NATIONAL SENIOR CERTIFICATE EXAMINATION
SUPPLEMENTARY EXAMINATION 2015

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 7 pages (i – vii). 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.

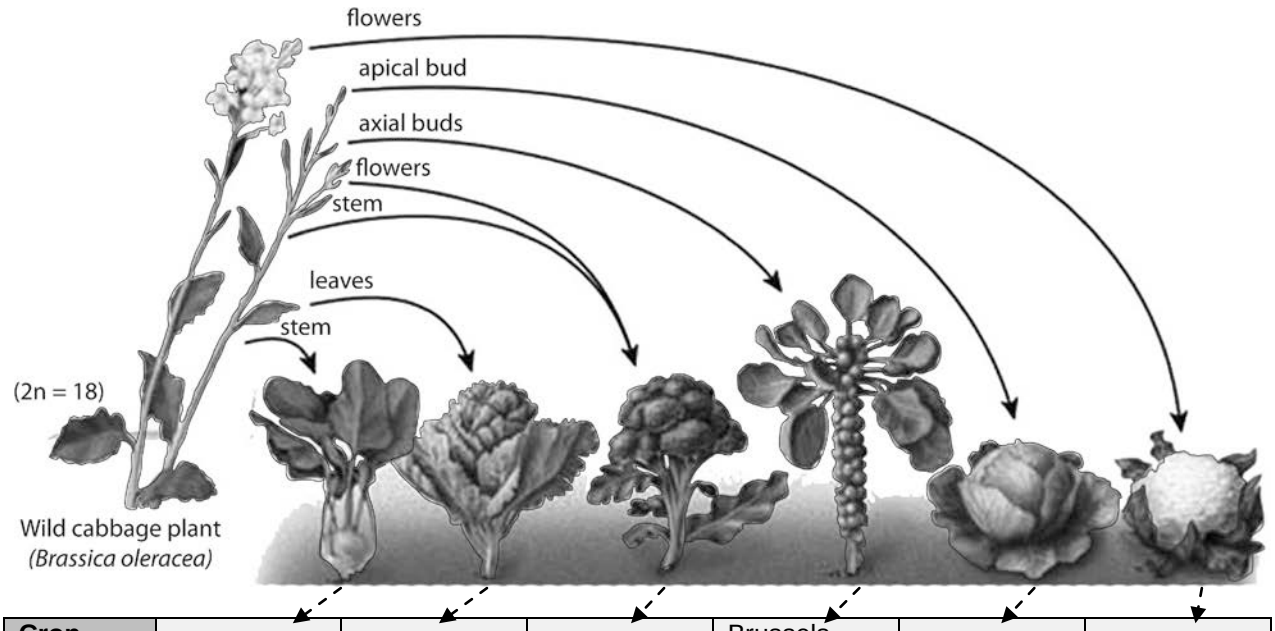
7. It is in your own interest to write legibly and to present your work neatly.

8. **Please hand in this question paper.**

QUESTION 2

2.1 Read the source material below and use it and your own knowledge to answer the questions.

The wild cabbage is the weedy looking ancestor of the domestic cabbage. Over the last few thousand years farmers have bred many varieties of cabbage-like plants that look very different to their wild cabbage ancestor *Brassica oleracea*. Almost all parts of the plant have been developed through selective breeding. The 'evolutionary pressure' to artificially 'select' cabbages was to develop nutritious sources of food.



Crop Variety	Kohlrabi	Kale	Broccoli	Brussels sprouts	Cabbage	Cauliflower
Modified trait	Stem	Leaves	Flower buds and stem	Lateral leaf buds	Terminal leaf bud	Flower buds

[<http://www.newtonsapple.org.uk>]

Facts about varieties of cabbage-like plants

The cabbage-like varieties have high nutritional value, contributing essential vitamins to the diet of millions.	They are crucial in preventing vitamin A, C and iron deficiencies.
Almost all parts of the plant have been developed through breeding. There are over 400 varieties of cabbage-like plants.	The cabbages are also an important source of oils and spices. E.g. mustard.

