NATIONAL SENIOR CERTIFICATE EXAMINATION
SUPPLEMENTARY EXAMINATION – MARCH 2019

LIFE SCIENCES: PAPER II

Time: 2 hours 100 marks

PLEASE READ THE FOLLOWING INSTRUCTIONS CAREFULLY

1. This question paper consists of 6 pages and a **Source Booklet** of 11 pages (i–xi). Please check that your question paper is complete. Remove the Source Booklet from the middle of the question paper.

2. The question paper consists of three questions. Question 1 and Question 2 are case studies and Question 3 is an essay. Read the sources provided in the Source Booklet and use the information and your own knowledge to answer the questions.

3. Use the total number of marks that can be awarded for each part of the questions in Questions 1 and 2 as an indication of the detail required.

4. Use the source material information and your own knowledge to first plan and then write your essay response.

5. All questions must be answered in the Answer Book provided.

6. Read the questions carefully.

7. Please start **each question** on a **new** page and leave lines open between each sub question (e.g. 1.1 and 1.2).

8. Number the answers exactly as the questions are numbered.

9. It is in your own interest to write legibly and to present your work neatly.

SECTION A

QUESTION 1

These questions refer to the sources in Question 1 on pages (ii–iii) in the Source Booklet. Use the information in the sources as well as your own knowledge to answer the following questions.

1.1 1.1.1 Explain what is meant by the term "mutation". (2)

1.1.2 Describe ONE way in which a mutation can result during

(a) DNA replication. (2)

(b) Meiosis. (4)

1.1.3 Name ONE example of a human genetic disease that is caused by a chromosome mutation. (1)

1.2 This new genome editing tool is known as a "base editor". What is meant by a "base" in this context? (1)

1.3 Using information in the sources as well as your own knowledge, answer TRUE or FALSE to the following statements:

1.3.1 Hydrogen bonds join free nucleotides to their complementary partner. (1)

1.3.2 A chromosome consists of tightly packed DNA and proteins. (1)

1.3.3 DNA polymerase joins the sugars and phosphates together in DNA replication. (1)

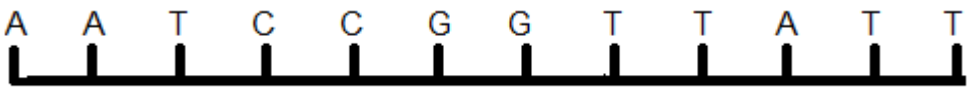
1.3.4 Haemochromatosis is due to a deletion mutation. (1)

1.3.5 Helicase is an enzyme that "unzips" DNA. (1)

1.4 Consider the following strand of DNA, which has TWO errors.

To correct it, the base editing enzyme is used in the following manner:

- alters the **first** base in the **second DNA codon** with a G;
- and the **last** base in the **4th DNA codon** with its complementary base.



Rewrite the DNA strand to show these changes. (2)

1.5 Various comments have been made regarding the discovery of this base editor and its ability to treat diseases in humans.

1.5.1 One of the researchers (Robin Lovell-Badge) is from the Francis Crick Institute. Suggest why a genetics research institute is named after Francis Crick. (1)

1.5.2 List THREE reasons why this discovery would not yet be ready for use in the treatment of human diseases. (3)

1.6 Refer to the picture of the DNA and scissors on page (ii) of the Source Booklet.

1.6.1 Explain how the picture of the scissors cutting the DNA is a good representation of how CRISPR operates as a gene editor. (3)

1.6.2 Base editors are compared to being like a "pencil with an eraser". Explain this comparison. (2)

1.7 Consider the two cartoons shown in the article on page (iii) of the Source Booklet.

1.7.1 Explain clearly why A, C, G and T are considered the "alphabet" of DNA. (3)

1.7.2 Why is U not considered part of "the DNA club"? (1)

[30]

QUESTION 2

These questions refer to the sources in Question 2 on pages (iv–v) in the Source Booklet. Use the information in the sources as well as your own knowledge to answer the following questions.

