



NATIONAL SENIOR CERTIFICATE EXAMINATION
NOVEMBER 2012

LIFE SCIENCES: PAPER I

Time: 2½ hours

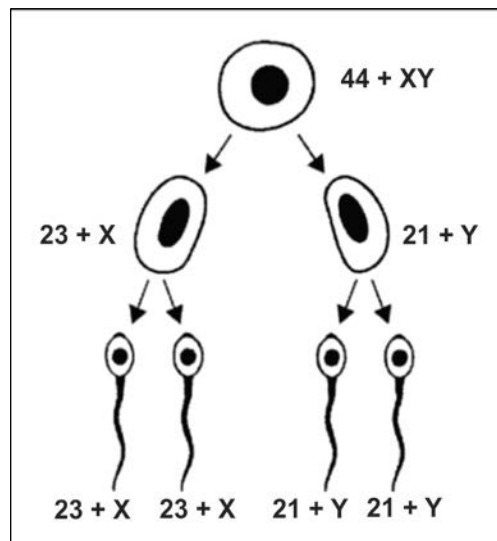
150 marks

PLEASE READ THE FOLLOWING INSTRUCTIONS CAREFULLY

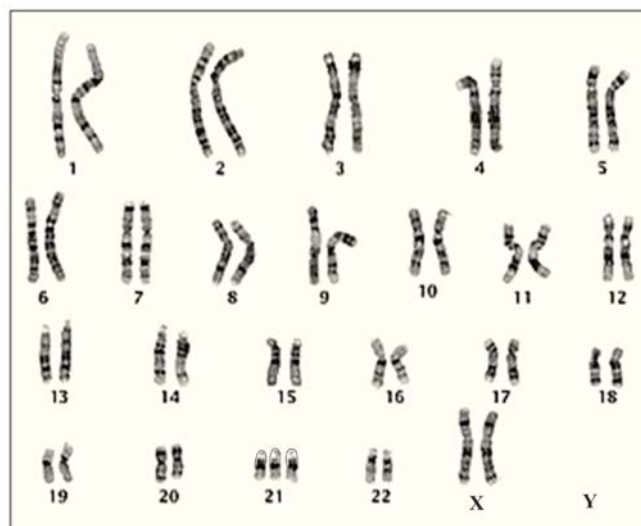
1. This question paper consists of 12 pages and a yellow Answer Booklet of 6 (i – vi) pages. Please check that your question paper is complete. Remove the yellow Answer Booklet from the middle of the question paper.
 2. This question paper consists of five questions.
 3. Question 1 must be answered in 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.
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QUESTION 2

- 2.1 The diagram below shows the chromosome number of cells formed during the development of abnormal human sperm.



- 2.1.1 (a) State the name of the biological process which produces sperm cells in males. (1)
- (b) In which organ in the human body are sperm produced? (1)
- 2.1.2 (a) If a sperm with a chromosome complement of **23 + X** fertilised a normal ovum, what is the sex and the number of chromosomes in the resulting zygote? (2)
- (b) Explain what could have gone wrong in the process mentioned in Question 2.1.2 (a) that resulted in the sperm being produced with the incorrect chromosome number. (2)
- 2.1.3 The inclusion of extra chromosomes in gametes occurs far more often in the formation of egg cells than in sperm cells. The karyotype below shows the chromosomes of an individual from an egg cell with an extra chromosome number 21.



- (a) What is the name for the disorder caused by the inclusion of an extra chromosome 21? (1)
- (b) State ONE phenotypic result in an individual with this abnormality. (1)
- (c) This karyotype is useful for studying the chromosomes of an individual. Choose the correct statements from the list below that refer to information one can obtain from this karyotype.

Write only the numbers of the correct statements in your Answer Book.

Information available from the karyotype

1. The chromosome number of this person
2. The sex of the individual
3. All genetic disorders on the chromosomes
4. The size of all the chromosomes (3)

- 2.2 The table below is taken from the records of the babies that were born at a hospital in South Africa. A total number of 1 119 babies was included in the survey.