2.1.1 Name TWO parts of the wild cabbage plant that have been selectively bred over the last few thousand years. (2)

2.1.2 Select ONE of the varieties of modern cabbage-like plants from the diagram and explain how farmers could have developed it through breeding from the wild cabbage plant. (5)

2.1.3 From the information provided, list THREE specific reasons for farmers selectively breeding modern varieties of cabbages. (3)

2.1.4 The original wild cabbage had a diploid chromosome number of 18. Do you think the six varieties of cabbage-like plants shown in the diagram on page 2 also have a diploid chromosome number of 18? Give a reason for your answer. (2)

2.1.5 Discuss the similarities between natural selection and selective breeding. (3)

2.2 The images below which are shown to the same scale, are of a wild type of strawberry and a modern type of strawberry that is the result of polyploidy.

Wild-type strawberry

Modern strawberry

2.2.1 What is polyploidy? (2)

2.2.2 State TWO possible advantages of polyploidy in strawberries. (2)

2.3 The table below shows the results of an investigation into breast cancer:

- The 442 women diagnosed with breast cancer in the study all had at least two close relatives also affected by breast cancer.
- Mutations of the *BRCA 1* and *BRCA 2* genes can cause breast cancer.
- A woman with a *BRCA* gene mutation has an 80% chance of developing breast cancer before the age of 70.
- Not all women in the study tested positive for the mutated genes *BRCA 1* and *BRCA 2.*

Results of study into *BRCA* mutations in 442 women with breast cancer

	***BRCA 1* Mutation**	***BRCA 2* Mutation**	**No *BRCA* Mutation**	**Total**
1. Number of patients	89	35	318	442
2. Average age at diagnosis	43,9	46,2	50,9	
3. Preventative mastectomy (surgical removal of breasts)	6	3	14	23
4. Number of deaths due to breast cancer	16	1	21	38
5. Percentage who died (%)	18	2,8	6,9	8,6

[Adapted: Biology; Starr, Taggert et al; 2009]

2.3.1 Suggest what could have caused the breast cancer in women with no *BRCA* mutations. (1)

2.3.2 Suggest a reason why the investigators chose women with at least two close relatives who were also affected by breast cancer. (1)

2.3.3 According to the table, what is a woman's risk of dying if she is diagnosed with breast cancer? (1)

2.3.4 Which breast cancer mutation is the most dangerous? Give a clear reason for your choice. (2)

2.3.5

> The role of healthy *BRCA* genes is to produce proteins that regulate the normal renewal of breast and ovarian tissue during a woman's lifetime.

From the information above and your own knowledge, suggest how *BRCA* mutations may cause breast and ovarian cancer. (2)

2.3.6

> Some women who test positive for the *BRCA* gene mutations may decide to have a mastectomy as a preventative measure. However, many of these women would never have developed breast cancer.

