



NATIONAL SENIOR CERTIFICATE EXAMINATION
NOVEMBER 2017

LIFE SCIENCES: PAPER I

Time: 3 hours

200 marks

PLEASE READ THE FOLLOWING INSTRUCTIONS CAREFULLY

1. This question paper consists of 13 pages and a yellow Answer Booklet of 11 pages (i–xi). Please check that your question paper is complete. Detach the yellow Answer Booklet from the middle of the question paper. Remember to write your examination number in the blocks provided.
 2. This question paper consists of four questions.
 3. Question 1 must be answered in the yellow Answer Booklet provided. Questions 2, 3 and 4 must be answered in your Answer Book.
 4. Start **each question** on a **new page**.
 5. Read the questions carefully.
 6. Number the answers exactly as the questions are numbered.
 7. Use the total marks that can be awarded for each of Questions 1, 2, 3 and 4 as an indication of the detail required.
 8. It is in your own interest to write legibly and to present your work neatly.
-

QUESTION 2

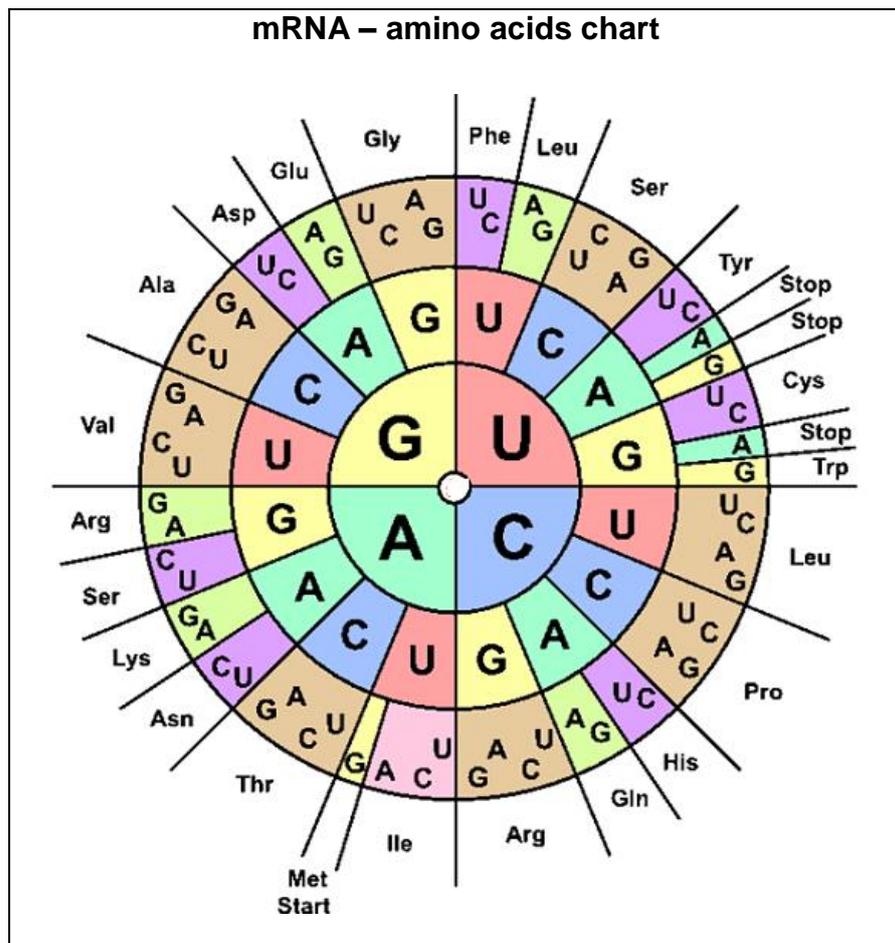
2.1 Read the extract below and answer the questions that follow:

DNA is exceedingly simple. Think of it like a language, but with only four letters — A, C, G, T. The complex ways in which these letters can be combined gives rise to life. These four letters build words, sentences, paragraphs, chapters and books — one for each living organism on Earth. It is a living code — the "biocode".

