



NATIONAL SENIOR CERTIFICATE EXAMINATION
NOVEMBER 2009

LIFE SCIENCES: PAPER I

Time: 2 ½ hours

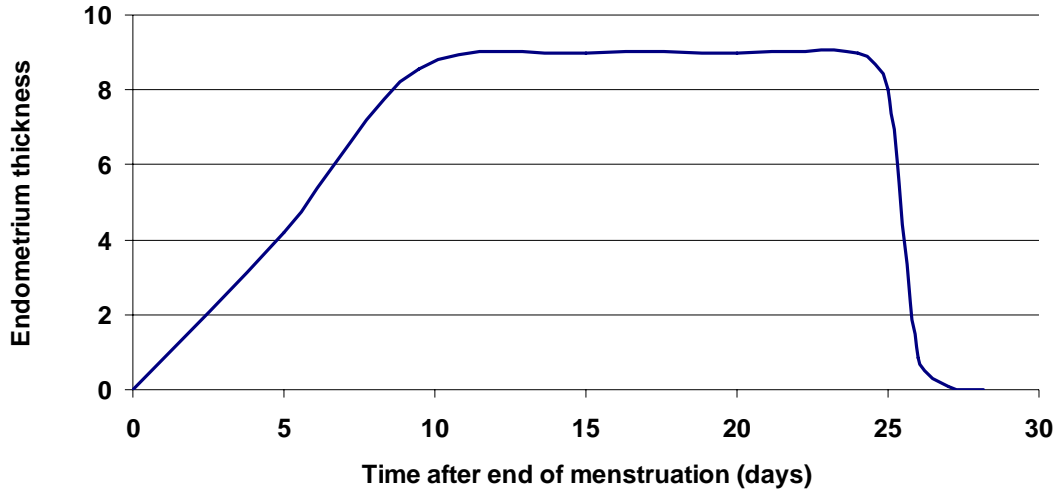
150 marks

PLEASE READ THE FOLLOWING INSTRUCTIONS CAREFULLY

1. This question paper consists of 13 pages. Please check that your question paper is complete. Detach the yellow Answer Booklet from the middle of your question paper.
 2. Question 1 must be answered in the yellow Answer Booklet provided. Questions 2, 3, 4 and 5 must be answered in your Answer Book.
 3. This paper consists of five questions.
 4. Read the questions carefully.
 5. Number the answers exactly as the question is numbered.
 6. Use the total marks that can be awarded for each question as an indication of the detail required.
 7. It is in your own interest to write legibly and to present your work neatly.
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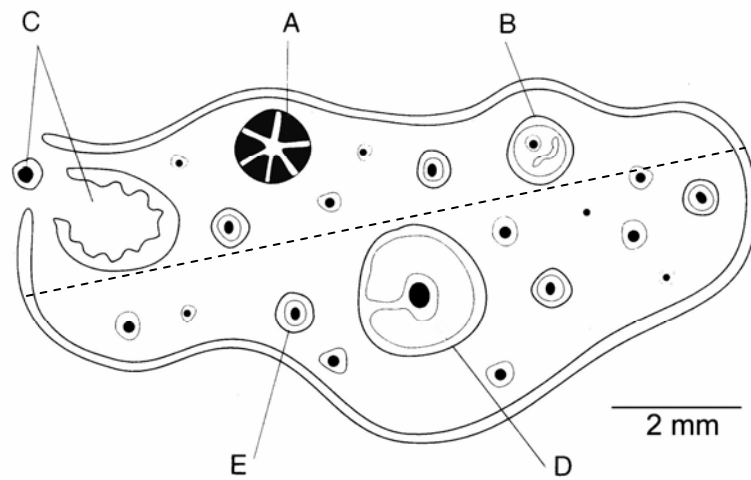
QUESTION 2

2.1 The graph below shows the thickness of the endometrium over one menstrual cycle. Note that the graph begins at the **end** of menstruation.