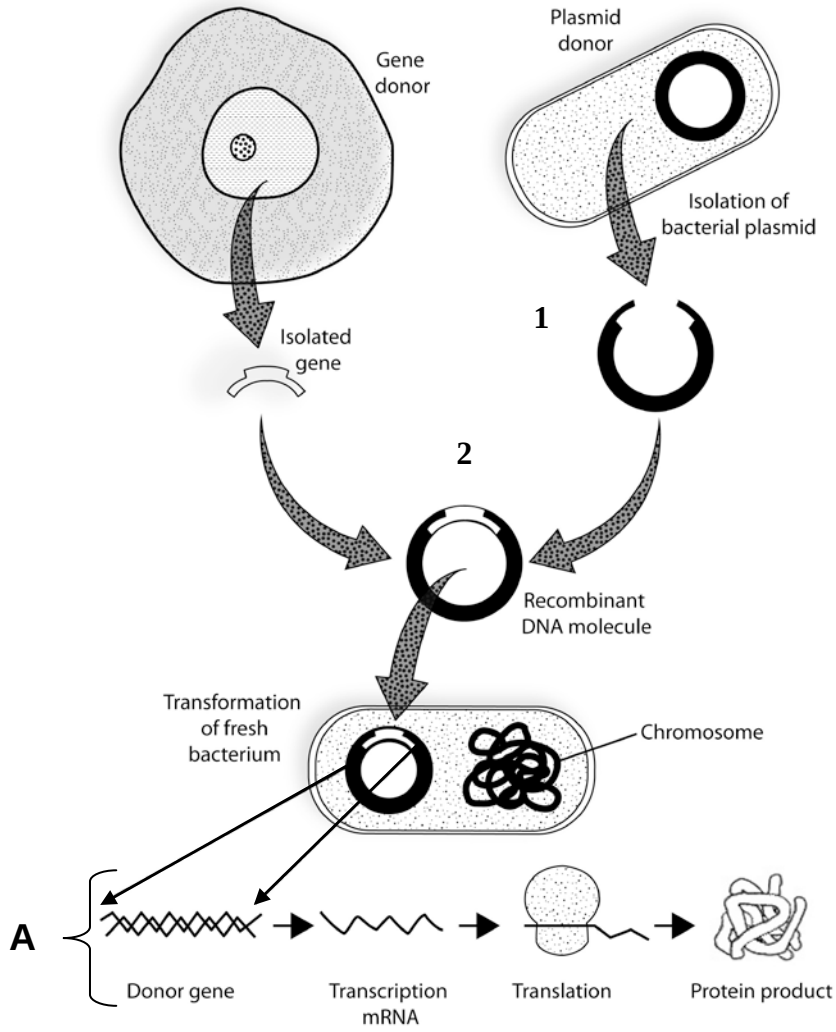
Do you support the right to have breasts removed as a preventative measure if one tests positive for the *BRCA* mutations? Give reasons to support your answer. (4)

[30]

QUESTION 3

3.1 Study the diagram below which illustrates a process used in genetic engineering.

Reprogramming a bacterium to include a foreign gene



3.1.1 Name the following enzymes:

(a) enzyme used to cut open the plasmid at **1**. (1)

(b) enzyme used to insert a gene into the plasmid at **2**. (1)

3.1.2 State a term used to describe the bacterium with a new gene. (1)

3.1.3 Briefly explain ONE use in agriculture and ONE therapeutic (beneficial to humans) use of this technology involving bacteria. (4)

3.1.4 (a) Explain what is meant by the term 'vector' in genetic engineering and suggest why bacteria are useful vectors. (3)

(b) Discuss ONE disadvantage to using micro-organisms as vectors of foreign genes. (2)

3.2

Genes are able to code for a protein as seen at A in the diagram shown in Question 3.1.

3.2.1 Describe the features of a gene that make this coding possible. (3)

3.2.2 Draw a flow chart that explains the process illustrated at **A**, that ends with a protein product. Note: **A** is only a summary of the process. (9)

3.3 In the table below, **row 1** represents data for a fertile couple and **row 2** represents data for an infertile couple. The result of a chromosome analysis for these couples is given and the predictions of fertilisation occurring with these gametes.

	Egg/ovum	**Sperm cell**	**Zygote**	**Gender/ sex of child**
1.	22 + X	22 + X	44 + XX	(a)
2.	23 + X	22 + Y	45 + XY	(b)

3.3.1 State the predicted genders/sex of the children at (a) and (b). (2)

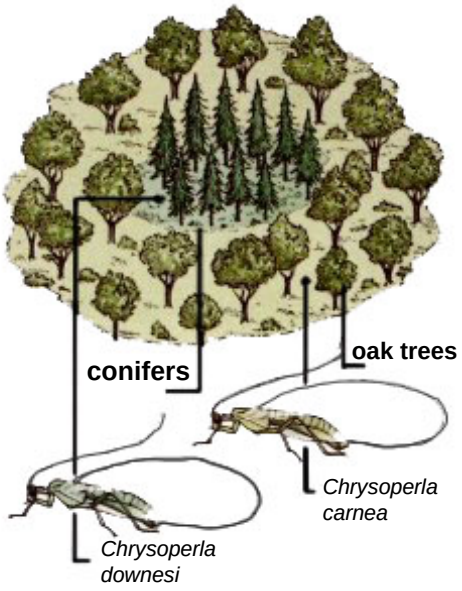
3.3.2 Explain the reasons why there is a difference in the chromosome numbers of the zygotes at number 1 and number 2. (3)

