NATIONAL SENIOR CERTIFICATE EXAMINATION
NOVEMBER 2011

LIFE SCIENCES: PAPER I

Time: 2½ hours 150 marks

PLEASE READ THE FOLLOWING INSTRUCTIONS CAREFULLY

1. This question paper consists of 14 pages and a yellow Answer Booklet. Please check that your question paper is complete. Detach the yellow Answer Booklet from the middle of the question paper.

2. This question paper consists of five questions.

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

4. Read the questions carefully.

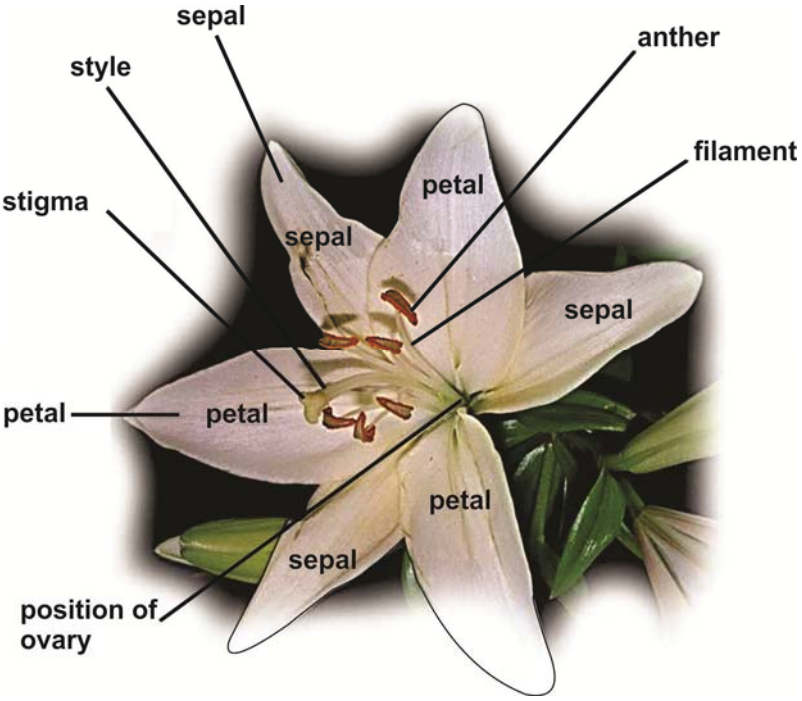
5. Number the answers exactly as the questions are numbered.

6. Use the total marks that can be awarded for each of Questions 1, 2, 3 and 4 as an indication of the detail required.

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

QUESTION 2

2.1 These photographs below are of a lily flower and some cells taken from a part of the lily flower. The photographs are not of the same scale.



A. Structure of a lily flower

B. Cells at the end of meiosis

[Images taken from: <http//botit.botany.wisc.eduresources>]

2.1.1 (a) Name ONE structure in A where you would expect to find cells such as those shown in B that have undergone meiosis. (1)

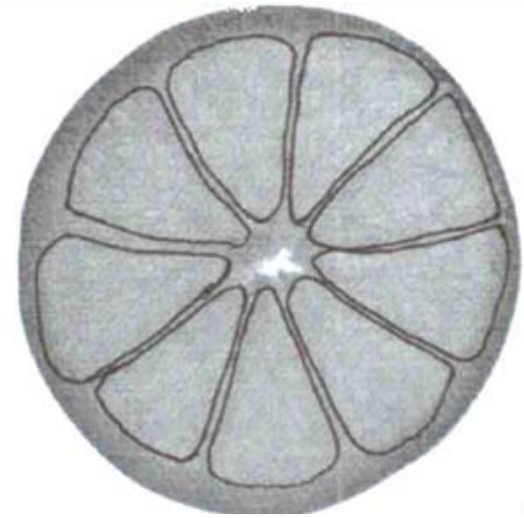
(b) Name any other part in the lily flower in A where meiosis would **not** occur. (1)

2.1.2 (a) Are the cells in B haploid or diploid? (1)

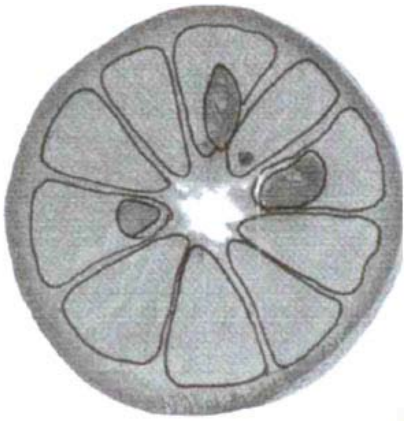
(b) What is their function? (2)

2.1.3 During the first stage of meiosis, the chromosomes in the parent cell underwent a **reduction division** which reduced the chromosome number. What is the biological importance of this process? (3)

2.2 The diagrams below are cross sections of two different oranges. These are drawn to the same scale.



Triploid Orange



Diploid Orange With Seeds

2.2.1 Which of these oranges is an example of polyploidy? Give a visible reason for your answer. (2)

2.2.2 What is the advantage of polyploidy in this plant? (1)

2.3

Researchers have developed antiretroviral drugs to combat the AIDS virus. One such medical drug is **3TC** which blocks the reproduction of the HI virus in the human body. It was first thought to be a most promising drug for HIV sufferers, but drug trials on humans showed that some HI viruses have evolved **resistance** to **3TC**.