Age of mothers (years)	20	25	30	35	40	45
Number of babies born with an extra chromosome 21	1	1	1	3	7	20

- 2.2.1 What percentage of all the babies recorded was born with the abnormal chromosome number? Show your working. (2)
- 2.2.2 **Sketch** a simple line graph to show the general trend provided by the results in the table. (4)
- 2.2.3 After considering the information provided below and in the table above, would you support a proposal by doctors that all pregnant women over the age of 40 should have an amniocentesis? Give TWO well-explained reasons for your decision. (4)

Risks associated with an amniocentesis:

- Infections can occur because of the puncture to the uterus made by the needle used to draw off amniotic fluid
- The amnion may not heal after being pierced and too much amniotic fluid may leak out of the amniotic cavity
- The risk of miscarriages after an amniocentesis increases by 1% to 2%

2.3 In the 1950s many scientists were trying to grow human cells for research purposes.

A scientist at John Hopkins University in America succeeded in culturing a sample of human cancer cells taken from an African-American patient, Henrietta Lacks. The cells were named *HeLa* after her. These cells grew at a very fast rate. The *HeLa* cells have been used extensively for important research such as:

- the development of the polio vaccine, which has saved millions of lives
- to investigate cancer, viral growth, protein synthesis and the effects of radiation
- they helped several researchers win Nobel Prizes

Sadly, Henrietta's own cells were growing just as quickly and she died of cervical cancer within 6 months. Her family only found out 25 years later that her cells were still alive and being used for research all over the world. They have received no compensation nor were they asked permission for their continued use.

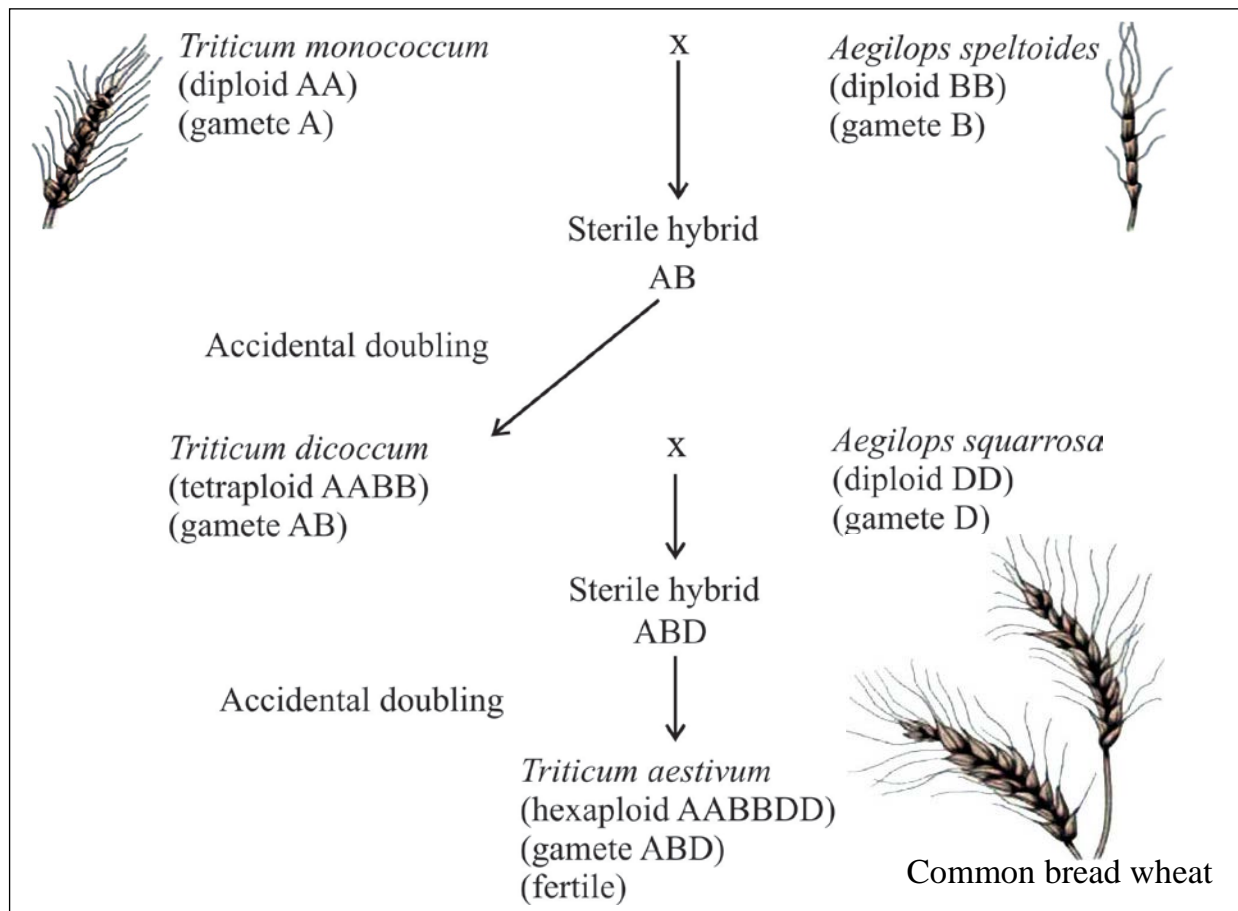
[Adapted from Campbell and Reece et al.: 2008]