2.1 In the following question, COLUMN 1 has a biological term, and COLUMN 2 contains TWO statements. For EACH of the terms in COLUMN 1, decide which statement (if any) is a match.

Write:

A if only statement 1 matches the term;
B if only statement 2 matches the term;
C if BOTH statements 1 and 2 match the term; and
D if NEITHER statement 1 or 2 matches the term.

	COLUMN 1	COLUMN 2
2.1.1	Recessive	1. Alleles that are expressed only when two copies are present 2. Alleles that are expressed only in heterozygotes
2.1.2	X-linked	1. Alleles that are expressed more often in females than in males 2. All are recessive conditions
2.1.3	Allele	1. Genes that occur in somatic cells only 2. Alternate forms of a gene
2.1.4	Somatic cell	1. Usually diploid in humans 2. E.g. skin cell
2.1.5	Chromosome	1. Section of DNA coding for a character 2. All of the DNA and RNA in the nucleus

(5)

2.2 Refer to the diagram showing the process of gene therapy on page (v) of the Source Booklet and to the description of gene therapy provided.

2.2.1 What is happening at steps:

(a) C; and (2)

(b) D? (2)

2.2.2 What is meant by the statement that the cells "become transgenic"? (2)

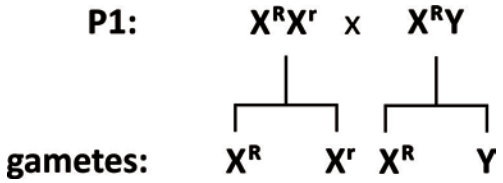
2.3 Protalix makes the enzyme that is missing in people who have Fabry disease. Gene therapy inserts the correct version of the gene into stem cells. Draw a table in which you compare the advantages and disadvantages of gene therapy to enzyme treatments. Provide any THREE comparisons. (5)

2.4 Refer to the graph on page (v) of the Source Booklet.

2.4.1 What is the percentage decrease in Gb3 fat in the livers of mice treated with high doses of gene therapy compared to control mice? Show ALL working. (2)

2.4.2 In which body region (plasma, liver, heart or kidney) is gene therapy most effective in reducing Gb3 fat percentage? (1)

2.5 Consider the following cross: A person who is a carrier for Fabry Disease has the genotype X^RX^r. (X^r represents the allele for the faulty enzyme X^R = allele for the normal enzyme). This person has a child with a normal male (X^RY).



2.5.1 Explain, by referring to the relevant processes in meiosis, how the X^r and X^R chromosomes came to be present in separate gametes. (6)

2.5.2 Refer to the Punnett square below and write the correct genotypes (a) and (b) that result from this cross in your Answer Book.

	X^R	**Y**
X^R	X^RX^R	b.
X^r	a.	X^rY

(2)

2.5.3 Answer **True** or **False** to the following statements with respect to the results of the Punnett square.

(a) The cross shows that when these parents have children, ¼ of all of the children will **definitely** suffer from Fabry disease. (1)

(b) There is a 50% chance that the males will have Fabry disease. (1)

(c) There is a 50% chance that the females will have Fabry disease. (1)

[30]

60 marks

SECTION B

QUESTION 3

Consider the following statement:

Private companies have the right to patent new crop varieties.

Patent – a government authority or licence providing a sole right for a set period to exclude others from making, using, or selling an invention.

[Adapted: merriam-webster dictionary]

Using the source material on pages vi–xi in the Source Booklet, as well as your own knowledge, discuss your opinion on the above statement in the form of a 2½–3 page essay.

To answer this question you are expected to:

- Read the source material carefully and present a debated argument to illustrate your point of view.
- Select relevant information from sources A to G in the Source Booklet on pages vi–xi.
- It is important to integrate your own relevant biological knowledge.
- Take a definite stand on the question and arrange the information to best develop your argument.
- Write in a way that is scientifically appropriate and communicates your point of view clearly.
- **Provide** a clear **plan** of your essay before you start writing. Note that the plan will be marked as part of the assessment of this question.

40 marks

Total: 100 marks