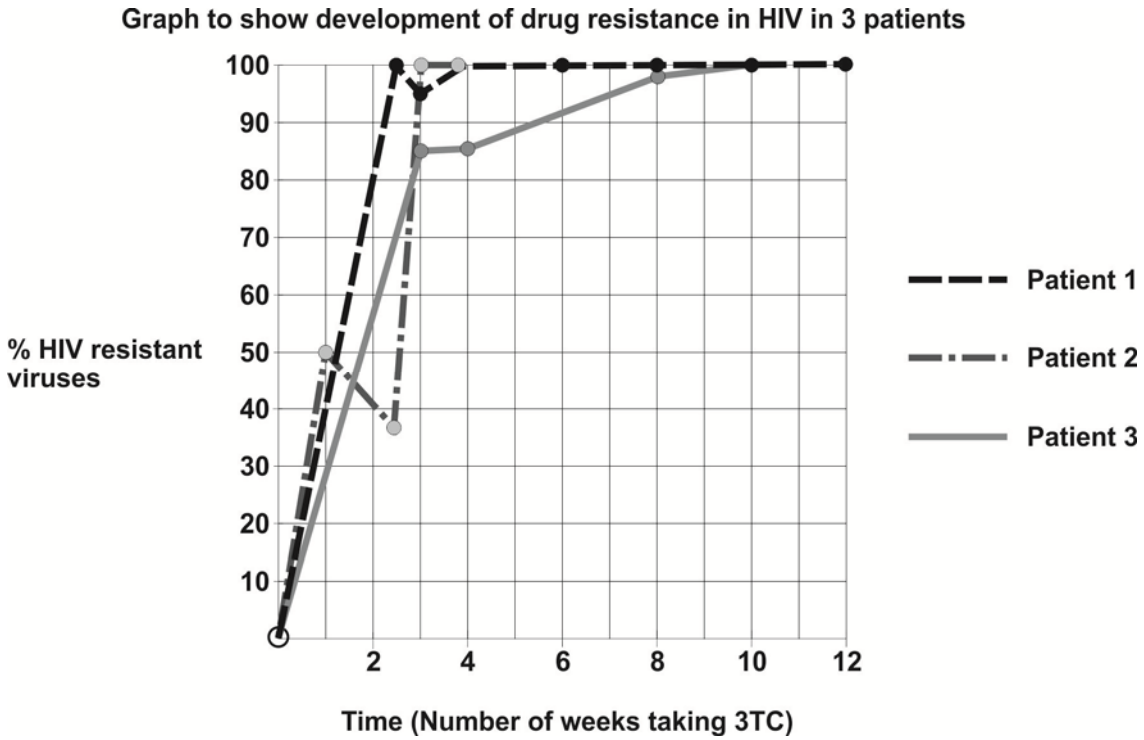
2.3.1 (a) The list of statements below shows some of the changes in the HI viruses of a patient taking part in the drug trial for **3TC**. Write down the numbers of the statements in the correct order to show the development of **drug resistance** in HIV.

1. These mutated viruses could reproduce rapidly
2. At first, after taking **3TC**, most of the HI viruses in the patient's blood were reduced to a low level and the treatment seemed to be working
3. At the end of the trial, his blood contained only the resistant HI viruses
4. However, after a short period of treatment, a few mutated viruses that were resistant to **3TC** were present by chance and remained in his blood (2)

(b) Explain what is meant by the term a **mutation**. (1)

2.3.2 Drug resistance can develop in microorganisms such as viruses if an AIDS sufferer stops taking their medication or does not take their medicine at the same time each day. Suggest a practical way of assisting AIDS patients to remember to take their medicine correctly. (2)

2.3.3 Study the graph below which shows the results of a drug trial with **3TC** in 3 different patients.



(a) In which patient was there a good response to the drug in the first 3 weeks? (1)

(b) In which patient did the drug have the least antiretroviral effect? (1)

2.3.4 Data on these patients was collected over a 12 week period. Do you think this was sufficient time to test the effectiveness of the drug? Give a reason for your answer. (2)

2.3.5 What do you think a pharmaceutical company would conclude about the experimental trial for **3TC** as shown above? (2)

2.3.6

When pharmaceutical companies test new drugs, they may select two groups of people for their trials. One group receives the new drug and the other group receives a **placebo**. A placebo contains none of the active ingredients of the drug, e.g. it might just be a sugar pill.

