SENIOR SECONDARY IMPROVEMENT PROGRAMME 2013

education
Department: Education
GAUTENG PROVINCE

GRADE 12

LIFE SCIENCES

LEARNER NOTES

The SSIP is supported by

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LEARNER NOTES

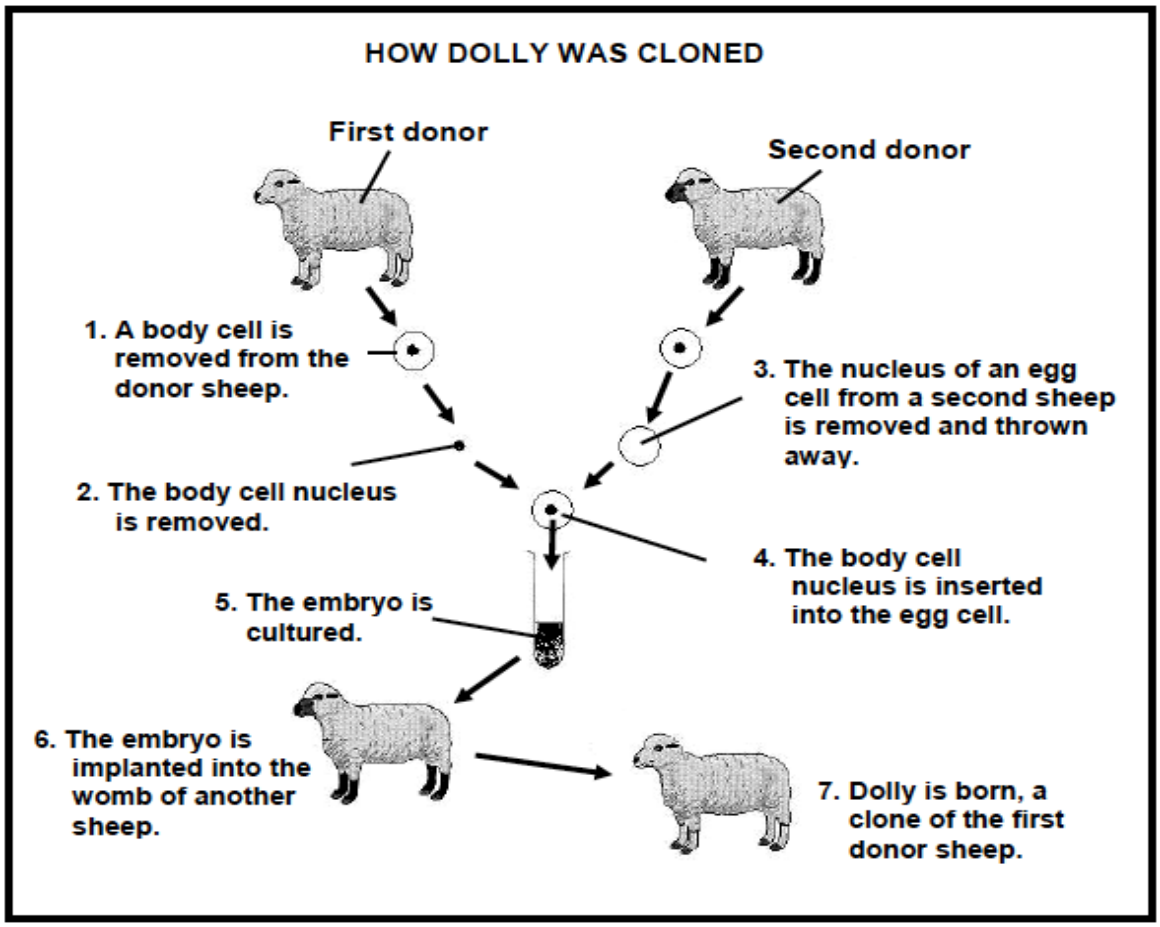
SESSION 3: TOPIC 1: MUTATIONS AND NATURAL SELECTION, GENETIC ENGINEERING

Learner Note: This section is a small section in the work but relates to LO3 and is often examined. In fact, most of the past exam papers contain questions on mutation, natural selection and genetic engineering. It is important that you are encouraged to read about genetic engineering so that you form an opinion of whether this is good or bad, but also so that you understand the basic process and the benefits to human beings.

SECTION A: TYPICAL EXAM QUESTIONS

QUESTION 1: 10 minutes *(Taken from DoE Additional Exemplar 2008 Paper 1)*

Study the diagram below that shows the cloning of a sheep named Dolly.