- 2.1.1 In what organ is the endometrium normally found? (1)
- 2.1.2 No unit is given for 'Endometrium thickness'. Suggest a suitable unit. (1)
- 2.1.3 Determine from the graph the day ...
 - (a) when the endometrium was 4 units thick.
 - (b) when the endometrium first achieved full thickness.
 - (c) when menstruation began.
 - (d) when ovulation was most likely to happen. (4)
- 2.1.4 The corpus luteum maintains the thick endometrium for about two weeks. Briefly explain how the corpus luteum does this. (3)
- 2.1.5 Sometimes the embryo implants in the fallopian tubes/oviducts instead of the endometrium. This puts the lives of both the mother and foetus at risk. Briefly describe how this is so for the ...
 - (a) mother.
 - (b) foetus. (2)

2.2 The following diagram shows the ovary of an adult human with follicles in various stages of development. These stages would not all be visible at the same time in a real ovary.



[Adapted from Toole & Toole, 1999]

- 2.2.1 How many ovaries are found in a normal human female? (1)
- 2.2.2 Name the event that is occurring at C. (1)
- 2.2.3 Structures A to E are parts of the ovary that develop in a time sequence. Starting with structure E, write down these letters in their correct sequence. (2)
- 2.2.4 Give TWO pieces of evidence from the diagram that show this ovary does **not** belong to a 6-year old girl. (2)
- 2.2.5 The length of the ovary is indicated with a dashed line. Use the scale indicated to calculate the length of the ovary. (3)

- 2.3 A brochure entitled, 'All you should know about cervical cancer' contains the following statistics:

After breast cancer, cervical cancer is the 2nd most common cancer worldwide in women under 45, and it's the third leading cause of cancer deaths among women worldwide after breast and lung cancer.

Over the last 30 years, scientists have proven that cervical cancer is caused by Human Papilloma Virus (HPV); the main cause is not hereditary and women of all ages are at risk. HPV has been detected in up to 99.7% of all cervical cancers worldwide.

The virus can be transmitted during sexual intercourse or skin-to-skin contact between genitals. Condoms do not offer full protection. Up to 80% of women will be infected by HPV in their lives. Most will fight off the HPV infection but samples of cells from the cervix should be regularly checked for anything unusual. The procedure to do this is called a PAP smear. Early detection of unusual cells is vital.

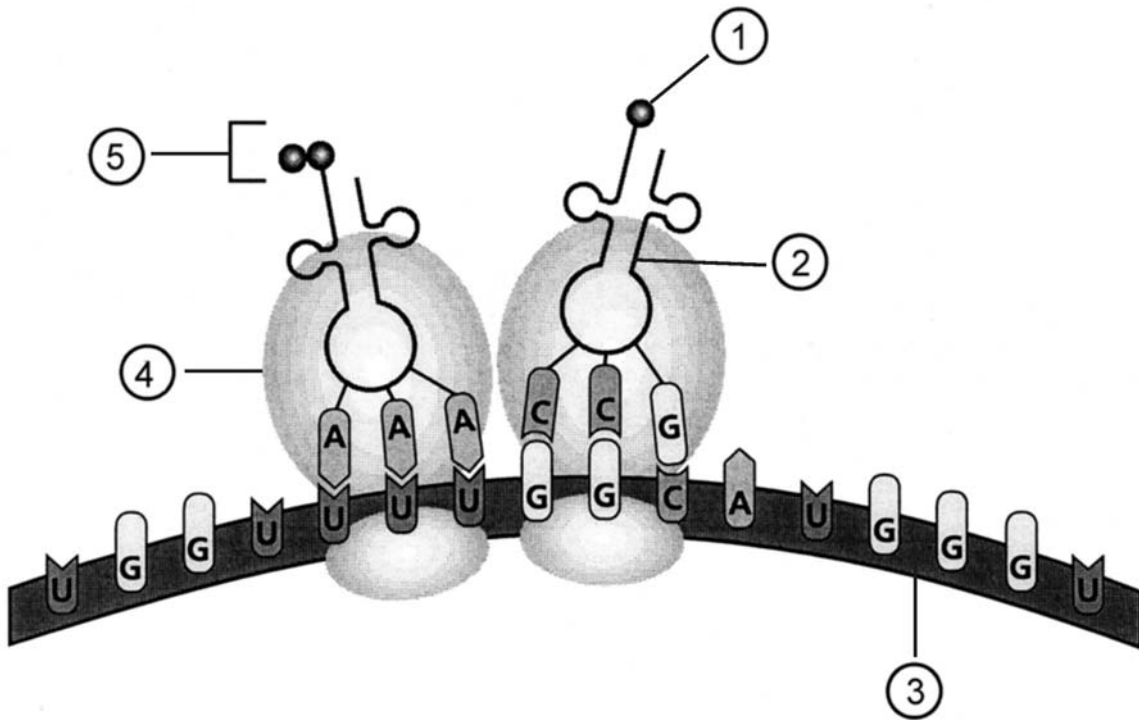
[Adapted from GSK brochure: *Cervical Cancer Special*]

