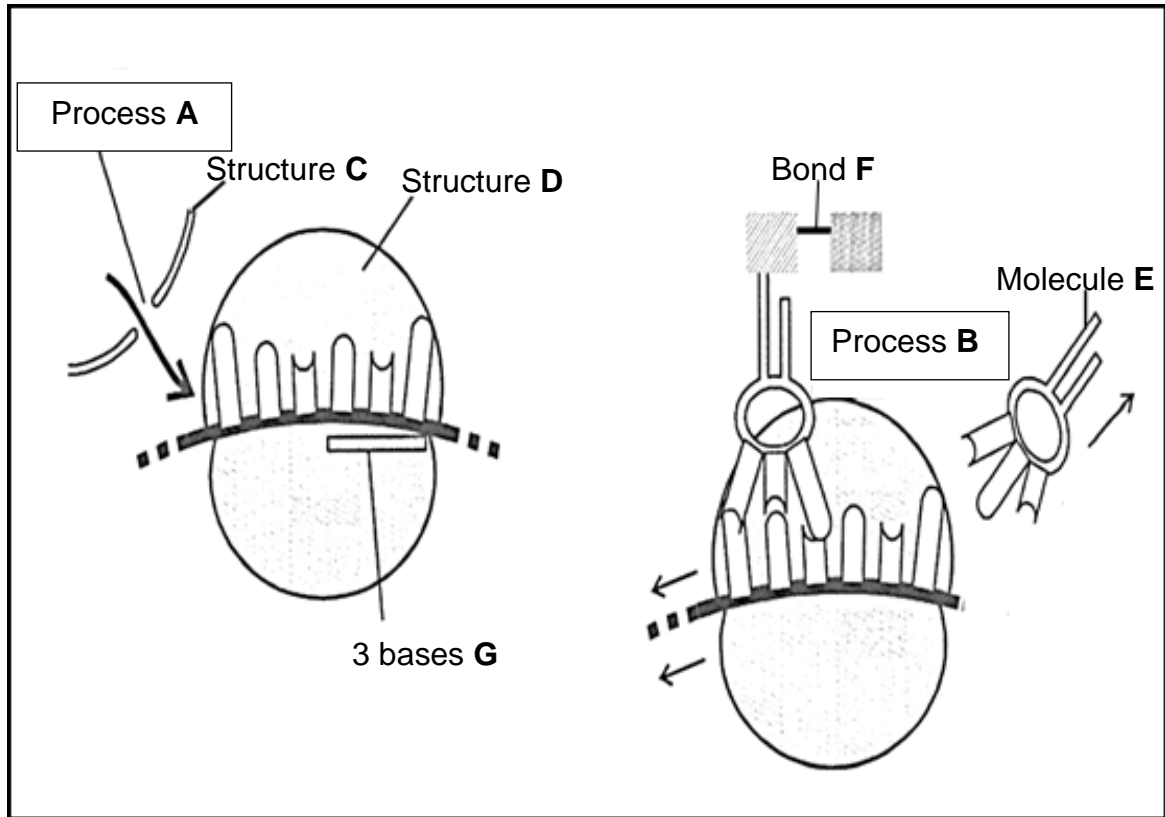
(1)

1.5.2 Where in a mammal could the cell **A** possibly be found?

(1)

(3)

1.6 The diagram below represents a process that takes place in the cell.



1.6.1 Name the processes marked **A** and **B** respectively. (2)

1.6.2 Identify:

(a) Organelle **D** (1)

(b) Molecule **E** (1)

(c) Bond **F** (1)