1.1. Why was it necessary to remove the nucleus from the egg cell of the second donor before the sheep could be cloned? (2)

1.2. Would Dolly have any characteristics of the second donor sheep? (1)

1.3. Explain your answer to QUESTION 1.2. (2)

1.4. Number 5 on the diagram states that 'the embryo is cultured'. Through which process of cell division does the embryo develop? (1)

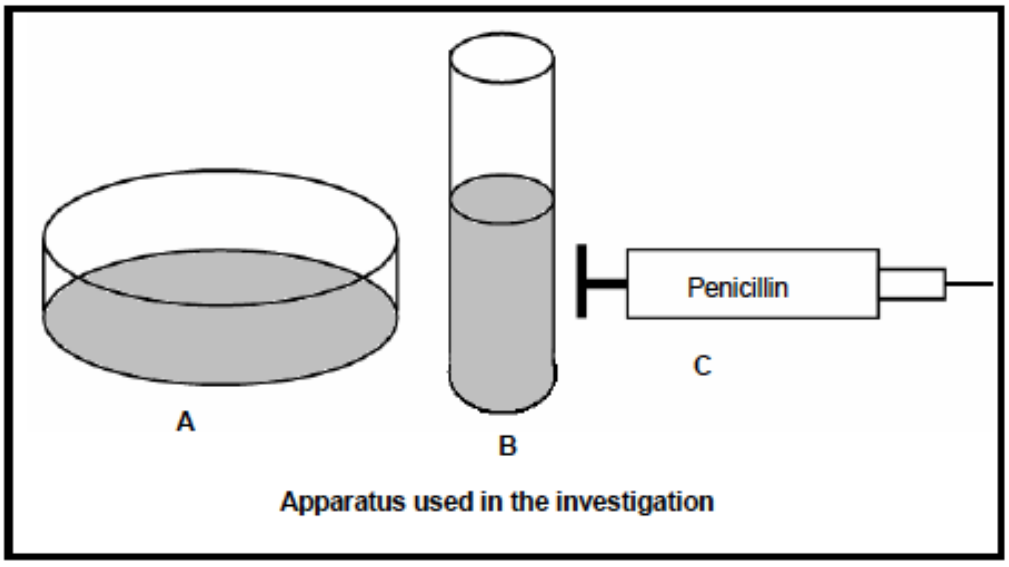
1.5. Describe TWO reasons why people could be against genetic engineering. (4)

[10]

QUESTION 2: 4 minutes *(Taken from DoE Exemplar 2008 Paper 1)*

Antibiotics work by interfering with various stages of protein synthesis in a bacterial cell. A group of Grade 12 learners wanted to test the effect of the antibiotic penicillin on the bacterium *Staphylococcus aureus.*
They were provided with the following apparatus:

1. Petri dishes containing agar (agar supports bacterial growth) (A)
2. Culture of *Staphylococcus aureus* (B)
3. The antibiotic penicillin (C)



List the steps that you would follow to determine the effect of the antibiotic penicillin on the bacterium *Staphylococcus aureus.* [4]

HINT: Just think of a step by step process. Write it down on this question paper first and then write it on your answer sheet. It must follow a logical order.

QUESTION 3: 14 minutes *(Taken from DoE Feb/March 2009)*

Read the passage below and answer the questions that follow.

GENETICALLY MODIFIED PIG BRED WITH 'GOOD FAT'

Scientists in the United States of America have produced genetically modified pigs with fat containing omega-3 fatty acids. These fatty acids, which are usually found in salmon, mackerel and fresh tuna, are thought to be responsible for a number of benefits, from combating heart disease to improving intelligence.

Researchers from the University of Pittsburgh – School of Medicine created piglets capable of converting less useful omega-6 fatty acids into omega-3 fatty acids. They implanted 1 800 embryos into 14 female pigs. Ten live offspring, which were able to make high levels of omega-3 fatty acids, were born.

[Adapted from: Cape Argus, 27 March 2006]

HINT: Read the passage through and underline what you think will be the important facts. Read the passage again, now answer the questions.