3.3.3 Name a possible disorder that a child with the chromosome number 45 + XY could suffer from. (1)

[30]

QUESTION 4

4.1



Chrysoperla carnea and *Chrysoperla downesi* are two closely related lacewing insect species. They are genetically and phenotypically very similar and live in the same ecosystem. However, they occupy different habitats and breed at different times of the year.

Chrysoperla carnea live on oak trees which lose their leaves in winter. This species of insect changes colour – they are light green in summer and brown in winter.

Chrysoperla downesi lives off evergreen conifer trees and they are dark green in body colour all year round.

[<http://www.nap.edu/>]

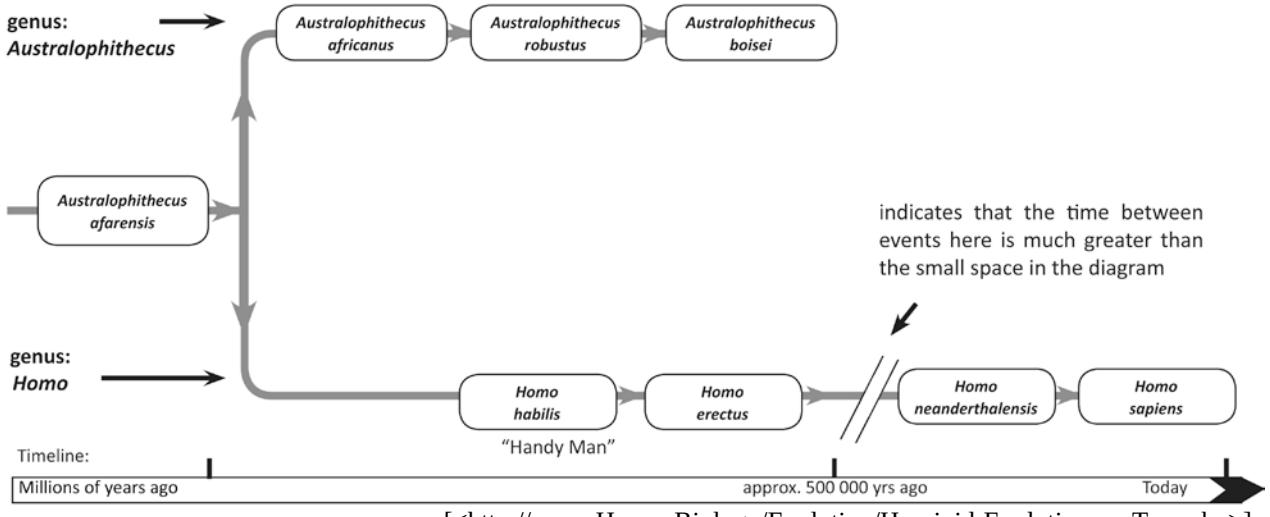
4.1.1 Name the type of speciation displayed by the lacewings? Give reasons for your answer. (4)

4.1.2 Do you think changing colour in different seasons has any evolutionary significance for *Chrysoperla carnea*? Explain your answer. (3)

4.1.3 Discuss the possible selection pressures that led to the development of the two different species of lacewing insects. (3)

4.1.4 Explain what is meant by the term 'species'. (2)

4.2 Study the diagram of a simplified Hominid Evolutionary Tree.



[<http://www.HumanBiology/Evolution/Hominid-Evolutionary-Tree.php>]