(a) When choosing candidates for the drugs trial, explain two variables which need to be controlled in order to ensure a fair and valid test. (4)

The trials must be run in a scientific and ethical way as human beings are being used as 'guinea pigs'.

(b) List FOUR examples of guidelines for a pharmaceutical company that would ensure that their trials are run in an ethical and safe way. (4)

[30]

QUESTION 3

3.1

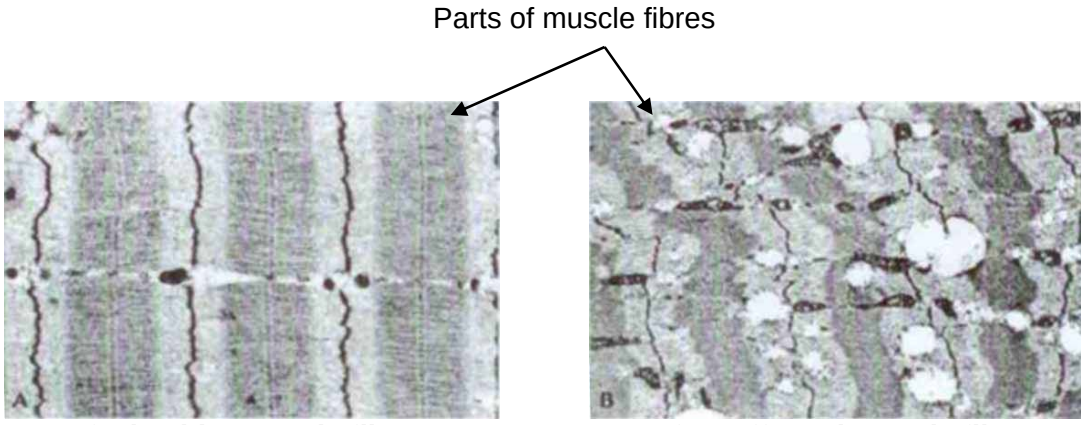
Duchenne muscular dystrophy is a genetic disorder in which the skeletal muscles progressively weaken. The disease is a sex-linked disorder caused by a recessive gene mutation on the **X** chromosome. The dominant gene codes for a strong protein which builds the membranes of muscle fibres. A recessive gene codes for a weak form of the muscle protein which causes the muscle fibres to weaken and break down.

3.1.1 Explain what you understand by the term 'sex-linked' disorder? (2)

Duchenne muscular dystrophy affects mostly boys and the muscle weakness starts in childhood. When a boy reaches his teens he is confined to a wheelchair as his muscles are too weak to support his body. Most of those affected die in their twenties as their breathing muscles stop functioning.

3.1.2 Why is it more common for boys to suffer from sex-linked disorders than girls? (2)

3.2 Study the micrographs below of parts of muscle fibres from a person with Duchenne muscular dystrophy and a healthy person.



Part of a healthy muscle fibre **Part of an affected muscle fibre**

[Adapted from: Campbell, Reece, et al]

List TWO visible differences that you can see between these parts of muscle fibres. (2)

3.3 A healthy 30 year-old-man with a history of Duchenne muscular dystrophy in his family is concerned about the possibility of his passing on the disorder to his children.

3.3.1 Based on the information provided in Question 3.1 above, what advice would you give to him about his likelihood of being a carrier for the mutated gene? (2)

3.3.2 The man seeks advice from a genetic counsellor. She draws the following punnet diagram to explain to him the possibility of passing on the gene to his children if he marries a woman who carries the muscular dystrophy gene.

Punnet diagram showing a genetic cross with a woman with a mutated gene

	X^D	X^d
X^D	X^DX^D	X^DX^d
Y	X^DY	X^dY

(a) The table below refers to the punnet diagram above. Complete the statement in column A by selecting the correct option in B. Write **only** the number of the statement and the **correct** answer next to it in your Answer Book.

	Column A	**Column B**
	Statement	**Answer**
1.	The letters which represents the male genotype are:	**XX / XY**
2.	The letter '**d**' represents the gene which is:	**dominant / recessive**
3.	The genotype representing a homozygous condition is:	**X^DX^D / X^DX^d**
4.	The chances of a boy being born with the condition is:	**50% / 25%**

(4)

