NATIONAL SENIOR CERTIFICATE EXAMINATION
EXEMPLAR 2008

LIFE SCIENCES: PAPER I

Time: 2½ hours 150 marks

PLEASE READ THE FOLLOWING INSTRUCTIONS CAREFULLY

1. This question paper consists of 13 pages. Please check that your question paper is complete. Detach the booklet from the middle of the question paper.

2. Question 1 must be answered in the booklet provided. Questions 2, 3, 4 and 5 must be answered in your Answer Book.

3. Read the questions carefully.

4. Number your answers exactly as the questions are numbered.

5. Use the total marks which can be awarded for each question as an indication of the detail required.

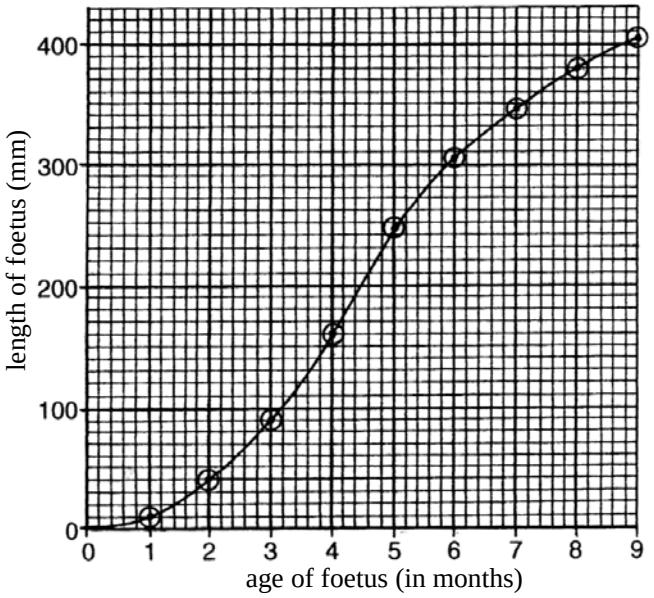
6. It is in your interest to write legibly and to present your work neatly.

QUESTION 2

2.1

2.1.1 Name the organ in the human female body in which oogenesis occurs. (1)

2.1.2 The graph below shows the growth in length of a human foetus before birth.

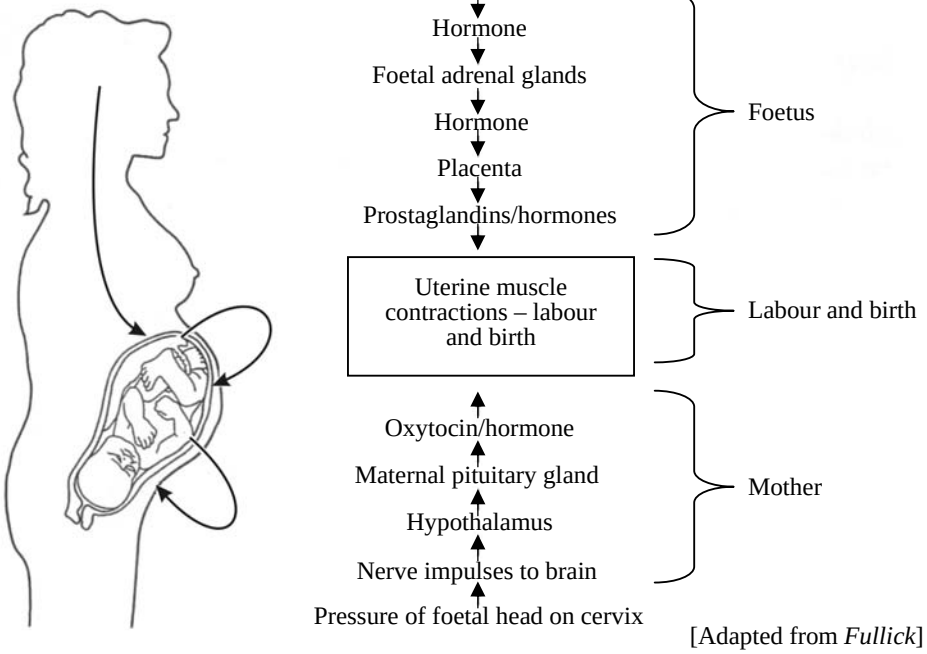


[Adapted from *Torrance*]