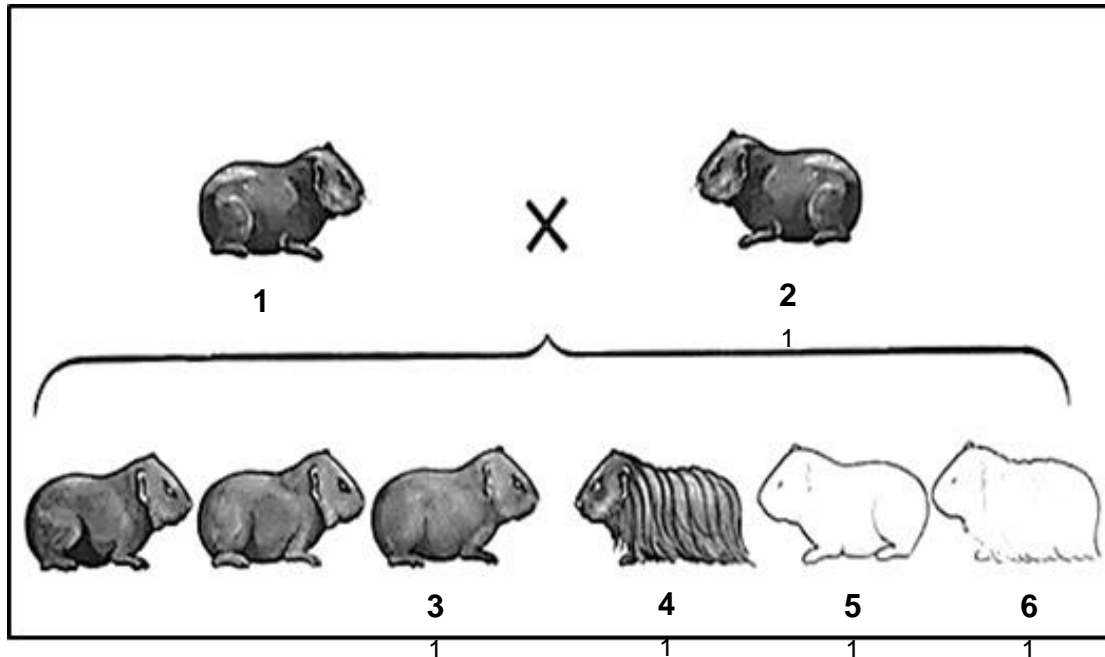
(d) Group of three nucleotide bases at **G** (1)

(6)

TOTAL SECTION A: 50

SECTION B**QUESTION 2**

- 2.1 In guinea pigs, the allele for black fur, represented by **(B)**, is dominant over the allele for white fur **(b)**. The allele for short hair **(H)** is dominant over the allele for long hair **(h)**. Two guinea pigs with short black hair mated and produced six offspring. The diagram shows the cross and the offspring.



- 2.1.1 State why the example above represents a dihybrid cross. (1)
- 2.1.2 Explain why parents **1** and **2** must be heterozygous for both characteristics. (2)
- 2.1.3 Write down the:
- (a) Phenotype of guinea pig **4** (1)
- (b) The genotype/s of guinea pig **5** (1)
- 2.1.4 Give the genotypes of all the possible gametes produced by guinea pig **6**. (1)
- (6)
- 2.2 Human blood groups are controlled by multiple alleles.
- 2.2.1 Name ALL the alleles that control human blood groups. (3)
- 2.2.2 How many of the alleles named in QUESTION 2.2.1 can any individual inherit? (1)
- 2.2.3 A man has blood group A and his wife has blood group B. Their first child has blood group AB and second child has blood group O. What can one conclude about the blood groups of their future children? (4)

(4)
(8)