- 2.3.1 Suggest a possible mutagen (mutation causing agent) that could have caused Henrietta Lacks' cells to grow out of control. (1)
- 2.3.2 In your opinion should the family of Henrietta Lacks have benefitted from the scientific research done on her cancer cells, e.g. receiving financial reward and/or scientific recognition? Give TWO well-argued reasons for your opinion. (4)
- 2.3.3 List TWO unethical practices in this research and explain what the correct procedures should have been. (4)

[30]

QUESTION 3

- 3.1 The diagram below shows how common bread wheat was formed from the natural hybridisation of related species of grasses. Diagrams are drawn to scale.



[www.ibri.org]

- 3.1.1 (a) What is the term used to describe organisms with more than two sets of chromosomes? (1)
- (b) Explain what is meant by the term 'sterile hybrid'. (1)
- 3.1.2 (a) How many more single sets of chromosomes are there in common bread wheat than in each of the original grasses, *Triticum monococcum* and *Aegilops speltoides*? (1)
- (b) Common bread wheat is more beneficial to humans than the original grasses. List TWO beneficial changes that you can observe from the diagrams. (2)
- 3.1.3 Suggest why the development of common bread wheat is an example of sympatric speciation and why it could not have been formed by allopatric speciation. (2)
- 3.1.4 Discuss ONE specific example of artificial selection in animals that is useful to humans. (3)

- 3.2 DNA fingerprinting may be used in forensic science to solve crimes. Read the information below and answer the following questions.

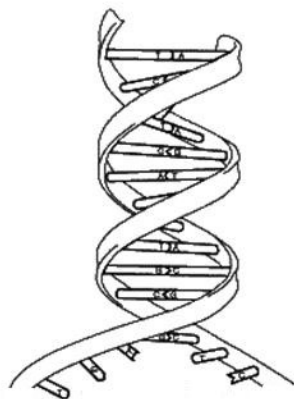
The first step to making a genetic fingerprint requires getting a sample of DNA. This sample can come from blood, semen, hair or saliva, and may be an extremely small sample. A blood sample contains white blood cells which are broken open using detergent, and the DNA is extracted.

Next, restriction enzymes are used to cut the non-coding DNA into many pieces of different lengths. This non-coding DNA consists of short sequences of bases that are repeated. The number of times the non-coding segments are repeated varies from individual to individual.

[Adapted from: Taylor, Green, Stout: 1984]

- 3.2.1 How are enzymes used in the process described above? (1)
- 3.2.2 Suggest why white blood cells and not red blood cells are used for the extraction of DNA. (1)
- 3.2.3 What is meant by the term 'non-coding or junk DNA' and explain how it is different to 'coding DNA'? (2)
- 3.2.4 Explain how a forensic scientist could use a DNA fingerprint to solve a crime. (2)
- 3.2.5 Explain how a PCR (Polymerase Chain Reaction) would produce a larger amount of DNA if a forensic sample was too small for DNA analysis. (3)
- 3.3 3.3.1 Construct a flow chart showing the stages in the process of DNA replication. A flowchart is a summary of a process using words and arrows. (10)

Diagram showing a section of a DNA molecule



- 3.3.2 State what useful information could be obtained from the analysis of mitochondrial DNA (other than the use of DNA in forensic science). (1)
- [30]

QUESTION 4

- 4.1 On his voyage on the HMS Beagle, Darwin collected many fossil specimens such as those of the extinct vertebrates known as glyptodonts. He noted that they had many traits in common with modern living armadillos. For example:

- Armadillos are now found only in places where glyptodonts once lived
- Both have bony helmets and shells made of bony scales
- Both were/are herbivores

The extinct glyptodonts had a mass of 2 000 kilograms (about the size of a small car), and were much larger than living armadillos, which are cat-sized.