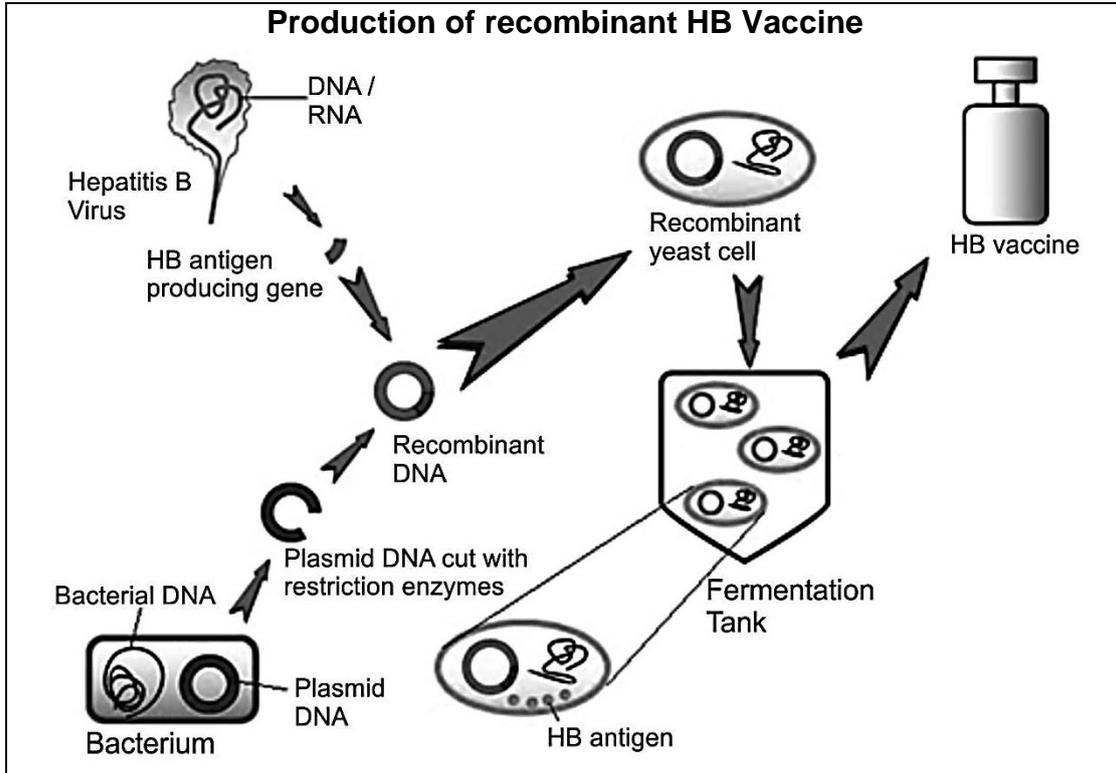
[Adapted from: <<http://www.huffingtonpost.com>>]

The "biocode" as it is referred to above translates to "chapters and books" through a complex mechanism known as protein synthesis.

- 2.1.1 Describe how the DNA code is transcribed into a molecule known as messenger RNA. (4)
- 2.1.2 Explain how the transcribed code on mRNA provides a template for the synthesis of a protein. (4)
- 2.1.3 Using the mRNA-amino acid chart provided, list the sequence of amino acids coded for by the mRNA sequence UAUCCUGAC. (You may use the amino acid abbreviations from the chart). (3)