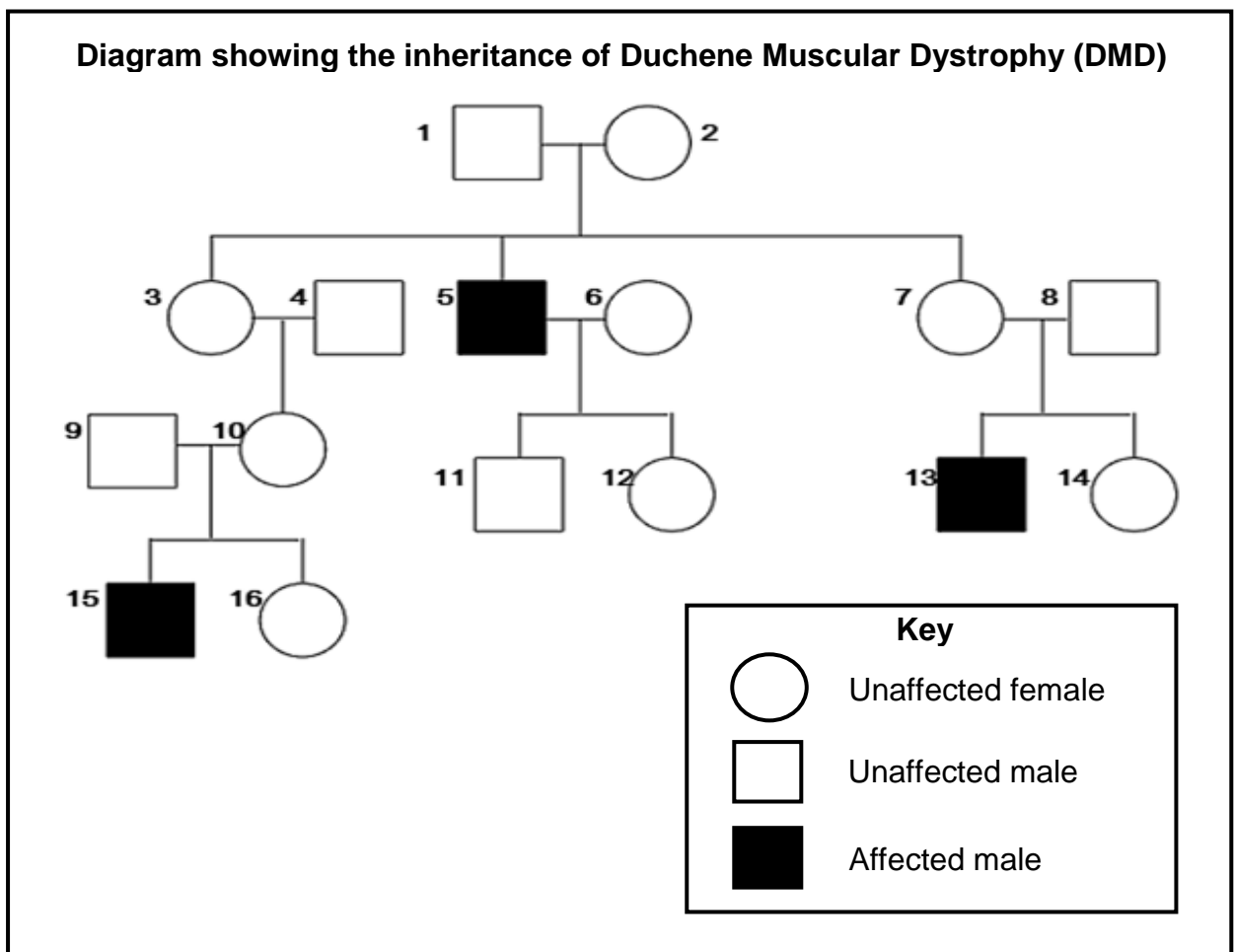
2.3 Meiosis is an important process that takes place in plant and animal cells.

2.3.1 Give ONE reason why meiosis is biologically important. (1)

2.3.2 Tabulate TWO differences in between meiosis I and meiosis II. (5)
(6)

2.4 Duchene Muscular Dystrophy (commonly referred to as DMD) is a sex-linked disorder caused by a recessive gene on the X chromosome. The chart below shows the inheritance of DMD in a family.

Use X^d for the affected allele and X^D for the normal allele and analyse the chart in order to answer the questions that follow.



2.4.1 Name the type of diagram shown above. (1)

2.4.2 What does the term *recessive allele* mean? (1)

2.4.3 Write down:

(a) The genotype of the individual **5** (1)

(b) The phenotype of the individual **16** (1)

Use the codons from your answer in QUESTION 2.5.1 above to determine the amino acids that are being coded for at **1** and **4** on the DNA molecule. (2)

2.5.3 If you study the above wheel carefully you will notice that there are more than one codon coding for an amino acid.

Name the codons that code for the amino acid **Lysine**. (2)
(6)

2.6 DNA samples from a patient with an illness showed that there were two different types of DNA present.

Researchers performed an investigation and revealed that one was from human and the other one was from a virus. The two types of DNA were isolated and put into different test tubes.

The analysis of the nitrogenous base composition of each type of DNA is shown in the table below.

TYPE OF DNA	NITROGENOUS BASE COMPOSITION (%)			
	Adenine	Cytosine	Guanine	Thymine
Type 1	22,1	27,9	27,9	22,1
Type 2	31,1	31,3	18,7	18,9

2.6.1 Identify the:

(a) Independent variable (1)

(b) Dependent variable (1)

2.6.2 List TWO ways to improve the reliability of this investigation. (2)

2.6.3 State TWO ways in which the design of the investigation may be improved upon to ensure that the results obtained are more valid. (2)

2.6.4 Give evidence from the table for the identification of Type 1 DNA as being that of a human. (2)

2.6.5 State ONE objection that people may have against keeping a DNA database of all citizens in a country. (1)

(9)
[50]