Figure 1 **Biological illustrations of an armadillo and a glyptodont drawn to scale**

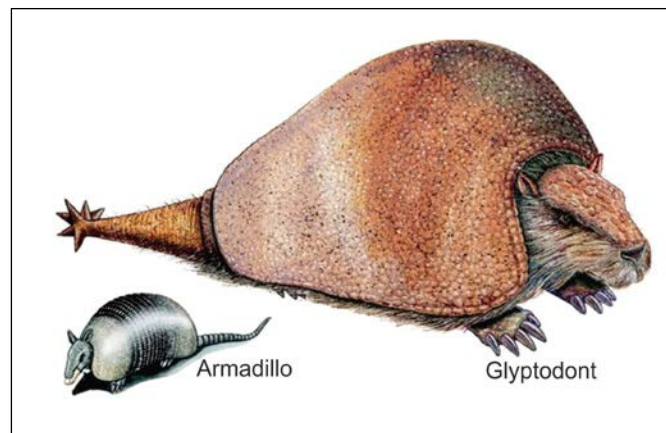
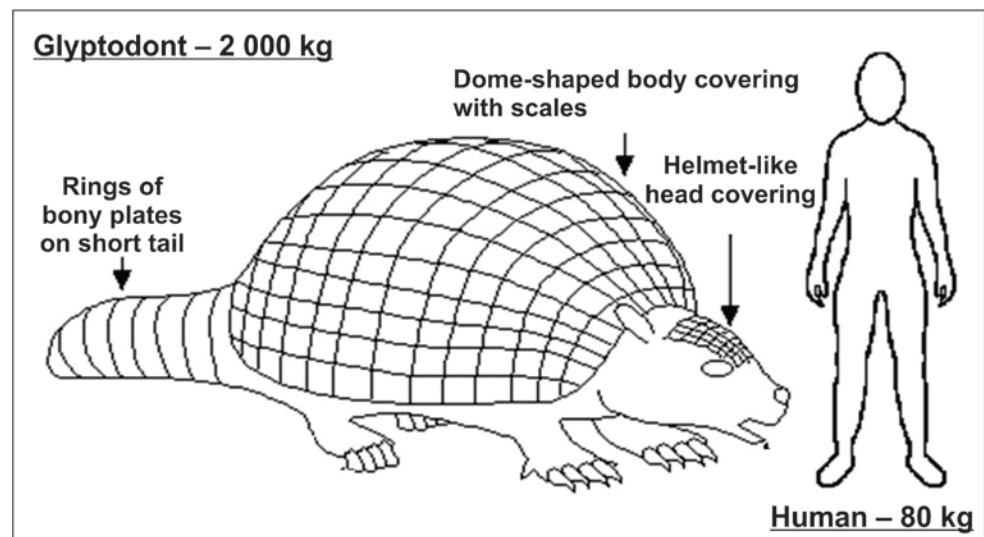


Figure 2 **A glyptodont and a human drawn to scale**



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

- 4.1.1 What could the function of the bony shells of the large glyptodonts have been? (1)
- 4.1.2 Use the information in Figure 2 above to calculate how much greater the glyptodont was in mass than the average human. Show your working. (2)
- 4.1.3 Darwin used similarities between living and extinct organisms to formulate his theory of 'modification by descent'. What is the scientific term for 'modification by descent'? (1)

4.1.4 Many people do not accept Darwin's theories. They may point out the fact that there is no direct visible evidence linking living armadillos and extinct glyptodonts, making it unlikely that an earlier species can give rise to modern species.

Use the information provided to give TWO well explained scientific reasons why scientists believe that glyptodonts are the ancestors of modern armadillos.

(4)

4.1.5 Suggest and explain a possible reason for the glyptodonts becoming extinct.

(2)

4.2 The survival of organisms in an ever changing environment is dependent on a high degree of variation among the individuals of a species.

Choose ONE of the following and explain how it is responsible for variation within a species.