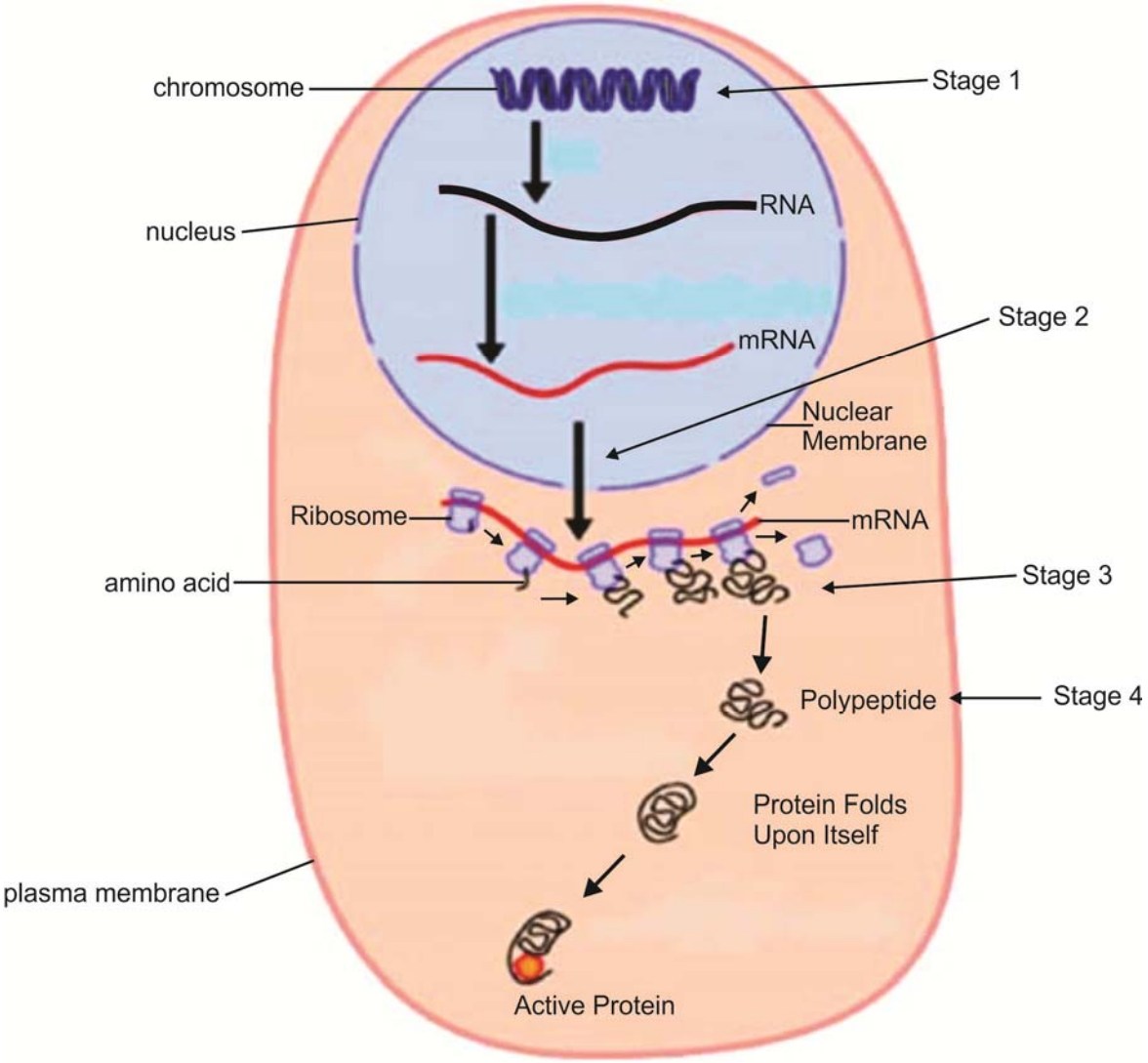
(b) In your opinion is a punnet diagram a useful tool for a geneticist to use to explain the inheritance of genes to a patient?
If you **agree**, then explain why you think it is useful.
If you **disagree**, suggest a better way of explaining inheritance to a patient. (2)

3.3.3 There are a variety of options available to someone who would want to avoid passing on Duchenne muscular dystrophy to their children.

Some of them are: Amniocentesis
Abortion of an affected foetus
Adoption

Which ONE of these options would you choose? Briefly describe the process and explain the reasoning for your answer. (3)

3.4 The diagram below represents the process of **protein synthesis**.



[Adapted from: <www.eduresources.wisc.com>]

Study the diagram carefully and then decide whether the following statements based on the diagram are true or false. Write **T** if you think the statement is true and **F** if you think the statement is false.

(1) The diagram explains how proteins are made in a body cell.

(2) Translation is the copying of the genetic code from the chromosome at stage 1.

(3) The mRNA is transferring the genetic code from the nucleus to the cytoplasm at stage 2.

(4) If a mutation occurred in the chromosome of this cell, it could be passed on to children.