QUESTION 3

3.1 Read the extract below.

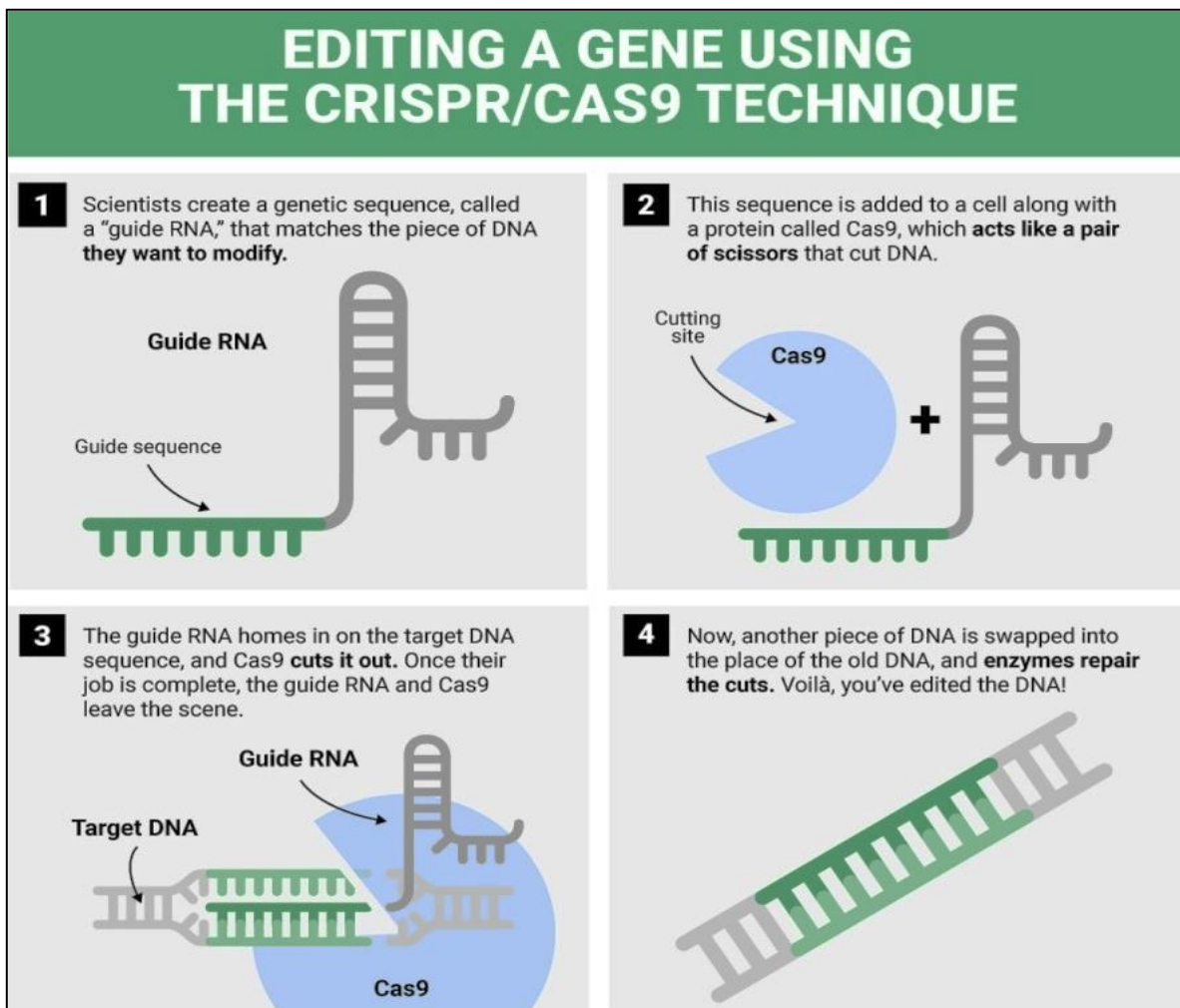
ONE EXCITING GENE EDITING TECHNIQUE

Jennifer Doudna and E. Charpentier were awarded the Nobel Prize in Chemistry in 2020 for their work on gene editing. The technique is known as CRISPR/CAS 9. This biotechnology tool could be useful in combating COVID-19 and other viral pandemics. A pandemic is a disease outbreak that spreads across many countries or continents.

They developed a type of “genetic scissor” called the CRISPR/CAS9 to alter the genome of an organism. This new technology is used for manipulating genome, detection of virus materials, and the kinds of reagents that we need for an effective vaccine.

Scientists can reprogram the CRISPR system to target different sections of the coronavirus to make sure that we are not missing viruses that have undergone gene mutation.