- 2.3.1 Give ONE function of the cervix. (1)
- 2.3.2 Compare each of the following statements with evidence in the article. If you think the statement is true as it stands, write 'T', if you think something about the statement is incorrect, write 'F'.
- (a) Heredity is the main cause of cervical cancer.
 - (b) Breast cancer is the second most common cause of female cancer deaths worldwide.
 - (c) An HPV was **definitely** not the cause of cervical cancer in 0.3% of cases.
 - (d) Condoms reduce the transmission of HPV. (4)
- 2.3.3 Suggest ONE reason why each of the following world regions have the lowest death rates from cervical cancer:
- (a) Countries with strict religious codes.
 - (b) Developed, wealthy nations with good health care. (2)
- 2.3.4 A pap smear is taken by a doctor or nurse using a special instrument which gently removes a few cells from the surface of the cervix. A friend of yours is 17 years old. She says, "Having pap smears is way too embarrassing and I'm not going to have them until it's absolutely necessary." What sensible advice do you give her as a responsible friend? (3)

30 marks

QUESTION 3

3.1 The following picture shows a stage in protein synthesis.



[Adapted from MSDE, 2005]

- 3.1.1 Name the stage shown. (1)
- 3.1.2 Provide specific labels for parts 1 to 4. (4)
- 3.1.3 What will molecule 5 be called once this stage is complete? (1)