1. Random assortment
2. Crossing over
3. Gene mutations

(5)

4.3 A group of university students planned to research the evolutionary effects of noise pollution on frogs. They had read about a study done on the Galapagos finches which showed that evolution can occur far more quickly than originally believed – within only 10 to 20 years, rather than hundreds to thousands of years.

Frogs are particularly vulnerable to environmental changes. A local newspaper reported that the mating calls of a species of frog had recently become much louder. Residents in the area claimed that since a major highway had been built near their local dam in 2000, the frogs' mating calls at night were much louder and the frogs were much larger than before. The students determined that the average level of peak time traffic noise before the highway was built was 56 decibels.

They worked on the following hypothesis: *Environmental conditions such as noise pollution can cause frogs to grow bigger so that they can call more loudly to attract mates.*

Method:

- The loudness of the mating calls at night was recorded
- The recorded frogs were caught and weighed
- Occasionally they were unable to catch the frogs in the dark and estimated their masses

The following results were presented to their supervisor after only 6 years of investigation:

Years	2006	2007	2008	2009	2010	2011
Average level of peak time traffic noise in decibels (dB)	60,1	62,4	62,8	64,2	64,4	64,9
Average loudness of mating calls in decibels (dB)	63,8	64,5	65,2	66,1	65,8	66,4
Average mass in grams (g)	122	125	130	128	129	132

- 4.3.1 Rewrite the hypothesis in the correct scientific format. (3)
- 4.3.2 Explain TWO criticisms of the way in which they conducted their research and suggest how they could correct each. (4)
- 4.3.3 What was the selection pressure on the frogs that the students were investigating? (1)
- 4.3.4 Why were the students concerned about the frogs' mating calls not being loud enough? (3)
- 4.3.5 Suggest a possible human solution to the noise pollution problem for these frogs. (2)
- 4.3.6 Do you think that the students should continue with this investigation? Give a reason for your answer. (2)

[30]

QUESTION 5

Genes can be transferred into an organism's cells to correct a genetic defect, treat a disease or alter the genome.

Do you think the advantages of this type of technology are more important than the dangers it may pose to humans and the environment?

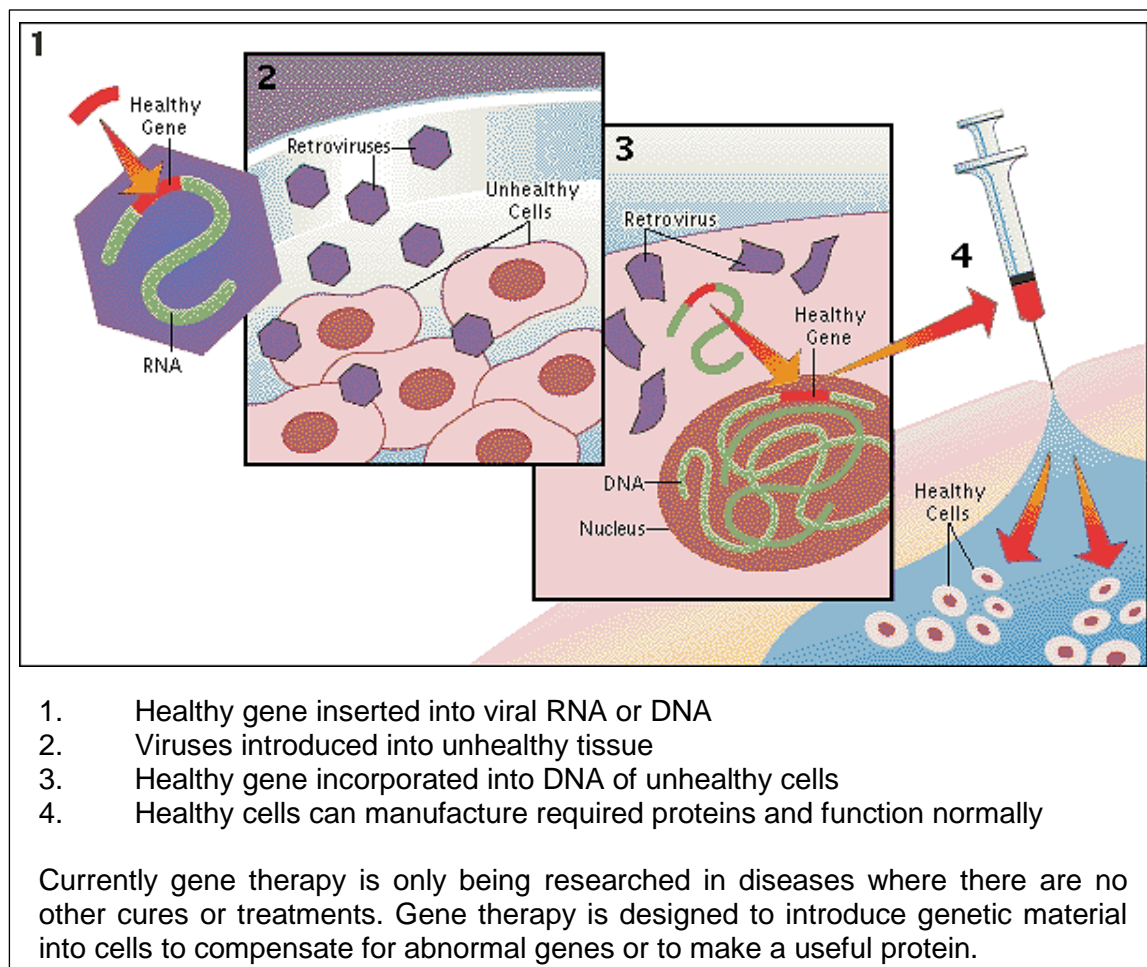
Present a debated argument to support your decision.