(a) What was the length of the foetus at four months? (1)

(b) What was the average rate of the growth of the foetus in mm per month during the final four months of pregnancy? Show your working. (3)

2.1.3 The graph in 2.1.2 illustrates the fact that at 9 months the foetus is cramped in the mother's body. It is believed that signals within the foetus start the birth process. Observe the following diagram and use the information it contains and your own knowledge to answer the questions that follow.



[Adapted from *Fullick*]

2.2

2.2.1 Explain the role of the cervix in the birth process. (3)

2.2.2 Oxytocin is a hormone given to some women at the start of the birth process (labour). Give a reason for this benefiting the foetus. (2)

2.2.3 At nine months the foetus is 400 mm long according to the graph in Question 2.1.2. Explain the mechanism by which the foetus can signal a start to the birth process. (3)

Read the following extract giving evidence for the role of the foetus in initiating birth.

'The importance of the foetal role in the birth process has been studied in a variety of ways, but some of the most interesting evidence came from simple observations. Shepherds in Idaho in the USA noticed that certain pregnant sheep died with their lamb foetuses unborn. The foetuses were extremely large (up to two to three times larger than the normal size). Careful observation showed that this occurred in sheep which had eaten large quantities of a certain weed (*Veratrum californicum*). When biologists investigated the weed they found that it contained a chemical which interferes with the functioning of two hormone secreting glands, the pituitary and adrenal, of the foetus.'

[Adapted from *Fullick*]

2.2.4 Evaluate the findings of the shepherds and biologists mentioned in this passage with the information provided in the diagram to:

(a) Write a hypothesis regarding the effect of *Veratrum californicum* on the birth process in sheep. (2)

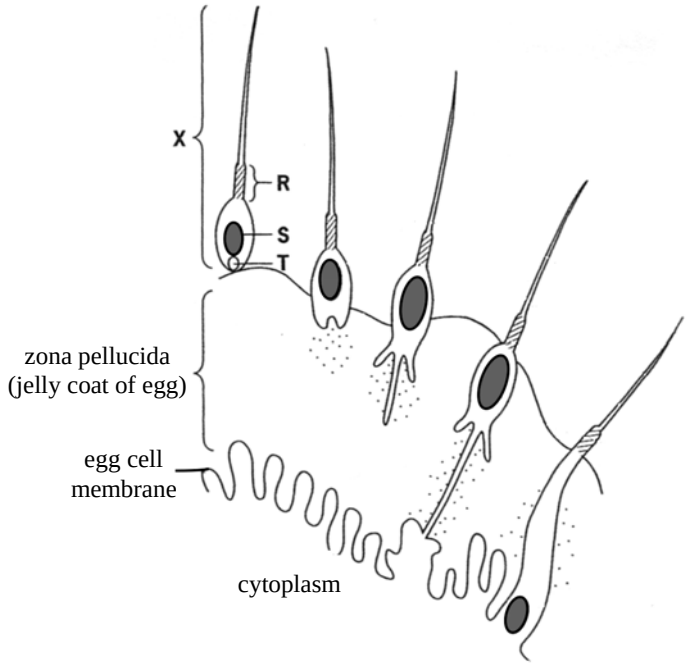
(b) Write a short paragraph for a farmer's magazine giving advice on the care of pregnant sheep (only based on the information given above). (4)

2.3

2.3.1 What is circumcision? (2)

2.3.2 Assume you are the parent of a newborn baby boy. Your doctor recommends circumcision soon after birth while your isiXhosa culture recommends this is delayed until puberty. Whose advice would you follow? Give a reason for your decision. (2)

2.4 Observe the following diagram showing the sequence of events which take place when the nucleus of a human sperm enters the cytoplasm of an egg in the female body.