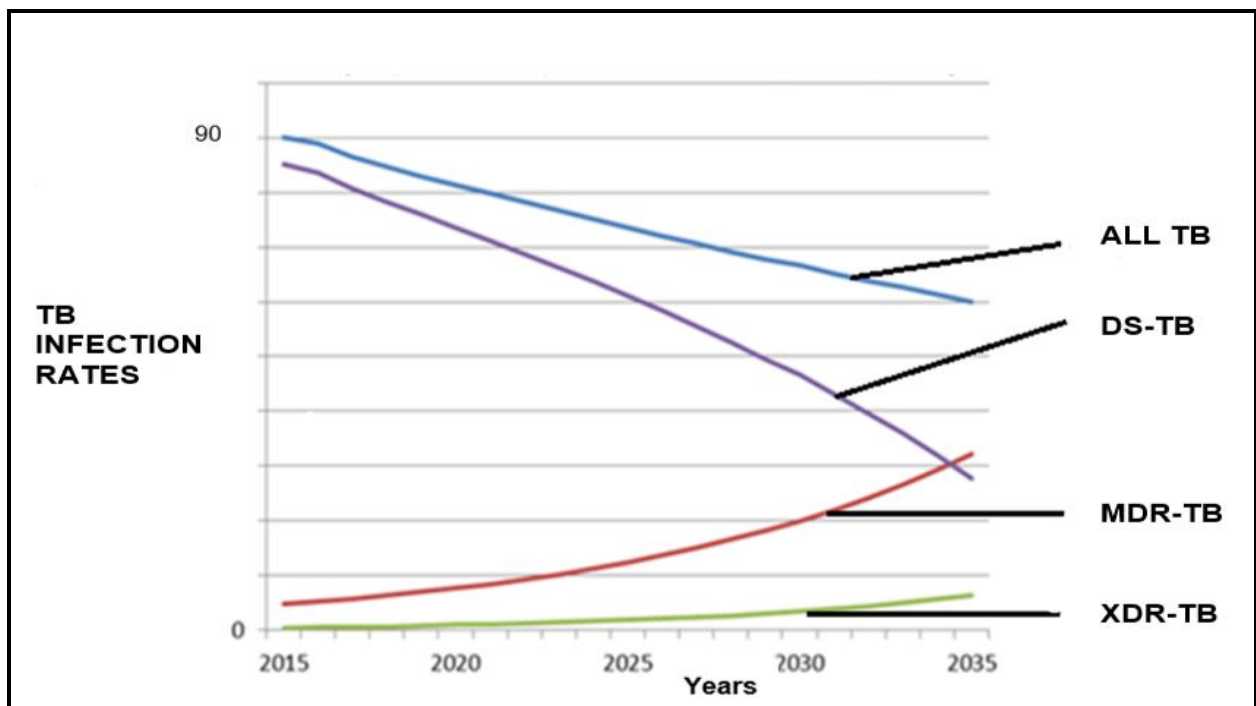
The procedure of gene editing technology is summarised in the following diagram.



- 3.1.1 A gene mutation caused variation among the coronavirus population.
Name THREE other sources of variation. (3)
- 3.1.2 Define the term *genome*. (1)
- 3.1.3 What is meant by a pandemic? (1)
- 3.1.4 According to the extract state ONE benefit of CRISPR technology. (1)
- 3.1.5 Briefly describe the procedure followed by scientists to alter the genome of an organism. (5)
- (11)**

3.2 The graph below shows the expected TB infection rates of four different strains of TB for the next 20 years.

DS-TB stands for Drug susceptible TB and refers to the strains of TB that can be treated by antibiotics. MDR-TB and XDR-TB are drug resistant.



- 3.2.1 Provide a suitable heading for the above graph. (1)
- 3.2.2 Which strain/s of TB is/are expected to decrease over the next 20 years? Give a reason for your answer. (2)
- 3.2.3 Use the theory of evolution through natural selection to describe how strains of MDR-TB can become more resistant to antibiotics and become more prevalent in a population. (5)
- 3.2.4 What is meant by the term: *artificial selection*? (2)
- (10)**

3.3 Read the following extract.

DISCOVERY OF A NEW SPECIES IN SOUTH AFRICA

Professor Lee Berger, a paleoanthropologist at the University of the Witwatersrand found fossils in a cave at the Cradle of Humankind with the help of his son on 15 August 2008. Berger and 60 of his colleagues from all over the world, studied the fossilized bone fragments. They presented it as a new species called *Australopithecus sediba*.