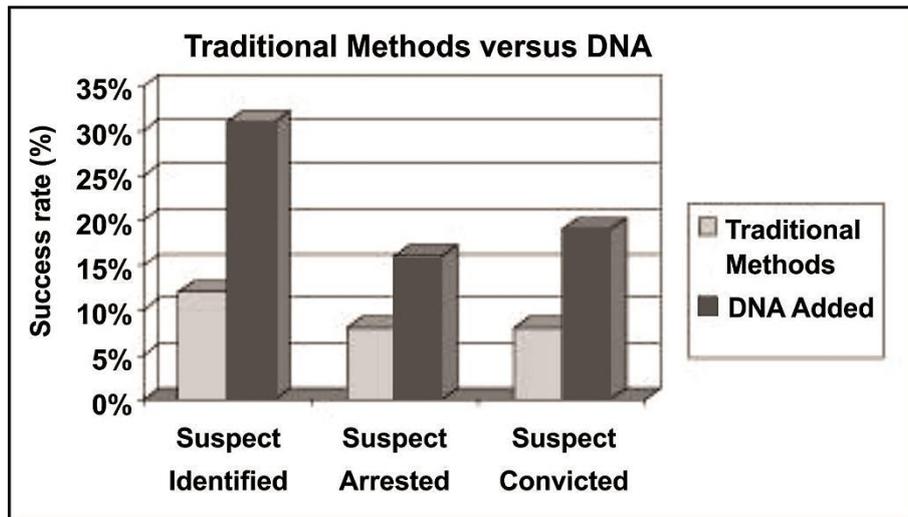
2.2 Recombinant DNA Technology has revolutionised the biomedical world. Study the diagram below, which shows how biotechnology has been used to produce a vaccine that is given to all babies.



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

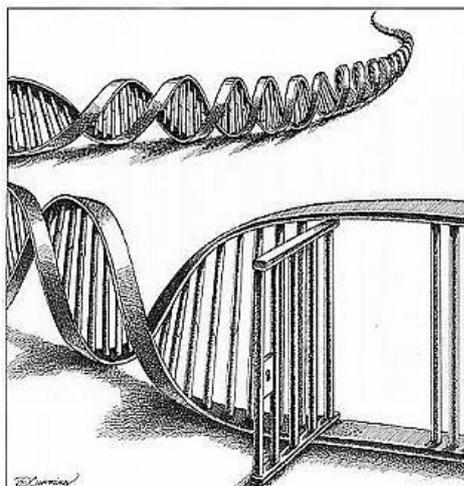
- 2.2.1 Name the enzyme used to join the gene from the HB virus into the bacterial plasmid. (1)
- 2.2.2 Why was a unicellular yeast cell used to insert the plasmid into? (2)
- 2.2.3 What is meant by the term "Recombinant DNA"? (2)
- 2.2.4 Identify six critical steps in this biotechnological process. (6)

2.3 Study the graph below that shows the success rates in criminal cases. Answer the questions that follow:



[Source: <<https://prezi.com/blykaa5mlxk1/case-3-dna-fingerprinting>>]

- 2.3.1 Explain how DNA can be used to identify a suspect. (3)
- 2.3.2 If a total of 3 000 crimes were committed in a year, how many successful arrests were made using traditional methods? Show your working. (3)
- 2.3.3 Formulate a hypothesis for this investigation. (2)
- 2.3.4 Calculate the increase in success rate (%) of suspects convicted using DNA evidence instead of using traditional methods. Show your working. (2)
- 2.3.5 The government wants to establish a national DNA database. Discuss TWO supporting arguments and TWO opposing arguments for this plan. (4)
- 2.3.6 In one sentence, sum up the message that is conveyed to you by the diagram below. (2)



[<<http://www.councilforresponsiblegenetics.org>>]

(2)

2.4 Read the following extract and answer the question that follows:

Scientists have long sought a strategy for curing genetic diseases, but have succeeded only in their dreams. Now, though, researchers in China and Texas have taken a step toward making the fantasies a reality for all inherited diseases.

Using the gene-editing tool known as **CRISPR-Cas9**, the researchers have successfully edited disease-causing mutations out of viable human embryos – this is the first report involving viable embryos.

[Adapted from: <<https://www.sciencenews.org>>]

Which of the statements regarding CRISPR-Cas9 are correct? (There may be more than one correct statement.) Write only the letter(s) of your choice.

- (a) The CRISPR-Cas9 system is only effective in bacteria.
- (b) CRISPR-Cas9 can cut out sections of DNA in a host cell.
- (c) There are many ethical concerns with regard to gene editing in human embryos.
- (d) CRISPR-Cas9 is currently being used to remove mutated genes in human adults.

(2)
[40]

QUESTION 3

3.1 Read the article below and answer the questions that follow:

South Africa's great white shark population is heading for extinction

That's the bleak assessment of a team of researchers from Stellenbosch University. Their findings are based on six years of fieldwork in the waters around Gansbaai – the largest great white research study undertaken in South Africa.