[Adapted from *Churchman and Peddar*]

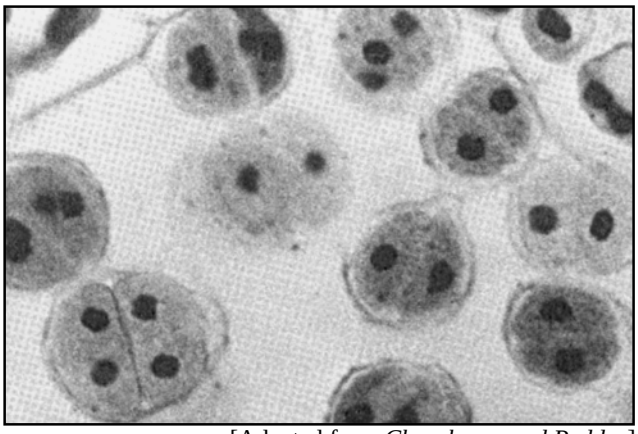
2.4.1 Give the letter of the haploid structure shown in the diagram. (1)

2.4.2 The jelly coat of the egg cell is largely made of protein. List the main stages of protein synthesis as it would take place in this cell. (6)

30 marks

QUESTION 3

3.1 Observe the following photograph showing a slide of plant cells which have formed pollen grains.



[Adapted from *Churchman and Peddar*]

3.1.1 How can a photograph be taken of such small structures? (1)

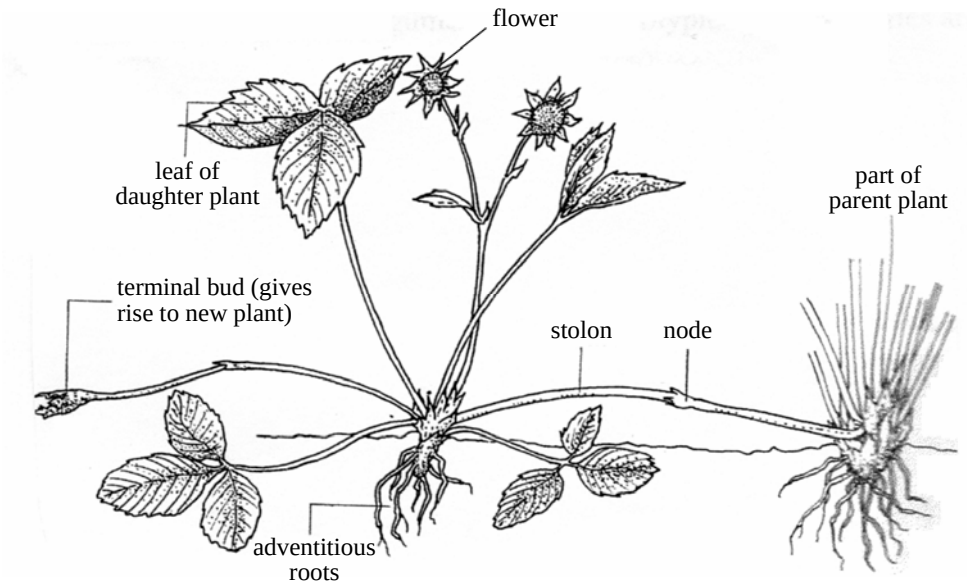
3.1.2 What would you use to ensure that the nuclei appear dark in the photograph? (1)

3.1.3 Name the type of cell division shown here. (1)

3.1.4 Name the other part of the flower where this type of cell division would occur. Make a simple labelled diagram of this part of the flower in longitudinal section. (5)

3.1.5 Give two important reasons for the type of cell division mentioned in 3.1.3 being important in living organisms. (4)

3.2 Observe this diagram of a strawberry plant and answer the questions that follow.



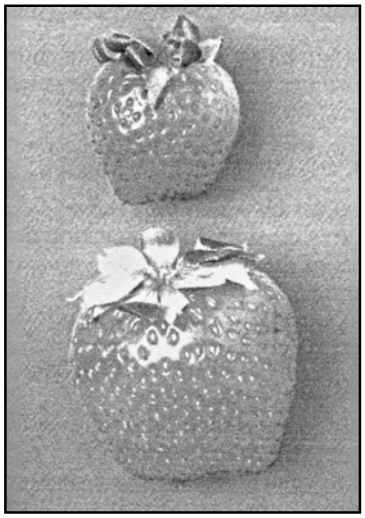
[Adapted *Phillips and Chilton*]