4.2.1 What is meant by a 'Hominid Evolutionary Tree'? (2)

4.2.2 Approximately how long ago did the genus Australopithecus become extinct? (1)

4.2.3 From your knowledge, describe TWO significant differences between *Homo habilis* and *Homo erectus*. (4)

4.2.4 What is the common hominid ancestor in the diagram (on page 7)? (1)

4.2.5 (a) Between which two hominids does Professor Lee Berger suggest *Australopithecus sediba* should be placed? (1)

(b) Discuss why *Australopithecus sediba* is an important South African fossil find. (3)

4.2.6 Discuss ONE way in which this simplified diagram of a hominid family tree may appear misleading or incorrect. (2)

4.3 Select ONE of the two theories, the Multiregional hypothesis or the Out of Africa hypothesis you studied on the origins of modern humans; then explain how it accounts for the spread of humans across the continents. (4)

[30]

QUESTION 5

Do you think that selecting a desirable mate plays a significant role in the process of natural selection?

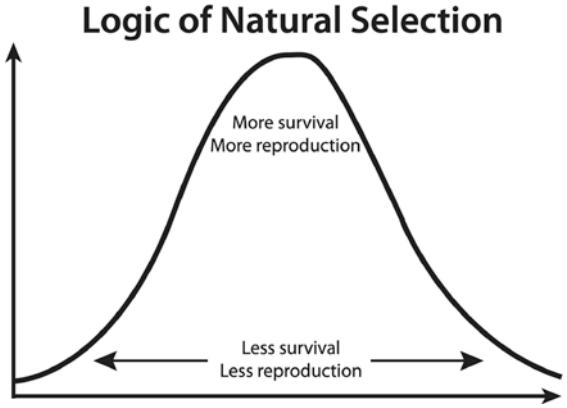
- Read the source material carefully and present a debated argument to illustrate your point of view.
- To answer this question you are expected to:
  - Select relevant information from Sources A to F below. Do not attempt to use all the detail provided.
  - Integrate your own relevant biological knowledge. However, do not write an essay based solely on your own knowledge.
  - Take a definite stand on the question and arrange the information to best develop your argument.
  - Write in a way that is scientifically appropriate and communicates your point of view clearly.

Write an essay of not more than 1½ to 2 pages to answer the question. **[20]**

SOURCE A NATURAL SELECTION – DARWIN'S MOST FAMOUS THEORY

One of the most important contributions made to the science of evolution by Charles Darwin is the concept of natural selection. The idea that members of a species compete with each other for resources and that individuals that are better adapted to their lifestyle have a better chance of surviving to reproduce, revolutionised the field of evolution, though it was not accepted until several decades after Darwin first proposed it. Today, natural selection forms the basis for our understanding of how species change over time.

[<http://www.sparknotes.com/biology/evolution/naturalselection>]



Natural selection is one of the most elegant and powerful theories in science. The graph curve depicts a population's members on the x-axis and 'genetic' fitness on the y-axis.

Adapted: [<http://science.howstuffworks.com/life/evolution>]

SOURCE B

CHEATING CHEETAHS PROSPER

The cheetah cubs in this photo are likely to be only half-siblings.

Philandering (cheating) males, such as male lions, male chimps and male elephant seals play the Casanovas, pairing up with multiple females. But now researchers have revealed that female cheetahs also 'cheat'.

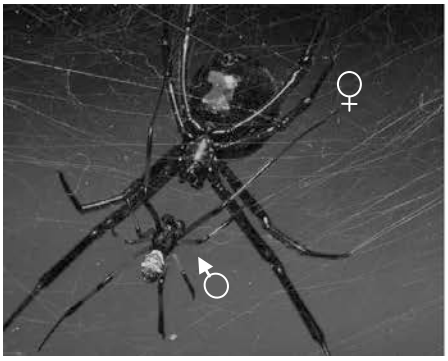
According to a study in May 2007, female cheetahs seem to be at least as promiscuous as their male counterparts. Females frequently mate with several different males while they are fertile and are then likely to bear a single litter of cubs fathered by multiple males – making many of the cubs within a single litter only half-siblings. This discovery has important implications for the conservation of these endangered animals. It impacts on the cheetah population's level of genetic variation. Genetic variation is a key ingredient of evolution. A population with low genetic variation is vulnerable to all sorts of environmental changes that a more variable population could resist.