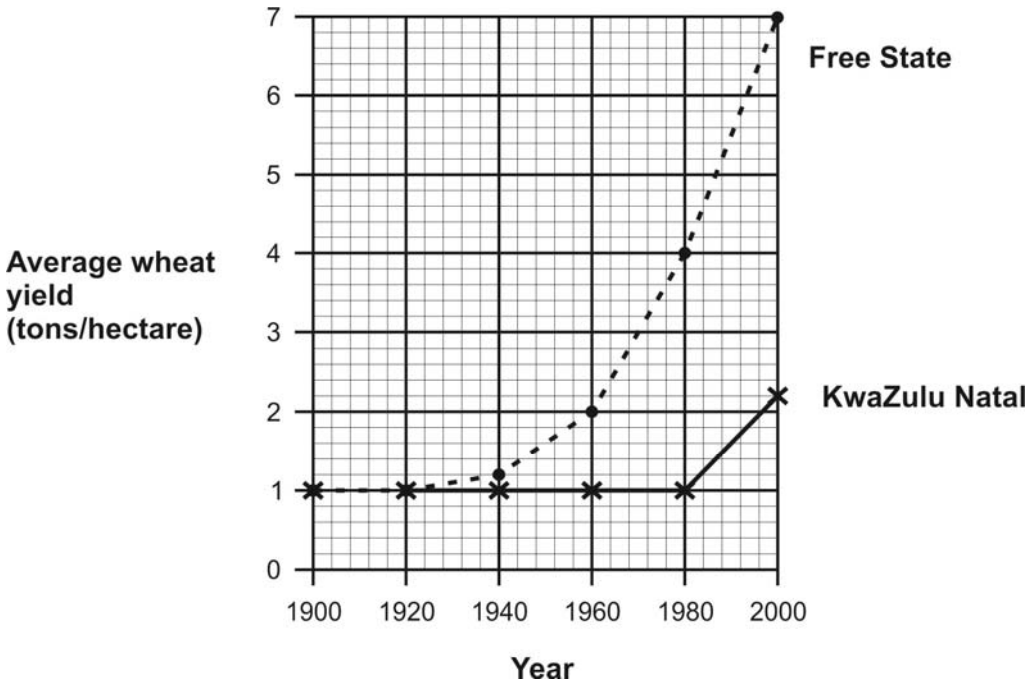
(5) tRNA is clearly visible in the cell.

(6) It can be said with certainty that the active protein is a hormone.

(7) The polypeptide is made from the amino acids joining together at stage 3. (7)

3.5 The graph below shows the average wheat yields in the Free State and in KwaZulu Natal from 1900 to 2000.

Graph of average wheat yield in the Free State and KwaZulu Natal



3.5.1 Describe the trend of average wheat yield for KwaZulu Natal from 1900 to 2000. (2)

3.5.2 During which 20-year-period did the greatest increase in average wheat yield take place in the Free State? (1)

3.5.3 Calculate the difference in average wheat yield in these two provinces in 2000. (1)

3.5.4 The advances in genetic engineering methods in the wheat industry would be one of the factors contributing to the increase in wheat yields in KwaZulu Natal over the last 20 years.

Briefly describe ONE scientific method that would improve the quantity of wheat harvested. (2)

[30]

QUESTION 4

4.1 Read the following extract and answer the questions below using the text and your own knowledge.

In April 2010, Professor Lee Berger, a paleoanthropologist, unveiled fossils of a new species of early human ancestor. Named ***Australopithecus sediba***, the fossilised skeletons of a young female and a boy were discovered in late 2008. They were estimated to have lived in the Cradle of Humankind about 1,78 to 1,95 million years ago. This exciting find is believed to be a **transitional species** between the more primitive ape-men, or **australopithecines**, and human's direct ancestors the **Hominid** species.

Australopithecus sediba has a combination of the primitive features seen in australopithecines, and the more advanced ones seen in humans.

Some of its distinctive human features are:
- short, powerful hands
- small generalised teeth for a more omnivorous diet
- long legs which were capable of walking and running

The australopithecine features are:
- the long 'orangutan' arms
- a small cranium for a small brain size

These early humans lived in a mixed savannah grassland and forest area and shared it with some fierce predators such as sabre-toothed cats and long legged hyenas.

[Adapted from various scientific sources]

4.1.1 What is meant by the term 'transitional species'? (2)

4.1.2 What type of work do the following do?

(a) Paleontologist
(b) Anthropologist (2)

4.1.3 *Australopithecus sediba* displayed bipedal features. What is the importance of bipedalism in the evolution of humankind? (3)

4.1.4 Professor Berger described *Australopithecus sediba* as 'becoming a terrestrial biped, but has a reserve safety parachute with its ape-like arms, and is still climbing trees.' What do you think he means by this description? (3)