3.2.1 Explain the role of pollen grains in the production of strawberries. (2)

3.2.2 Describe how this strawberry plant could reproduce asexually to produce a new plant. (3)

3.2.3 A strawberry farmer chooses to produce strawberry plants by asexual means only. Provide two reasons for her choice. (2)

3.3 Observe the following photograph of two strawberries. A useful mutation resulted in a polyploid strawberry. This has several extra sets of chromosomes.



normal strawberry

Polyploid strawberry

3.3.1 Define a mutation. (2)

3.3.2 The farmer decided to grow these polyploid strawberries rather than the normal type. Why? (1)

3.3.3 Your friend is not keen to eat these strawberries as they result from a mutation. Use your knowledge of mutations to explain to your friend that polyploid strawberries are safe to eat. (4)

3.4 Read this description of how the Flavr Savr™ Tomato was formed.

The Flavr Savr™ Tomato

> As tomatoes mature, they change from green to red and become softer. Often they are picked green and turn red during distribution to the shops. They can go soft very quickly after this and shoppers do not want to buy them.
> There is a transgenic answer to this problem. Genes have been transferred into the tomato, which prevent the 'softness' changes. This results in the Flavr Savr ™ staying firmer for longer.
>
> [Adapted from *Letts*]

The Flavr Savr™ tomato results from a type of genetic engineering. Briefly describe how a bacterium could have been used to transfer the genes into the tomato. (4)

30 marks

QUESTION 4

4.1 Use the information provided to support the claim that Gregor Mendel carried out important scientific experiments.

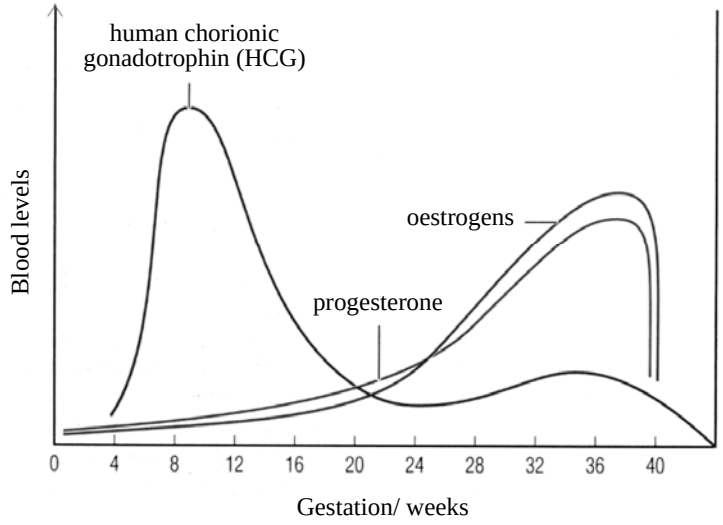
Table showing summary of Mendel's experiments on the inheritance of single pairs of characters in the garden pea.

Character investigated	**Cross**	**F_2 products**	**Ratio**
Form of seed	Smooth x wrinkled	5474 smooth, 1850 wrinkled	2.96:1
Colour of cotyledons	Yellow x green	6022 yellow, 2001 green	3.01:1
Colour of flower petals	Purple x white	705 purple, 244 white	3.15:1
Form of seed pods	Inflated x constricted	882 inflated, 299 constricted	2.95:1
Colour of unripe pods	Green x yellow	428 green, 152 yellow	2.82:1
Position of flowers	Axial x terminal	651 axial, 207 terminal	3.14:1
Height of stem	Tall x short	787 long, 277 short	2.84:1

[Adapted *Roberts, Reiss and Monger*]

(5)

4.2 The following graph shows the levels of certain hormones in the blood of a human female during pregnancy. Answer the questions that follow.