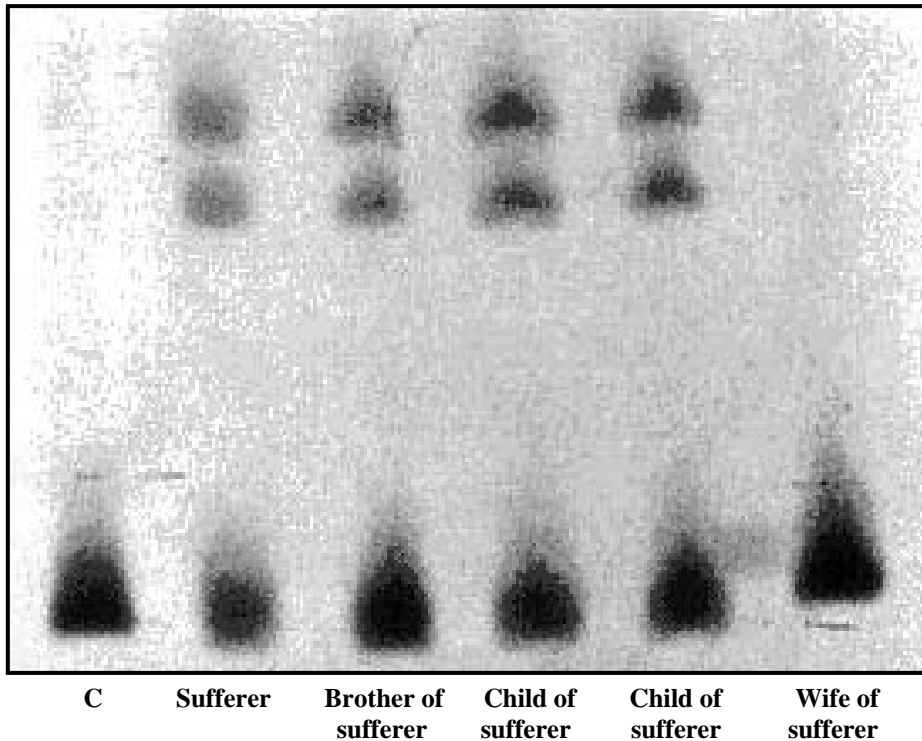
3.2

Porphyria variegata is a group of diseases caused by over 200 different genetic mutations. It can cause paralysis, skin sensitivity in sunlight and death. In South Africa 96% of *porphyria* sufferers carry the same dominant mutation on chromosome 1. It is believed that it was brought to South Africa in 1688 by a Dutch orphan sent to South Africa to marry an early settler. This condition has since spread widely.

If the symptoms show, a simple blood test can confirm if a patient is suffering from *porphyria*.

'If we unpack our pasts, we will also be unpacking our health risks,' says Lynne Smit of the Africa Genome Education Institute.

- 3.2.1 What is a 'mutation'? (2)
- 3.2.2 What in the text indicates that *porphyria* is an autosomal condition? (1)
- 3.2.3 A *porphyria* sufferer visits a medical expert trained to predict and advise on inherited conditions. The sufferer is concerned that other members of his family may also have inherited his condition. What is such a medical expert called? (1)
- 3.2.4 The picture below shows the results of a test done by the expert to see which family members have the mutation. The results are compared to someone without the mutation (C).



- (a) What is the above image known as? (1)
- (b) What would the expert conclude from the above results? (2)
- (c) The sufferer's parents could not be tested. Suggest a possible reason for this. (1)
- 3.2.5 Re-write Lynne Smit's comment using your own words. (2)

- 3.3 This adapted version of an article appeared in a South African newspaper on Thursday May 8, 2003. Use the article to answer the questions that follow.

SA SCIENTISTS CLONE CALF

Futhi a first for Africa

<p>JOHANNESBURG: Africa's nutrition problems could one day disappear, thanks to animal cloning.</p> <p>This was said by one of the scientists who succeeded in Africa's first cloning of a cow. Yesterday Futhi made its first appearance to the public in the North West province. The calf's name means 'repeat' or 'replica' in Zulu.</p> <p>The donor cow is a South African milk-production record-holder, producing 78 litres per day.</p> <p>"There is no reason why the calf will not produce the same amount of milk as the donor," said De la Rey, a veterinarian from the Embryo Plus Centre.</p> <p>De la Rey and his colleague have been working on the cloning project for nearly two years.</p> <p>"It is quite an achievement for us as it was the first time we tried cloning," he said. "We were lucky it was a success first time round."</p>	<p>Their technique is different from normal cloning methods in that the protective covering around the egg is removed before cloning takes place.</p> <p>They then took DNA from the donor cow's ear. This was inserted into an empty cow egg. The egg was then planted into the recipient cow.</p> <p>"Again we were lucky that the recipient cow did not reject the egg," De la Rey said.</p> <p>By cloning it is possible to replicate the characteristics of high-quality animals and prevent the unknown variability that can occur in normal breeding.</p> <p>But De la Rey said that the process was currently very expensive and the procedures need more development.</p> <p>He said cloning could be very useful to countries in Africa where there are increasing food shortages.</p>
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- 3.3.1 On what date was Futhi first shown to the public? (1)
- 3.3.2 Explain why Futhi is a suitable name for the new calf. (3)
- 3.3.3 De la Rey makes the statement that cloning can prevent the 'unknown variability that can occur during normal breeding'.
- (a) What does he mean by 'normal' breeding? (1)
- (b) Why does normal breeding lead to 'unknown variability'? Give two reasons. (2)
- 3.3.4 In what way does normal cloning differ from De la Rey's method? (1)
- 3.3.5 In what organ of the recipient cow would the cloned egg develop? (1)
- 3.3.6 Futhi is just one cow. How does this make cloning useful in solving the food shortages of whole countries? (1)
- 3.3.7 The process of producing a cloned animal is difficult. Write down ONE difficulty mentioned in the article. (1)
- 3.3.8 Recombinant DNA technology may be another way to make cows that produce large amounts of milk. Briefly outline the steps such a procedure might involve. (3)