To answer the question you are expected to:

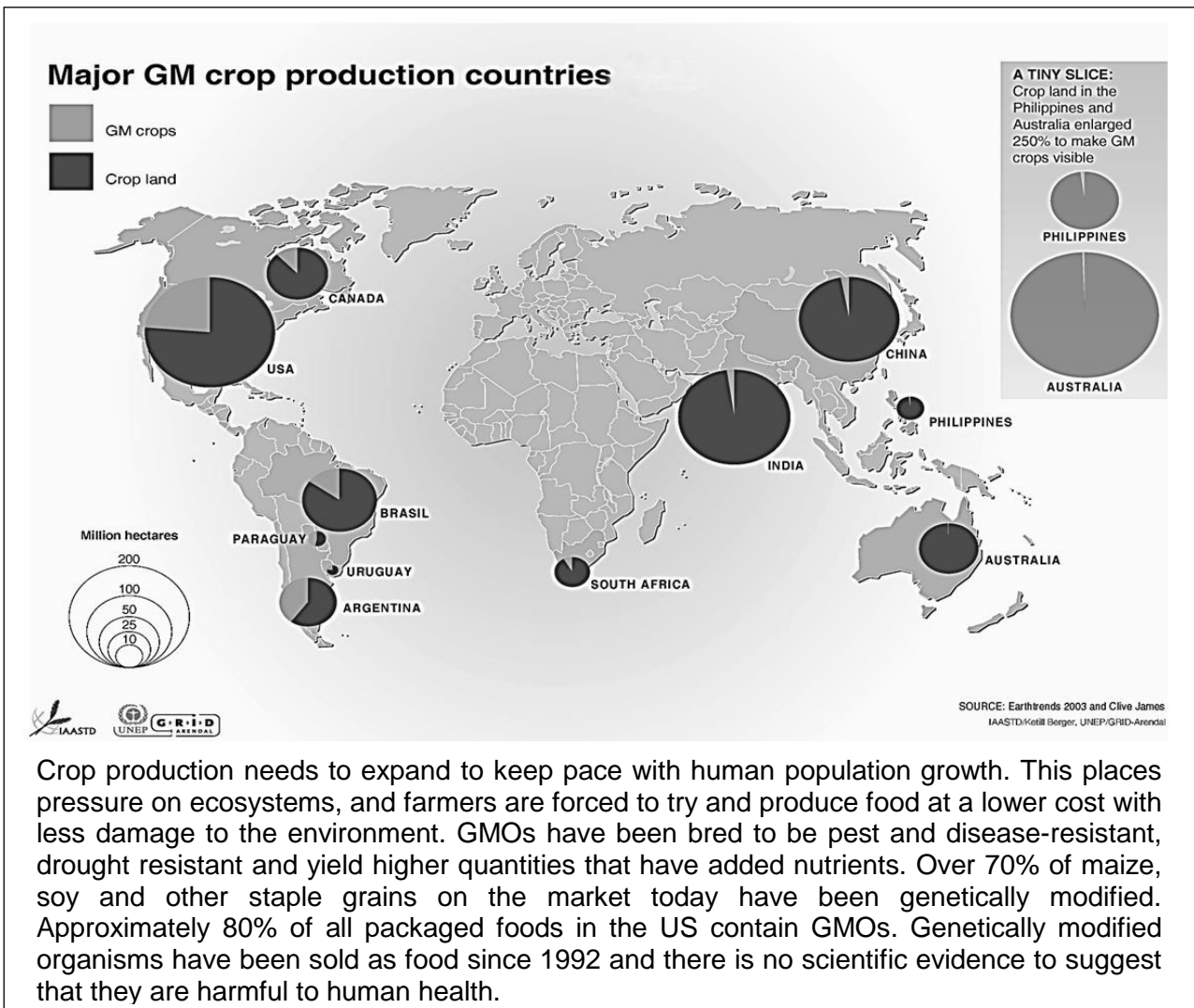
- Read the source material (A to F) in order to help you add to your knowledge and respond to the question.
- Select only the facts from the information given that will assist you in your answer; do not attempt to use all the material.
- Integrate authentic biological knowledge from the source material. 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.