[Adapted from *Clegg and Mackean*]

4.2.1 What does 'gestation' mean? (2)

4.2.2 Give two functions of oestrogen during **puberty**. (2)

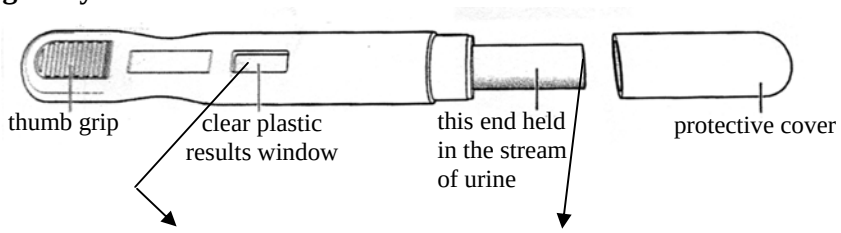
4.2.3 Name the organ and specific structure that produces progesterone in a non-pregnant female. (2)

4.2.4 Human chorionic gonadotrophin is initially secreted by the cells of a developing embryo. It is also released in the urine of a pregnant mother in significant quantities and can be used as an indicator of pregnancy.

Study the diagrams below showing how a home pregnancy kit is used and answer the questions.

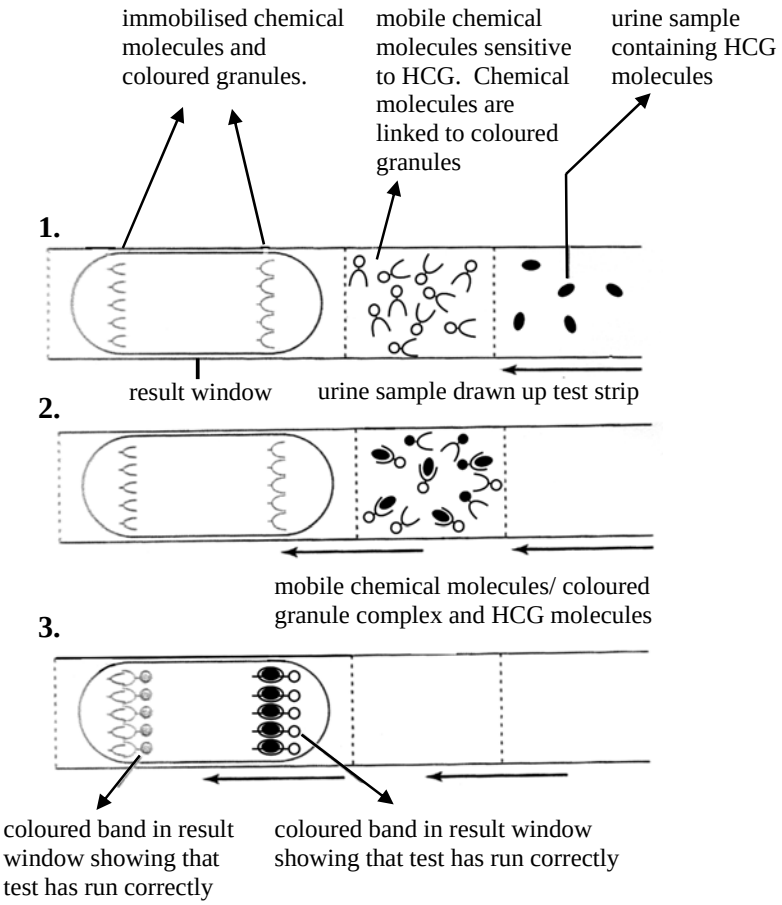
This kit works in the following way. It contains a test strip with tiny coloured granules attached to chemicals that are sensitive to Human chorionic gonadotrophic hormone (HCG). The granules and chemicals can move up this strip. Further up the strip are other chemicals, also sensitive to HCG but immobile. This serves as a check that the kit is active.

Home pregnancy kit

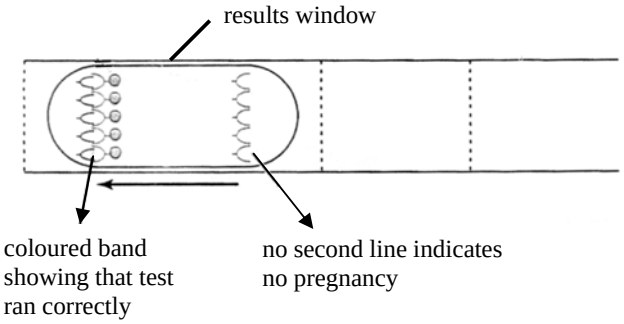


This section is enlarged below.