"The numbers in South Africa are extremely low," confirmed Sara Andreotti of Stellenbosch University. "If the situation stays the same, South Africa's great white sharks are heading for possible extinction." Using mark-recapture techniques, the study indicates a population estimate of between 353 and 522 individuals. According to Andreotti, this is 52% fewer than what was estimated in previous mark-recapture studies.

Andreotti thinks a number of factors are behind the species's rapid decline. These include the shark nets and baited hooks used to protect bathers and surfers along South Africa's eastern seaboard. Between 1978 and 2008, these culling mechanisms killed 1,063 great white sharks.

Poaching for trophies like shark jaws is another issue, the study says. This is despite the fact that in 1991, South Africa became the first country to make great-white-shark fishing illegal. Also overfishing is adding to the problem. As fish stocks continue to dwindle, it is possible that there are fewer Cape fur seals. These make up the bulk of the sharks' diet.

A key reason for the decline of South African great whites in particular, is their limited genetic diversity. Results from the analysis of Andreotti's biopsy samples show that South African great whites have the lowest genetic diversity of any white shark population.

Andreotti believes that urgent management measures are the South African population's only hope — and the only hope that future generations have of experiencing their magic.

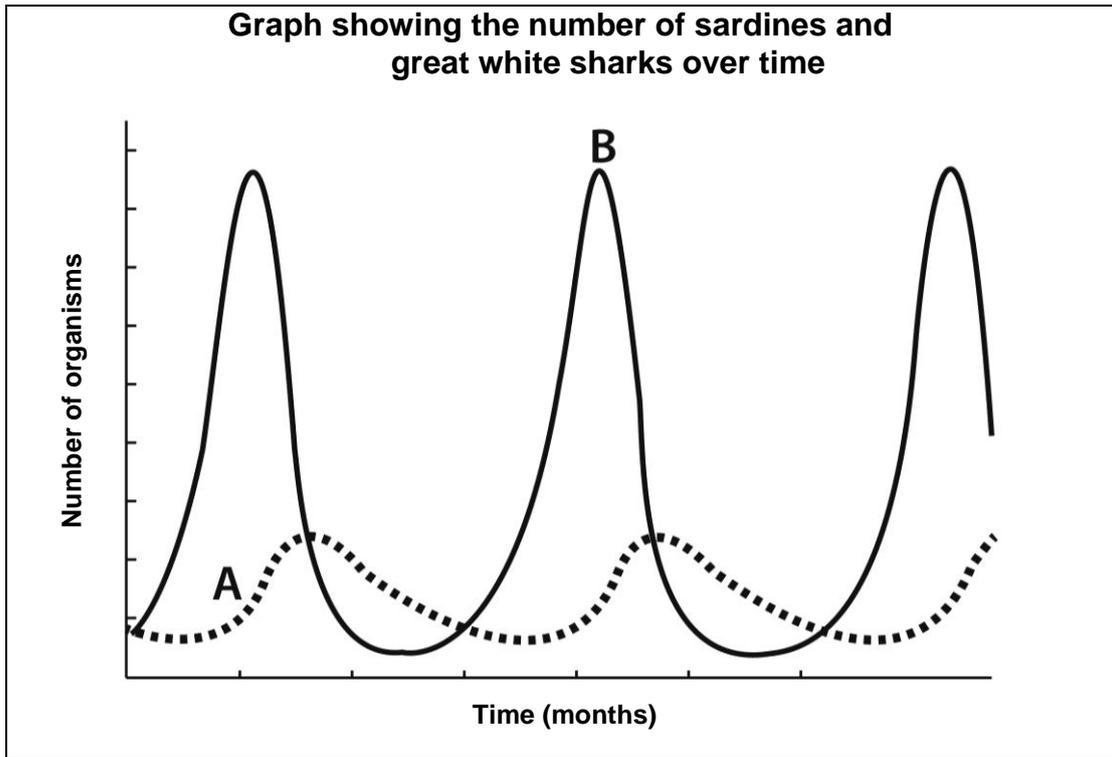
[Adapted from: <<http://scubadiverlife.com/south-african-great-whites-verge-extinction>>]