30 marks

QUESTION 4

- 4.1 The term 'ploidy' describes the number of chromosome sets in a cell. A diploid ($2n$) gamete can form if homologous chromosomes do not separate properly during meiosis. If such a gamete joins with a normal haploid (n) gamete at fertilisation, it will form a triploid ($3n$) individual. In flowering plants, triploid individuals do not develop seeds and are therefore infertile.

Commercial bananas (below right) are carefully engineered to be triploid. This stops them developing the hard seeds of their wild diploid parents (below left). In general, polyploid ($3n$ or more) plants tend to be hardier and produce bigger fruit than their wild parents. Polyploidy is much more common among plants than animals.



Transverse sections through a wild banana (left) and a commercial banana (right). (Not to scale.)

[Adapted from: <www.humanflowerproject.com> and <www.worldofstock.com>]

- 4.1.1 What part of a flower ...
 (a) becomes the seed?
 (b) forms the greatest part of the fruit? (2)
- 4.1.2 Use the information above to give TWO reasons why farmers grow triploid plants. (2)
- 4.1.3 What is the ploidy of the commercial banana? (1)
- 4.1.4 Farmers may grow commercial bananas in fields next to where wild bananas are growing. Why in this case is it an advantage for the farmer that commercial bananas are infertile? (2)
- 4.1.5 By what simple method could **farmers** reproduce their own new banana plants? (1)
- 4.1.6 Scientists can supply farmers with young banana plants produced through tissue culture. Give a brief overview of the steps in the tissue culture process. (4)

4.2 The following table shows the effectiveness of some contraceptive measures.

Method of contraception	Number of pregnancies (per 100 women per year)
None	115
Condom, used incorrectly	56
Condom, used correctly	14
The Pill used correctly	0
Vasectomy (male sterilisation)	0

- 4.2.1 Account for the number of pregnancies where a vasectomy was used as the method of contraception. (2)
- 4.2.2 Give one way in which a condom might be 'used incorrectly'. (1)
- 4.2.3 Calculate the percentage of all pregnancies that occurred in the year where a condom was used correctly as the method of contraception. (2)
- 4.2.4 Give **three** reasons why condom use is encouraged by the South African government even though condoms are not the most effective method of contraception. (3)

4.3 The apparatus below can be used to demonstrate how genes (represented by beads) are sorted in heredity. The apparatus is shown shortly after the start of the demonstration.

[Adapted from Roberts, 1986]

Method

1. Get 50 white beads and 50 black beads, identical except for their colour.
2. Put 25 white beads and 25 black beads into Jar 1. Do the same for Jar 2.
3. Place three empty jars (Jar L, Jar M and Jar R) alongside.
4. Without looking, remove one bead from Jar 1 and one bead from Jar 2. Now look at the two beads. If the beads are both black, put them into Jar L, if they are both white put them into Jar R, if one is black and the other white put them into Jar M.
5. When Jars 1 and 2 are empty, count the number of **pairs** of beads in each of the three jars.