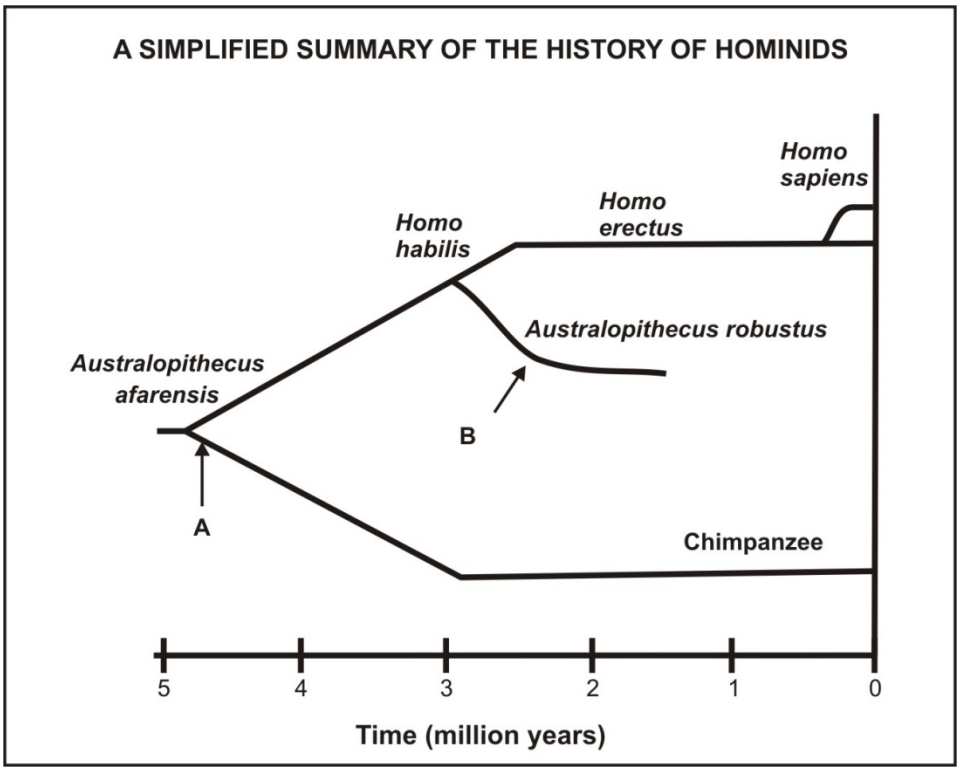
4.1.5 Some scientists agree with Professor Berger's hypothesis that *Australopithecus sediba* is a transitional species. What would scientists still need to do before they could state with certainty that this idea has become a scientific theory? (2)

4.1.6 Below are photographs of the skulls of *Homo sapiens* and *Australopithecus sediba*. These skulls are not shown to the same scale.

Homo sapiens skull *Australopithecus sediba* skull

List TWO differences between the skulls as seen in the photographs above, that show evolutionary trends in the development of modern humans. (4)

4.2 Study the diagram below and answer the questions that follow.



4.2.1 Why does the line B with *Australopithecus robustus* end in the middle of the diagram? (2)

4.2.2 Between which TWO species of human ancestors on the diagram in Question 4.2 above would you place *Australopithecus sediba*? (2)

4.2.3 When the fossils of *Australopithecus sediba* were found they were embedded in rock and soil. Fossils can be very fragile and need to be carefully handled. How do you think the scientists would ensure that they were carefully removed from the rock and soil? (2)

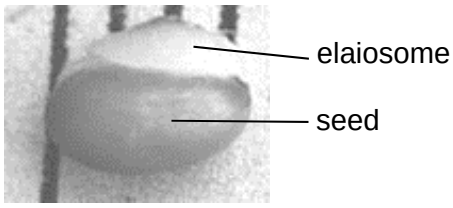
4.3

Fynbos is one of the world's six floral kingdoms. About 30% of fynbos plants produce seeds with an **elaiosome** – this is an extra fleshy structure that is rich in lipids and proteins.

- Ants take the seeds underground to their nests to feed the elaiosome to their larvae.
- After the larvae have eaten the elaiosome, the ants drag the remains with the seed into their waste disposal area.
- This site is rich in nutrients from the waste matter of the ants and allows the seeds to germinate quickly.

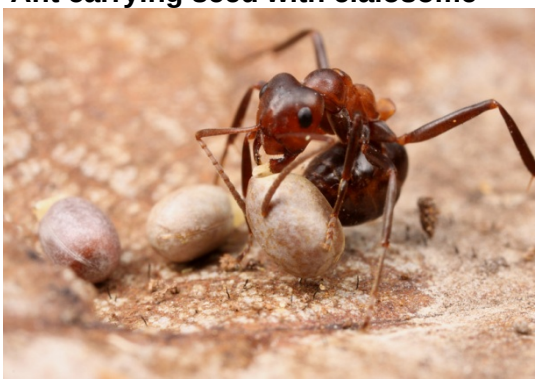
This is an example of co-evolution between plants and animals.

Seed of *Trillium grandiflorum*



[<synodresourcecenter.org>]

Ant carrying seed with elaiosome



[Image taken by Alex Wild <http://www.alexanderwild.com>]

4.3.1 Explain in terms of Darwin's theory of natural selection how the co-evolution of the ants and fynbos plants developed to ensure the survival of both species. (7)

4.3.2 The *Afzelia africana* tree from the African continent and the *Myrtus* shrubs from Europe are different species of plants on opposite sides of the world that have seeds with elaiosomes. Is this an example of divergent or convergent evolution? (1)

[30]

QUESTION 5

'A new era for 'body-parts' has dawned'. Scientists are researching the ability of stem cells to grow into replacement body organs and tissues.