- 3.1.1 Define the term "population". (3)
- 3.1.2 Using information from the article above, identify FOUR factors that have led to the declining numbers of great white sharks in South African waters. (4)
- 3.1.3 Explain the indirect link between overfishing and declining numbers of great white sharks. (3)
- 3.1.4 Explain how "limited genetic diversity" could be seen as a threat to population survival. (3)

3.1.5 The mark-recapture method of population measurement is an indirect method. Explain why this method is a better method than a census to establish the size of the great white shark population. (3)

3.1.6 Suggest TWO "urgent management measures" that could be put in place to protect the great white shark from possible extinction. (2)

3.2 The following graph shows the relationship between numbers of great white sharks and numbers of sardines (type of fish):

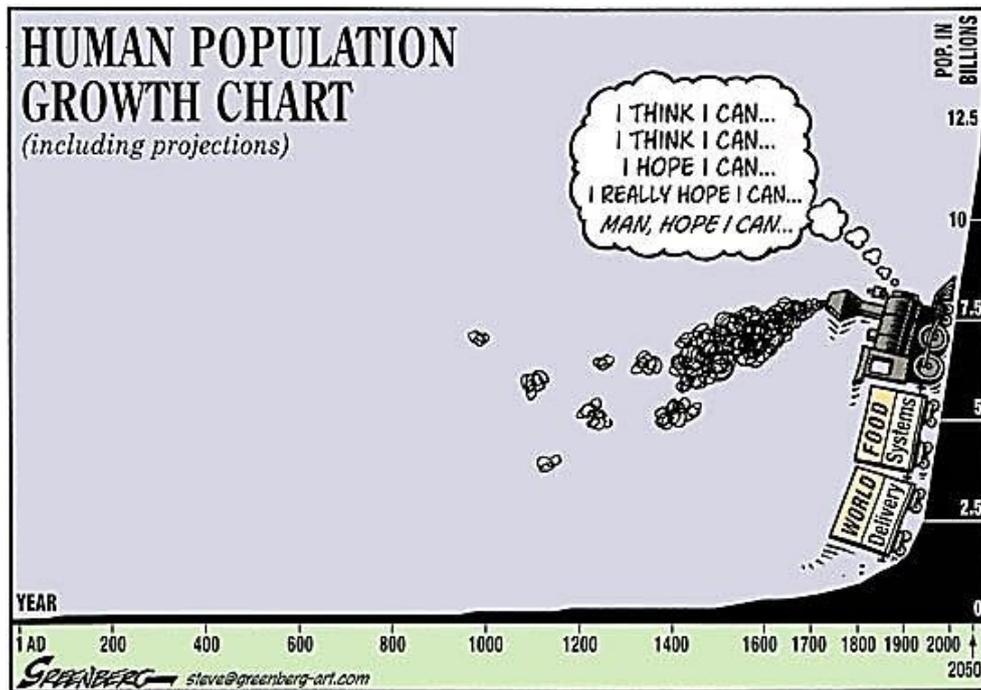


3.2.1 What type of relationship exists between the great white shark and the sardine? (1)

3.2.2 (a) Which line represents the great white shark population? (1)

(b) Explain how you arrived at your answer to Question 3.2.2 (a) above. (TWO reasons) (2)

3.3 Study the diagram below and answer the questions that follow:



[<<http://motherlode.population-sierraclub-calif.org/images>>]

3.3.1 According to the graph, what:

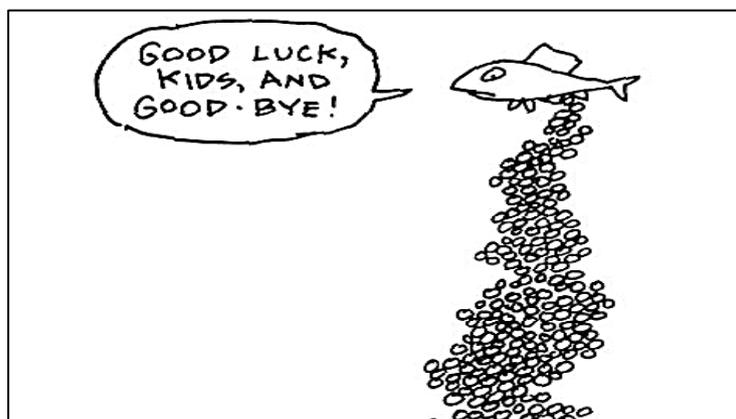
- (a) was the approximate human population in the year 1900? (1)
- (b) will the approximate predicted human population in 2050 be? (1)