- 4.3.1 Define the term 'gene'. (2)
- 4.3.2 What does any **pair** of beads in Jars L, M or R represent? (1)
- 4.3.3 What term would describe 'one black bead and one white bead together'? (1)
- 4.3.4 One would **expect** to find 25 pairs of beads in Jar M at the end of the demonstration. How would you explain it if the **actual** number of pairs was different from this figure? (2)
- 4.3.5 The beads must be identical apart from their colour.
- (a) To ensure fair testing, state **TWO** features of the beads (other than colour) which must be kept the same. (2)
- (b) Why is it important to keep the beads identical? (2)

30 marks

QUESTION 5

You are to answer this question in 1½ to 2 pages.

How possible do you think that *The Boys from Brazil* project would have been if it had been set in 2009? Present an argument to support your decision.

To answer this question you are expected to ...

- select relevant information from sources A to E below. Do not attempt to use all the detail provided.
- use your own biological knowledge.
- take a definite stand on the question and arrange the information to best develop your argument.
- write in a way that communicates your point of view clearly.

SOURCE A THE PLOT OF THE FILM 'THE BOYS FROM BRAZIL'

In 1978 a science-fiction film called *THE BOYS FROM BRAZIL* was made. The film started as follows:
 A small team of scientists loyal to a very powerful world leader (Adolf Hitler) wanted to secretly 're-create' their leader exactly. Before he died, they took some of his cells and preserved them. Some years after his death they chose 95 married German couples to be 'new' parents. Suitable couples ideally had to be working-class people. The home had to be controlled by the husband. The husband had to be about 60 years of age and the wife about 30. The scientists then made the wives pregnant with cells engineered to carry only Hitler's DNA. Each wife gave birth to a boy. Education for the boy was discouraged. When these children reached nine years of age the scientists began to have the 95 fathers murdered.

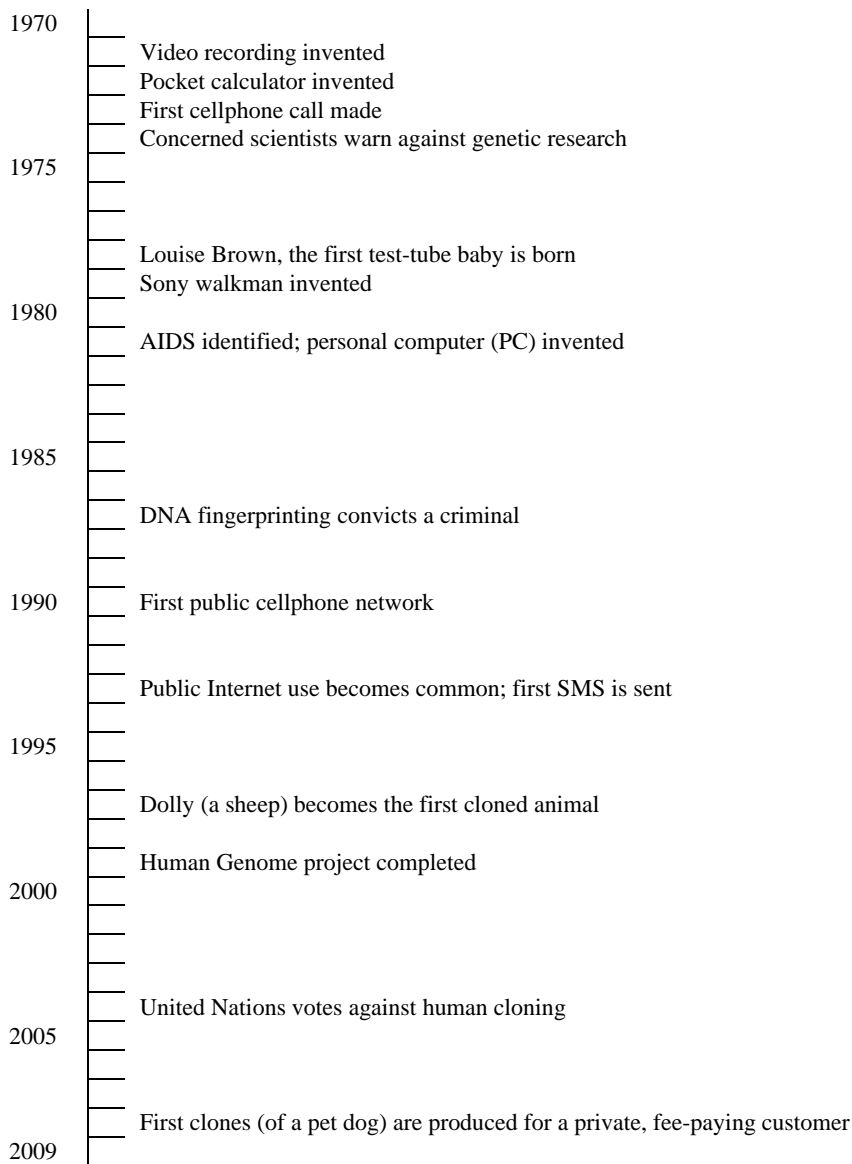
sci'ence-fic'tion: an imaginary story based on the possible outcomes of scientific discoveries