3.1. Name TWO health benefits of omega-3 fatty acids. (2)

3.2. What percentage success did the scientists have with the implanted embryos in forming a clone of pigs capable of producing omega-3 fatty acids?
Show ALL working. (3)
(Show each step of the calculation.) ``````````````````````````````

3.3. To produce genetically modified pigs, the gene that produces omega-3 fatty acids is inserted into the pig embryos. Describe the steps in forming and introducing many copies of the desirable gene (using bacteria) into the pig embryos. (4)

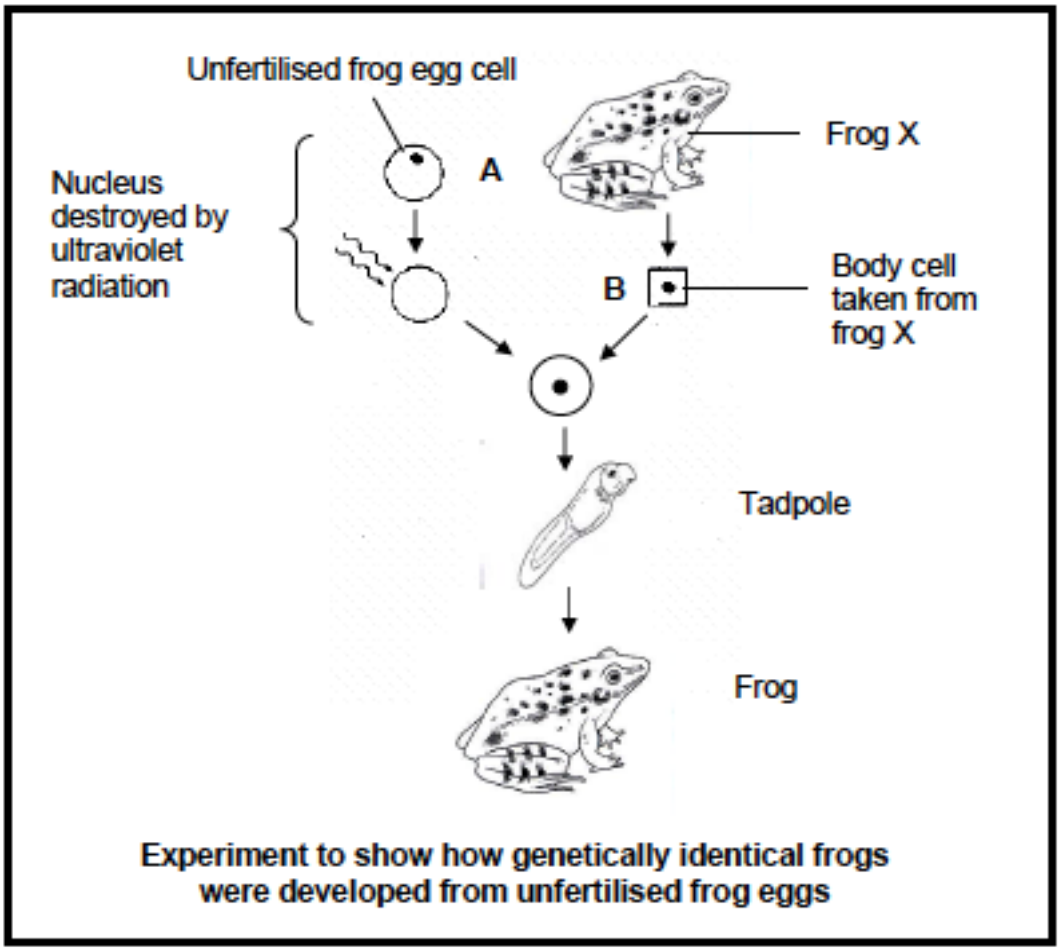
3.4. Give TWO reasons why:

(a) Some people may support the use of genetically modified pigs to produce omega-3 fatty acids. (2)

(b) Some people may be against the use of genetically modified pigs to produce omega-3 fatty acids. (2)
[13]

QUESTION 4: 12 minutes *(Taken from DoE November 2008 Paper 1)*

The diagram below shows the steps of an experiment in which a large number of genetically identical frogs were developed from unfertilised frog eggs. The nucleus of each unfertilised egg was destroyed and replaced by a nucleus obtained from a body cell from frog X.