(A) Urine sample containing HCG hormone molecules



(B) Urine sample without HCG hormone molecules



4.2.4 (a) A six week pregnancy cannot be very accurately confirmed using the test kit. Why? (2)

(b) What would be another indicator of pregnancy at this stage? (1)

4.2.5 During which week of pregnancy would this test kit give the most accurate results? Explain your answer. (2)

4.2.6 This 'home pregnancy test kit' has several features which make it effective to use. Explain three of these. (6)

4.2.7 The results of this test are very important to a woman. Provide an important suggestion to users of this kit to ensure that the results are reliable. (2)

4.2.8 Your best friend is a fellow Grade 12 learner. She uses this kit and records a positive result. She confides in you and says she has decided to have an abortion at an unregistered 'back street' clinic as there is a history of a genetically inherited disease in her family. As her friend, give a reasoned argument (based on your knowledge of Life Sciences and what you feel her responsibilities are) to persuade her to be more cautious in the decisions she needs to make regarding this abortion. (6)

30 marks

QUESTION 5

Read the following extracts (A and B) concerning two very significant scientific discoveries:

A The structure of DNA

B The mapping of the Human Genome

Which discovery do **you** think will have the most important implications for humankind?

Write a **motivation** to substantiate your answer using your Life Sciences knowledge **and** the information given on the next three pages.
Do not write more than one and a half pages.

20 marks

Information for Question 5

[A] Information on the discovery of the structure of DNA

In 1953 James Watson and Frances Crick, working together at the Cavendish laboratory in Cambridge, suggested a possible structure for DNA. **A1**

Some years earlier an American chemist, Erwin Chargaff, had used chromatography to separate the four bases in DNA samples from various organisms. Quantitative techniques were then used to work out amounts of the four bases in each sample. Some of Chargaff's original data is given in a table following this article. **A2**

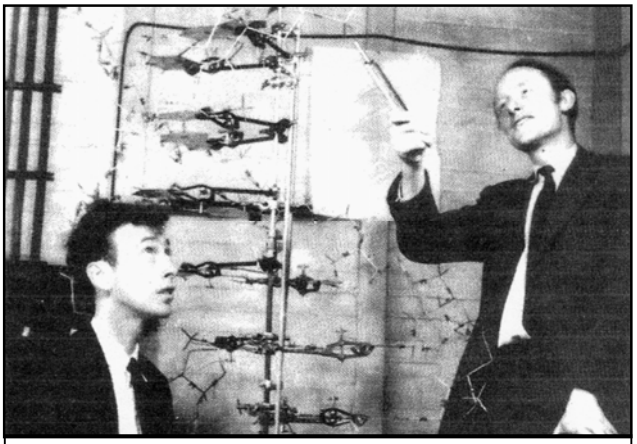
It can be seen that the ratio of adenine to thymine is close to one, as is the ratio of guanine to cytosine. How can this be explained? With a flash of insight Watson and Crick suggested that DNA might consist of two parallel strands held together by pairs of bases; adenine being paired with thymine, and guanine paired with cytosine.

Meanwhile, attempts had been made to work out the structure of DNA using X-ray diffraction analysis. Some clear X-ray photographs were obtained by Rosalind Franklin and Maurice Wilkins at King's College, London. **A3**

One such photograph is shown on next page. **A4**

Watson and Crick set to work on the the X-ray patterns, and after months of work they suddenly realised that both Chargaff's results and the X-ray diffraction data could be explained if DNA consists of two chains twisted around each other to form a double helix.

A1



James Watson (left) and Francis Crick with their model of DNA. Watson and Crick worked together in the Cavendish Laboratory at Cambridge in the early 1950s when Watson, an American, was on a post-doctoral visit to Europe. Their collaboration led to the discovery of the structure of DNA, for which, together with Maurice Wilkins, they were awarded a Nobel Prize in 1962.