SOURCE B HITLER'S CHILDHOOD

Born: 20 April 1889 in a small town.
Father: A junior policeman in Germany. Had little interest in children. Described as 'hard, unsympathetic and short-tempered'. Died when Hitler was nine years old.
Mother: A religious person. Worked for Hitler's father as a cleaning lady from age 16. Later married him. Aged 29 when Hitler was born. Spent her life working at home raising her children.
Home: Lived in various small villages in Austria and Germany.
Education: Attended school from age six. Left early after a poor school record.

SOURCE C A TIMELINE OF SOME SCIENTIFIC AND TECHNOLOGICAL EVENTS SINCE 1970



SOURCE D WEB INFORMATION FROM ONE OF THE FIRST OF MANY AMERICAN CLINICS TO PERFORM IN-VITRO FERTILISATION (IVF)



– building families in a loving and supportive environment since 1987

NOVA has been doing in vitro fertilisation since 1988. Receiving a donated egg and fusing it with your partner's sperm is the most effective treatment available to help infertile couples achieve pregnancy. The probability of a live birth depends greatly on the fertility potential of the donated egg and has been in the 50 – 80% range at NOVA (see table).

Oocyte Donation success rates at NOVA

Donor Age	After one Treatment	After two Treatments	After three Treatments	After four Treatments
Under 35	55 – 78%	71 – 85%	81 – 88%	86 – 90%
35 to 37	40 – 65%	55 – 78%	66 – 83%	74 – 86%
38 to 40	28 – 42%	41 – 59%	49 – 66%	55 – 71%
41 to 42	20 – 30%	27 – 42%	31 – 48%	34 – 51%
Over 42	13 – 17%	19 – 25%	23 – 32%	27 – 37%

Feedback from one of our clients:

"... We wanted to take the time to say how wonderful all of you at NOVA were throughout my entire treatment. From the very first time I walked in the door, to my last appointment, I felt treated with dignity and supported in a very caring and personal manner."

ST and DT Campbell

[Nova. Retrieved from <www.novivf.com> (Accessed September 2008)]

SOURCE E EXTRACT ABOUT THE WORLD'S VIEW OF HUMAN CLONING

At a United Nations meeting, the United States and many mostly Catholic countries voted against all human cloning, arguing that it was the taking of human life. However British Health Minister John Reid said that Britain would allow research into therapeutic cloning of human cells but not the cloning of new individuals (reproductive cloning). He said, "We regret that the United Nations does not seem to understand the difference between these two forms."

[BBC News (2005). Retrieved from: <<http://news.bbc.co.uk>> (Accessed September 2008)]

20 marks

Total: 150 marks