In your opinion does the life-saving potential of stem cell research outweigh the concerns around the destruction of life (human embryos)?

Write an essay in which you present a debated argument that helped you reach your opinion.

- Read the source material (A – E) in order to help you **add to your knowledge** and respond to the question.
- Select **only** the facts from the information given that will assist your answer, **do not** attempt to use all the material.
- Integrate authentic biological knowledge from the source material. Do **not** write a response based entirely on your own knowledge.
- Provide a clear written response of not more than two pages explaining your decision and the reasons/motivation for it.

SOURCE A The arguments in favour of and against using stem cells

CONS – the main objection is to using embryos left over from in vitro fertilisation to harvest stem cells, and destroying the embryos after harvesting the stem cells

Some people think:

- embryos have the potential for life
- embryos have a soul and dignity which should be preserved
- stem cell research constitutes murder
- using adult cloned cells is also wrong as it is creating a life (clone) with the express intention of destroying it
- stem cell therapy could pass on viruses or other life threatening microscopic organisms that cause disease
- embryonic stem cells are 'young' cells and tend to grow quickly. Their fast growth has the potential for growing out of control and could eventually form life threatening cancer tumours
- the possibility of transplanted stem cells differentiating into the wrong type of tissue in the recipients body with unknown consequences is yet another danger

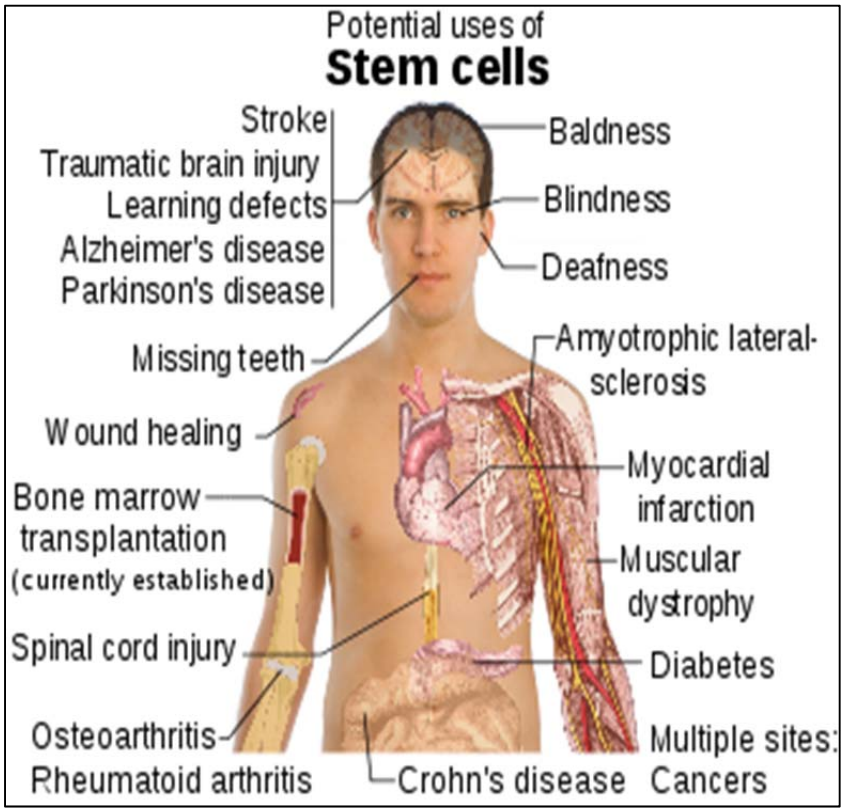
PROS – the main argument is that excess embryos not used by people for in vitro fertilisation need to be destroyed anyway, so why not use them for valuable research

Some people think:

- stem cell research has the potential to minimise suffering of people with many different diseases
- stem cells can teach us about how cells become different from each other
- we will be able to grow replacement organs and prolong the life of people with disease
- embryos cannot survive outside the womb and cannot be regarded as life
- more than a third of embryos do not implant after conception and that is much more than will be used in stem cell research
- blastocysts are a cluster of similar human cells that have not yet differentiated into organ tissues
- embryos are not humans, the life of *Homo sapiens* only begins when the heartbeat develops during the 5th week of pregnancy, or when the brain begins developing activity at about 7 to 8 weeks after conception

[Adapted from: <www.answers.com>]