3.3.2 The human population keeps raising its carrying capacity. Explain how we have achieved this. (THREE ways) (3)

3.3.3 In your own words, explain the warning expressed in this diagram. (2)

3.4 r-Strategists and K-strategists exist throughout the animal and plant kingdoms, ensuring the survival of the species from generation to generation.

Study the image below and answer the questions that follow:



[Adapted from: <<http://images.slideplayer.com>>]

3.4.1 Is the fish illustrated in the image above an r-strategist or a K-strategist? (1)

3.4.2 Discuss the effectiveness of this strategy by highlighting TWO advantages of this strategy. (2)

3.5 Read the article below and answer the questions that follow:



[Source: <<http://d1roc322tckjdp.cloudfront.net>>]

One of the exciting applications of DNA analysis is that it can be used to combat wildlife crime. It works by targeting areas of DNA that are highly variable within species, making them likely to show a difference between individual animals.

By separating out these markers from physical samples (such as a rhino horn or a piece of rosewood), forensic scientists are often able to determine where the animal or plant came from, what its parentage might be, the age of the sample, and how this relates to other seized shipments. Occasionally, it's possible to uncover more information about the criminal networks behind the trade by detailing where the animals were killed and which ports were used to transport them.

The University of Pretoria has created "rhODIS" – a genetic database of DNA samples from black and white rhinos throughout South Africa. This database will be used to help match recovered rhino horn to individual and poached rhinos by comparing the genetics of the seized horn to those in the database.

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

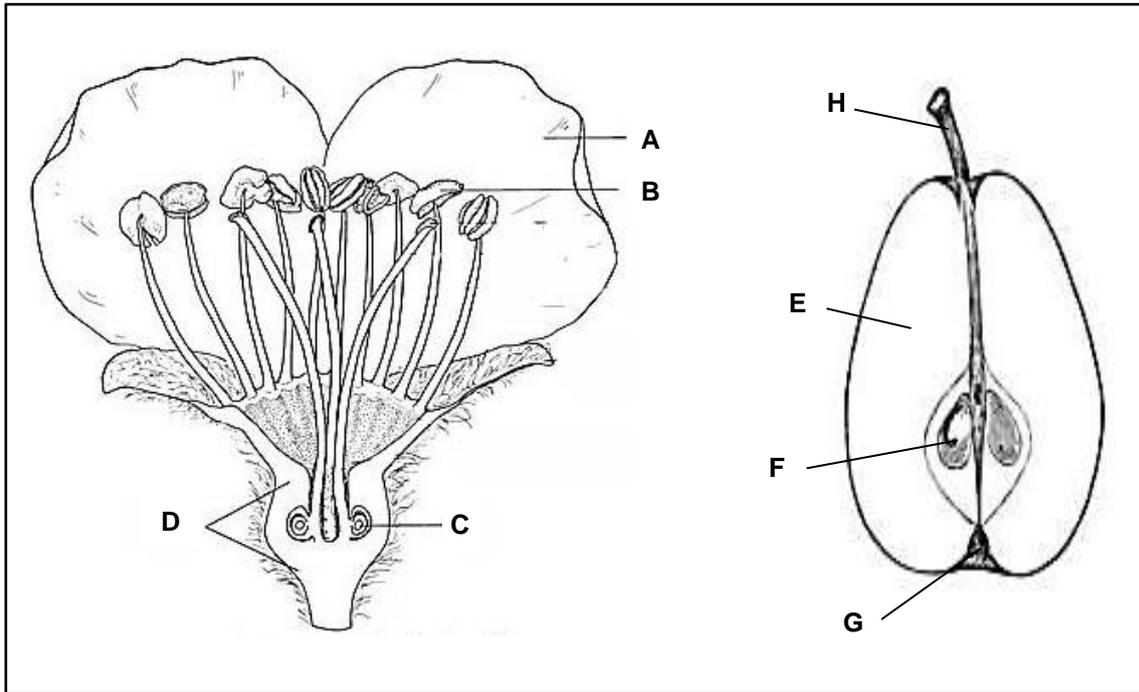
3.5.1 Would the "highly variable" sections of DNA be found in the genes or in the non-coding DNA? Explain. (3)