[20]

SOURCE A WHAT IS GENE THERAPY?



[Adapted from: <<http://library.thinkquest.org>>]

SOURCE B TRANSGENIC CROPS[<<http://gmcrops.yolasite.com>>]**SOURCE C APPLICATIONS OF GENE TRANSFER****Genetic Engineering Helps the Environment**

The environment today is highly polluted by chemicals, heavy metals, oil products and various other pollutants. Genetic engineering could change that. Already, genetically engineered oil-consuming bacteria have been released into the wild to clean up disastrous oil spills at sea and on land. Microbes that break down toxic pollutants and heavy metals commonly found near industrial sites are being inserted into plants that can absorb and remove them from the environment.

Potential for HIV and AIDS protection

White blood cells cultured from transgenic cats showed resistance to Feline Immune Virus replication. FIV is similar to HIV, but occurs in cats. "In the future, we might engineer people's cells by adding a gene that encodes resistance, to the T-cells that are targeted by HIV," commented Paula Cannon, a geneticist at the University of Southern California's Keck School of Medicine who specialises in HIV-1 research and gene therapy.

[<<http://openlibrary.org>>]

SOURCE D[<<http://polyp.org>>]**SOURCE E****WHAT ARE YOU EATING?****FAST FOODS – BLOG WRITTEN BY AN ENVIRONMENTAL WATCHGROUP**

Fried chicken has been a part of our American traditions for many years. Many people eat fried chicken religiously. Do they really know what they are eating? During a recent study of some fried chicken companies some very upsetting facts were found. First of all, has anybody noticed that recently these companies have stopped using the word 'chicken' in their names? Why? They actually use genetically manipulated organisms. These so called 'chickens' are kept alive by tubes inserted into their bodies to pump blood and nutrients throughout their structure. They have no beaks, no feathers and no feet.

They do not have to pay so much for their production costs. There is no more plucking of the feathers or the removal of the beaks and feet. I find this matter to be very disturbing.

[Adapted from: <<http://3.bp.blogspot.com>>]**SOURCE F****CONCERNS ABOUT GENETIC MANIPULATION**

- An alteration to a certain plant might make it inedible or harmful to another organism such as an insect that relies on it for food. It may harm organisms that are desirable, or upset the balance of the food chain.
- GMOs have the potential to harm human health. Altering the genetic makeup of an organism could potentially introduce new allergic properties to it.
- Critics of GMOs feel it is unnatural or wrong to introduce the genes of animals into plants, or from one plant to another, which may be likened to 'playing God'. In addition, animals used in genetic engineering procedures may be subjected to pain and stress.
- Viruses, while the carrier of choice in gene therapy, present many potential problems – toxicity, difficulty controlling the gene and targeting correct tissues and the fear that the viral vector, once inside the patient, may recover its ability to cause disease.

[Adapted from: <<http://onlinelibrary.wiley.com>>]**Total: 150 marks**