A2

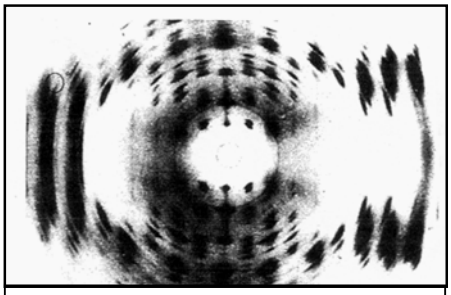
Source	Approximate per cent			
	A	C	G	T
Yeast	32	17	18	33
Avian tubercle bacilli	16	34	36	14
Ox thymus	30	18	24	28
Ox spleen	30	18	24	29
Human sperm	30	19	19	32

Chargaff's original data on the base composition of DNA from several sources

A3

Rosalind Franklin worked on the structure of DNA at King's College, London in the early 1950s. An expert X-ray crystallographer, she showed in 1952 that the phosphate groups of DNA must lie on the outside of the molecule. Her work was vital in enabling Watson and Crick to propose their hypothesis for the structure of DNA. After the structure of DNA had been determined, she worked on the structure of viruses. Her career was cut short when she died tragically of cancer at the age of 37 in 1958, four years before Crick, Watson and Wilkins were awarded the Nobel Prize. Nobel Prizes cannot be awarded posthumously.

A4



An X-ray diffraction photograph of DNA.

[Adapted from *Roberts, Reiss and Monger*]

[B] Information on the Human Genome project.

1. The human genome project is the largest piece of international collaboration in biology that has ever taken place. A **genome** is the name given to all the genetic material in an organism, i.e. all its genes. The aim of the project is to sequence accurately every one of the 3.2 billion bases which make up the DNA of a single human being. The project, which began in 1990, was so large that scientists agreed that specific laboratories in more than 50 countries would each take a different portion of a human chromosome and simultaneously work out the sequence of its DNA. In 1990 the project was expected to take 15 years at least but, the first draft of the human DNA base sequence was published on 26 June 2000.

2. **The following statements have recently been made about the Human Genome Project**.

Genomics, the science of obtaining knowledge about the human genome and determining what genes do, will dramatically influence healthcare. Further research should lead to improvements in the diagnosis of diseases, their prevention and treatment.

[BBC News Online]

I am concerned that there are some (people) who will want to use this new knowledge as a basis for discrimination (… to obtain power and wealth rather than for the good of all living organisms).

[Dr Craig Venter, Celera Genomics]

Now we can look down the 'list' of genes and see which one is causing the problem.

[Professor John Burn, Newcastle University]

The human genome will exist on the world's computers for as long as we exist.

[Dr John Sulston, Sanger Centre, Cambridge]

We need an international agreement that genetic information needs to be obtained by consent (from the people concerned).

[Dr Arthur Caplan, Bioethetics Dept, Pennsylvania University]

[Adapted from *Glen and Susan Toole*]

3. The human genome – the complete set of human genes – comes 'packaged' in twenty three separate pairs of chromosomes. Of these, twenty two pairs are numbered in approximate order of size, from the largest (number 1) to the smallest (number 22), while the remaining pair consists of the sex chromosomes: two large X chromosomes in women, one X and one small Y in men. In size, the X comes between chromosome 7 and 8, whereas the Y is the smallest.

For we, this lucky generation, will be the first to read the book that is the genome. Being able to read the genome will tell us more about our origins, our evolution, and our nature (make up) than all the efforts of science to date. It will revolutionise anthropology, (study of human origins) psychology, palaeontology (study of past geology and fossils), and virtually every other science.

I genuinely believe that we are living through the greatest intellectual moment in history. Some may protest that understanding the human being is more than knowing the genetic make up of his genes. I do not deny it. There is much, much more to each of us than a genetic code. But until now human genes were an almost complete mystery. We will be the first generation to penetrate that mystery.

[Adapted from *Ridley*]

TOTAL FOR THIS PAPER: 150 MARKS