3.5.2 Using the information provided in the text, explain by means of a flow diagram the procedure that would take place from the point at which the SA Police find smuggled rhino horn in the boot of a vehicle stopped at a road block, through to the point of conviction of the criminals in possession of the rhino horn. (5)

[40]

QUESTION 4

4.1 The diagrams below show a flower of a pear tree and a fruit of a pear tree.



[Adapted from <http://fruitandnuteducation.ucdavis.edu>]

4.1.1 Name structures A, C and D on the flower and match them with structures on the pear that develops from this flower. Draw a table similar to the one below in your Answer Book.

Letter of flower part	Name of flower part	Letter of pear part
A		
C		
D		

(6)

4.1.2 Read the following text and answer the questions that follow:

The genetically engineered Arctic Apple (which does not brown when cut) was approved by the United States Department of Agriculture (USDA) to be sold in grocery stores. According to an article by *Food Democracy Now!*, the same company that created two varieties of GMO apples with a new "gene-silencing technique" are working on developing new varieties of peaches, pears, cherries and bananas.

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

(a) What is meant by the acronym GMO? (1)

(b) In terms of the enzyme-catalysed browning process that happens when fruit is cut and exposed to air, explain how a "gene-silencing technique" could be used to develop the new variety of pear that does not brown when cut. (3)

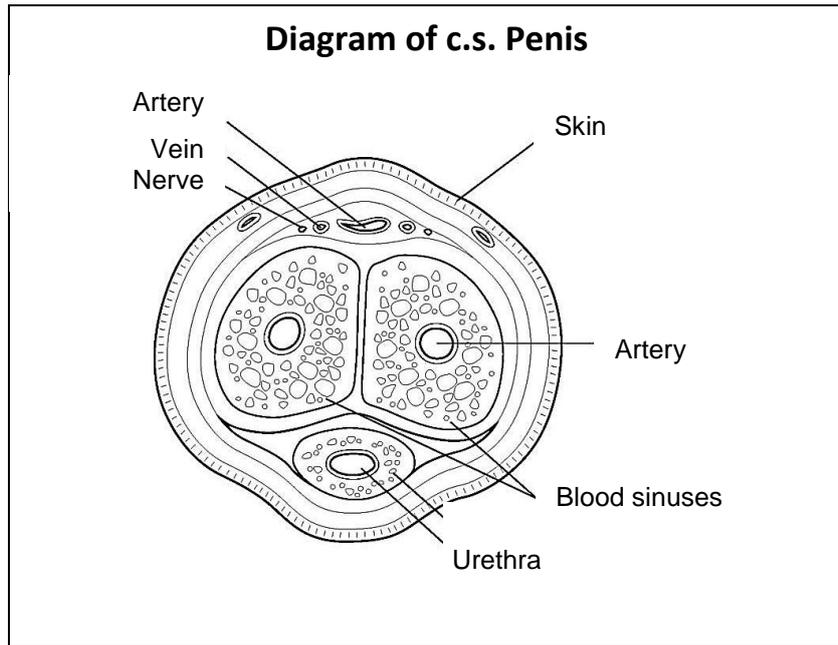
4.2 Ultrasound scans can be used to measure the size of follicles in the human ovary. Once a follicle is located, the screen is frozen while a measurement is taken. The diameter of a follicle gives us an idea of the stage of development of the follicle. In an investigation, the follicle size of 50 women was investigated over a period of 25 days, beginning when menstruation started in each woman. The changes in diameter of the follicles were measured and recorded. The average diameter on each day was recorded in the table below:

DAYS WHEN FOLLICLES WERE MEASURED	AVERAGE FOLLICLE DIAMETERS OF THE 50 WOMEN (mm)
5	6,9
10	13,3
13	18,8
14	22,0
20	3,4
25	2,6