SOURCE B



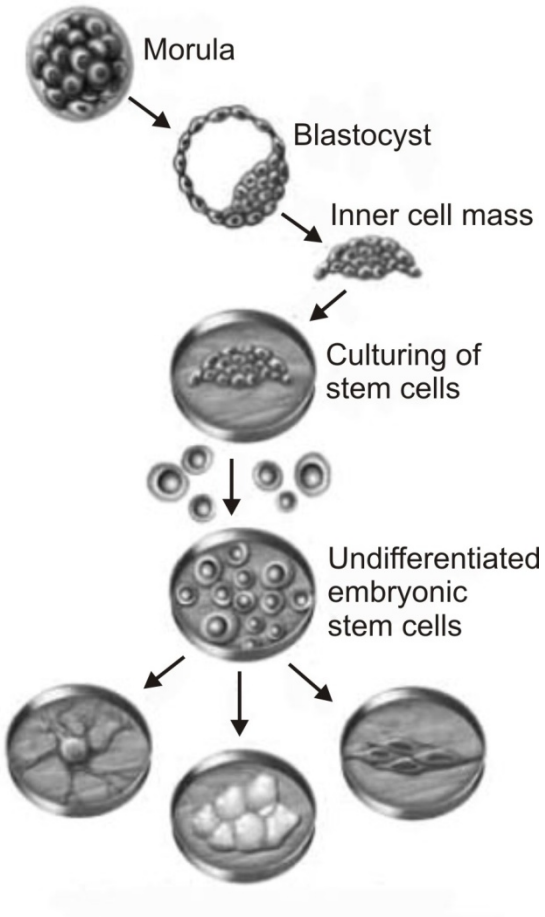
[http: <www.biologyresources.com>]

SOURCE C Background Information to Stem Cell Technology

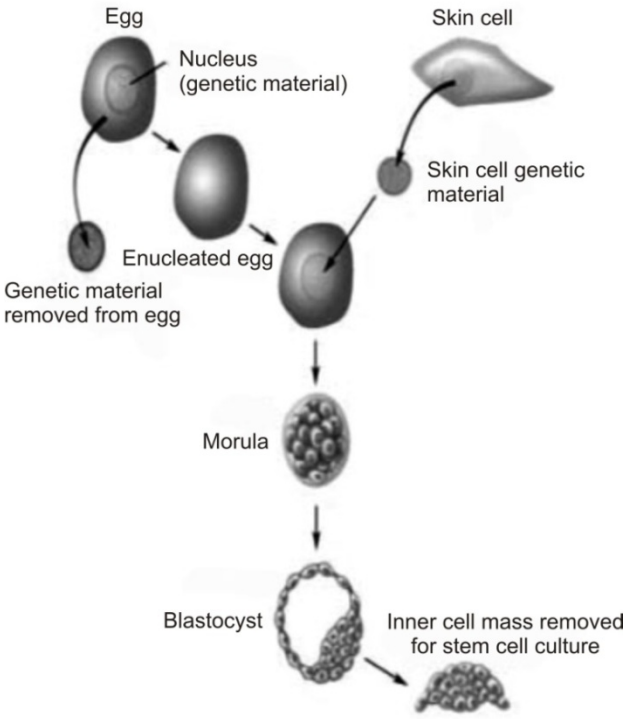
Stem cells have the extremely potent ability to regenerate themselves. They grow by mitosis and then turn into specialised cells for organs through cell differentiation. There are two types of stem cells found in mammals – **embryonic stem cells** differentiate into all the body systems and organs; **adult stem cells** repair organs and renew the skin and blood cells.

THE PROCESS: Two types of technology are possible

1. Embryonic stem cells are taken from the inner cell mass of the blastocyst of an embryo.



2. Scientists could produce a blastocyst by inserting the nucleus from a specialised cell (for example, a skin cell) into an egg without a nucleus. All the stem cells taken from this blastocyst are genetically identical to the patient's cells and can grow into that person's required organ or tissue.



[Adapted from: <www.national-academies.org>]

SOURCE D

Paralysis Facts and Figures

According to a study started by the Christopher and Dana Reeve Foundation in America, there are nearly 1 in 50 people living with paralysis in the USA – approximately 6 million people. That's the same number of people that would make up about 12% of South Africa's population.

We all know someone – a brother, sister, friend, neighbour, or colleague – living with paralysis.

Case Study: CHRISTOPHER REEVE'S LEGACY

There was hardly a household in America that was not waiting for news in the days following actor Christopher Reeve's accident at an equestrian competition in May 1995. He fell off his horse at a horse-jumping event. The fall caused multiple fractures of his 1st and 2nd cervical vertebrae. During surgery, his head had to be reattached to his spinal column. The actor known as Superman, 'the man of steel', was fighting for his life.

Eight weeks after surgery, Reeve was left paralysed from his shoulders down because of a 20-millimeter gap in his spine. Reeve's condition led to several medical complications, including pneumonia, blood clots, and wounds that wouldn't heal. He was confident that one day he would walk on his own. Reeve supported embryonic stem cell research and believed that this scientific breakthrough would help repair his damaged nervous system. He died in October 2004 of heart failure, at the age of 52.

Secondary complications, e.g. diabetes after paralysis are common. Most people think that walking again is the main concern. However, spinal cord injuries affect every organ in the body. People with spinal cord injuries die a decade earlier than a non-injured person.

[Adapted from: <www.answers.com>]

SOURCE E BEAUTY PRODUCTS

[Adapted from: <www.stemcellskinrepair.com>]

[20]

Total: 150 marks