The skeletons from the cave are ranked amongst the most complete finds to date. It has many primitive features characteristic of other australopithecine species and more advanced features typical of *Homo* species.

The almost 2-million-year-old partial skeletons are thought to be that of the transitional species between *Australopithecus africanus* and either *Homo habilis* or *Homo erectus*, the early ancestors of humans. Berger said that the brain, hand and foot have characteristics of both modern and early pre-human forms.

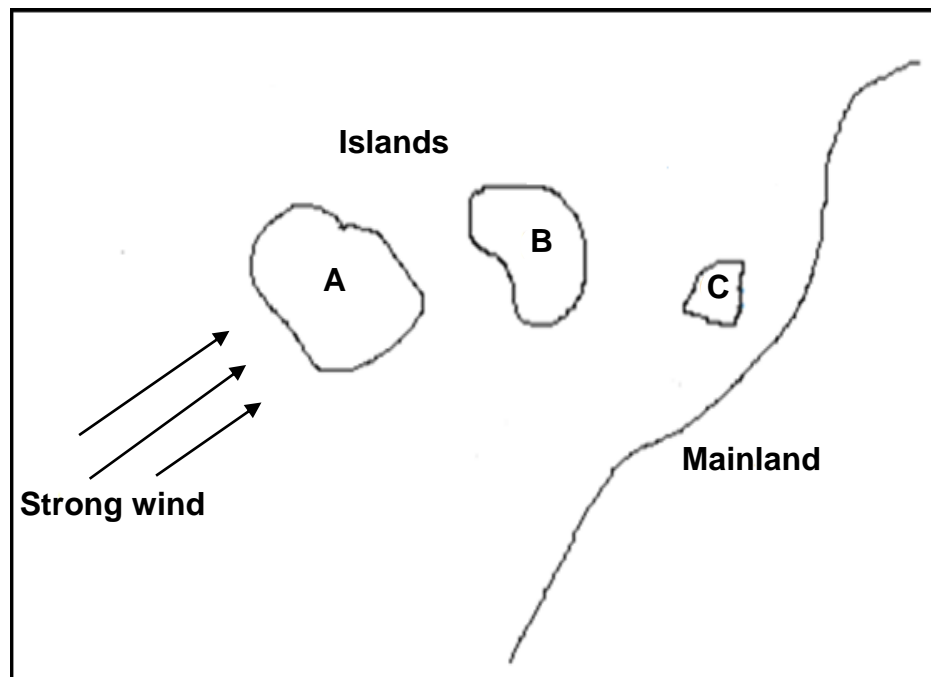
It was noted that the brain of *Australopithecus sediba* is small, like that of a chimpanzee, but with a re-organisation more human-like, particularly with an expansion behind and above the eyes. *A. sediba* was bipedal, the body and canines were smaller than that of *A. africanus*.

- 3.3.1 State TWO characteristics from the extract that also apply to the *Homo* species. (2)
- 3.3.2 Define the term *transitional fossil*. (1)
- 3.3.3 Professor Berger called *Australopithecus sediba* a *transitional fossil*. Use TWO characteristics from the passage to support the above statement. (2)
- 3.3.4 Explain THREE characteristics of a skeleton which are adaptations to bipedalism. (6)
- 3.3.5 The modern human has the largest brain volume of all *Homo* species. What is the significance of a larger brain size in *Homo sapiens*? (2)
- 3.4 3.4.1 The 'Out of Africa' hypothesis states that *Homo sapiens* originated in Africa and spread from here to the rest of the world. Describe the evidence that supports the 'Out of Africa' hypothesis. (6)

3.5 Read the following extract.

A study was done during early 1990's to determine why copper-coloured beetles on a group of islands show so many different characteristics.

The islands are subject to strong winds for a large part of the year. The possibility was investigated that the original beetles from island **A** were blown to islands **B** and **C**.



The investigation showed that beetles from island **A** could mate successfully with beetles from island **B** producing fertile offspring. They could not mate with beetles from island **C**. Beetles from island **B** could mate with beetles from island **C**, but the offspring were sterile.

- 3.5.1 How many species of beetles occur on the three islands **A**, **B** and **C**? (1)
- 3.5.2 From the information given which island would have first received beetles from the original population? Give a reason for your answer. (2)
- 3.5.3 Describe how speciation occurred on the islands. (7)
(10)
[50]

TOTAL SECTION B: 100
GRAND TOTAL: 150