[Adapted from: *Journal of Reproduction and Fertilisation*, 1983]

- 4.2.1 Name the hormone responsible for the increase in follicle size from Day 5 to Day 14. (1)
- 4.2.2 Explain the sudden drop in follicle size from Day 14 to Day 20. (2)
- 4.2.3 (a) A follicle not only responds to hormone messages, it also sends hormone messages. Name TWO hormones that are secreted by the follicles, relating your answer to the data in the left column in the table. (4)
- (b) Explain ONE function of each of the hormones named in Question 4.2.3 (a) above. (2)

4.3 Below is a diagram of a cross section of the penis.



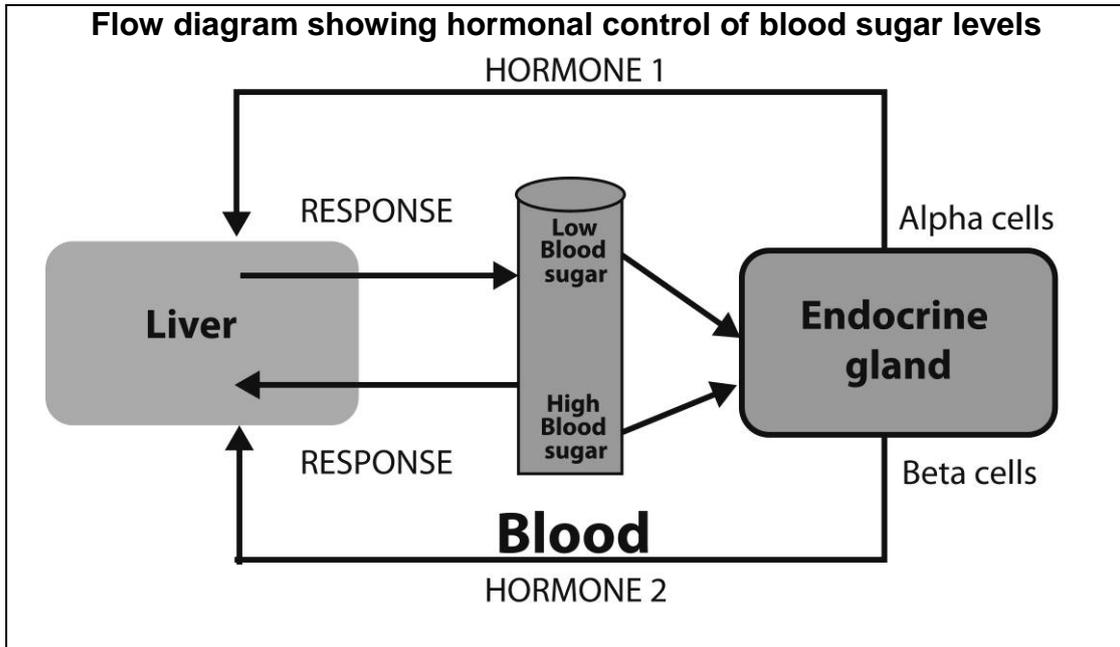
[Adapted from: <medicine.medscape.com>]

4.3.1 What is the significance of the presence of blood sinuses in the penis? (4)

4.3.2 Draw a table in which you record:

- THREE components of the semen that is released through the urethra. (3)
- the importance of the component in the reproductive process. (3)

4.4 Glucose in the diet is vital for our health and its levels in the blood need to remain constant. Study the information below and answer the questions that follow:



[Adapted from: <<http://www.patana.ac.th/Secondary/Science/IBtopics>>]

- 4.4.1 Identify hormones 1 and 2. (2)
- 4.4.2 In the flow chart above, an endocrine gland is mentioned. Identify the endocrine gland as well as the organ in which it is found. (2)
- 4.4.3 Explain the response that is carried out if Hormone 2 is activated. (3)
- 4.4.4 Type 2 Diabetes is described as a lifestyle disease.
 - (a) Explain how Type 2 diabetes differs from Type 1 diabetes. (2)
 - (b) Why is Type 2 diabetes described as a lifestyle disease? (2)

[40]

Total: 200 marks