[<http://www.evolution-textbook.org/>]

SOURCE C

THE DANGERS OF SEXUAL SELECTION

Sexual selection acts on an organism's ability to obtain (often by any means necessary!) and successfully copulate with a mate. Selection makes many organisms go to extreme lengths for sex: e.g. fruit flies perform dances, and some species deliver persuasive gifts. Sexual selection is often powerful enough to produce features that are harmful to the individual's survival. For example, extravagant and colourful tail feathers or fins are likely to attract predators as well as interested members of the opposite sex.



The male redback spider is much smaller than the female and is likely to be eaten after copulation.

Male peacocks maintain elaborate tails to attract females.

Elephant seals fight over territories with breeding females.

*sexual selection = choosing a desirable mate for breeding purposes.

Adapted: [<*evolution.berkeley.edu*>]

SOURCE D MISCONCEPTIONS ABOUT NATURAL SELECTION

Because natural selection can produce amazing adaptations, it's tempting to think of it as an all-powerful force, urging organisms on, constantly pushing them in the direction of progress – but this is not what natural selection is like at all.

1. Natural selection does not produce perfection. If your genes are 'good enough', you'll get some offspring into the next generation – you don't have to be perfect. This should be pretty clear just by looking at the populations around us: people may have genes for genetic diseases, plants may not have the genes to survive a drought, a predator may not be quite fast enough to catch her prey every time she is hungry. No population or organism is perfectly adapted.
2. It's more accurate to think of natural selection as a process, rather than as a guiding hand. Natural selection is the simple result of variation and heredity – it is mindless and mechanistic. It has no goals; it's not striving to produce 'progress' or a balanced ecosystem.

Adapted [<www.astro.umd.edu/~miller/teaching>]

SOURCE E REPRODUCTION IN WILD DOGS

A nuclear pack of about six dogs usually consists of one dominant breeding pair and several non-breeding adult male helpers. A breeding female gives birth about once a year. Their pups are born in a shelter of thick bush or grass, or in a hole. Usually twice as many males are born. Unlike many other species, the female offspring leave the group when they reach maturity, not the males.

The hunting members of the pack led by the alpha male return to the den where they regurgitate meat for the nursing female and pups. Although litters are very large, very few pups survive. Sometimes the dens are flooded, or the pups die from exposure or disease. The entire pack is involved in the welfare of the pups; both males and females babysit the young and provide food for them.

Previous studies have indicated that inbreeding with first-order relatives (parents, offspring and siblings) may be rare in wild dogs due to long-distance and sex-biased dispersal (females and males leave pack separately to form groups with non-related individuals). However, wild dogs are cooperative breeders living in highly social groups with mature offspring often remaining in the pack to help raise pups for 1 to 3 years before dispersal. The primary factor generally believed to regulate reproductive success (and inbreeding avoidance) is behavioural dominance displayed by the alpha male and female who, in turn, behaviourally (frequent urination to mark territory and vocalising by barking, whining twittering) and/or physiologically (suppression of the sex hormones of subordinates) prevent reproduction in remaining pack members.

Adapted: [<http://www.outtoafrica.nl/animals/engafricanwilddog.html>]

SOURCE F FIGHTING OFF RIVALS MAY BE RESPONSIBLE FOR MASCULINE TRAITS

According to David Puts, an anthropologist at Pennsylvania State University, in his research paper; *Evolution and Human Behaviour*:

"When two men fight over a woman, evolution may have shaped men to behave this way. Almost all of the traits considered to be masculine – big muscles, facial hair, square jaws, deep voices and a propensity to violence – evolved, it now seems, specifically for their usefulness in fighting off or intimidating other men, allowing the winner to get the girl."

[<www.economist.com>]

Total: 150 marks