Experiment to show how genetically identical frogs were developed from unfertilised frog eggs

4.1. The diploid number of chromosomes in the above frogs is 26. How many chromosomes are present in the nucleus of the following cells?
(a) Cell A (1)
(b) Cell B (1)

4.2. Why can an egg containing a nucleus from the body cell of a frog develop into a tadpole? (2)

4.3. Explain why all the frogs produced from the treated eggs are genetically identical. (2)

4.4. Name the method of producing genetically identical offspring as shown in the diagram. (1)

4.5. State ONE reason why some people might:
(a) Favour the process shown in the diagram (2)
(b) Be against the process shown in the diagram (2)
[11]

SECTION C: ADDITIONAL CONTENT NOTES

Genetic Variations and Mutations

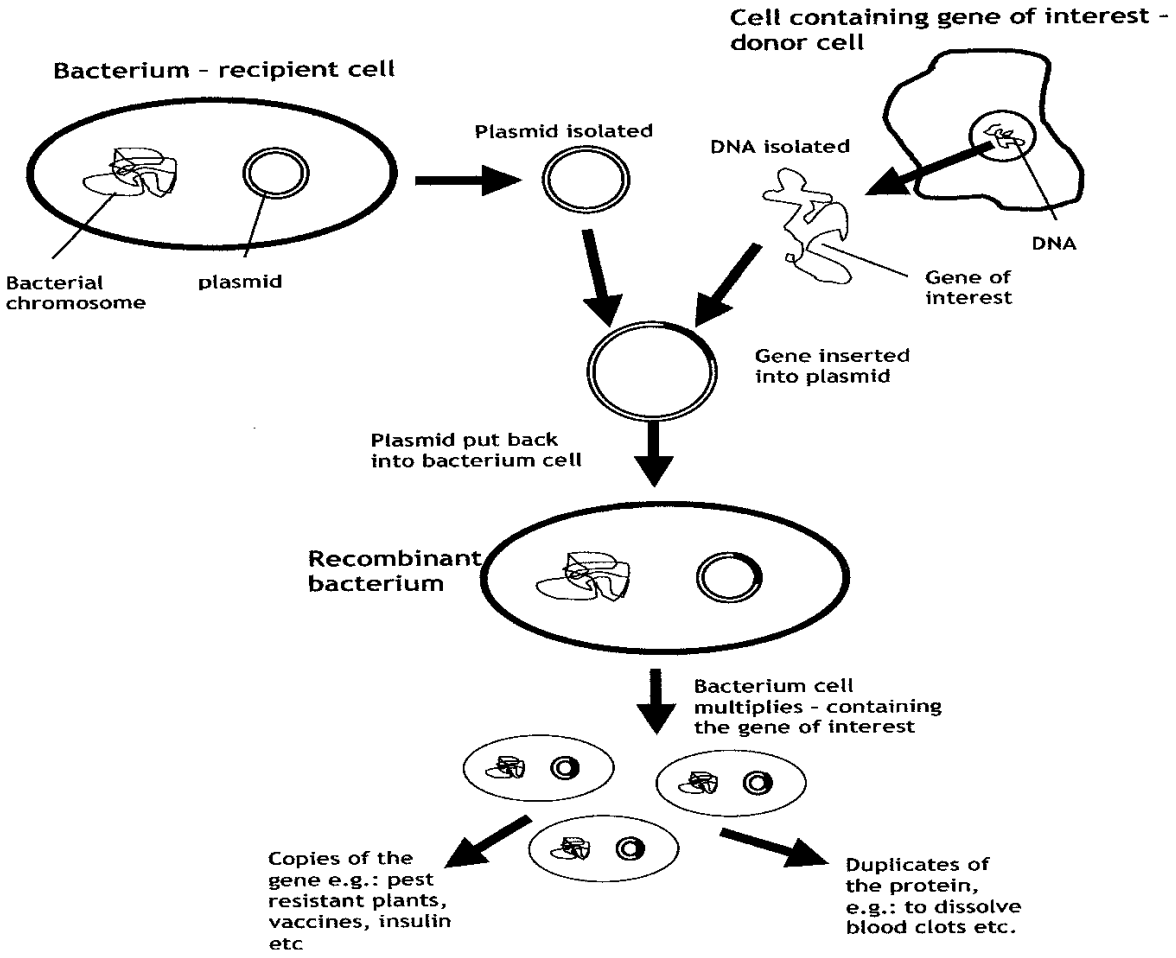
A gene mutation is a **change** in the genetic material of the cell. This will occur when:

- a codon is **substituted**
- one or more nitrogenous bases are **deleted** from the codon
- additional nitrogenous bases are **included** into the DNA.

When an allele gene is mutated into a new allele, it may be recessive. This mutated trait will, therefore, only be expressed in the phenotype when it is **homozygous**. Gene mutations allow for individuals within a species to be different. When these differences assist the organism to **adapt** to their environment, then it is a favourable mutation. This favourable mutation will be passed on to the next generation and ensures **natural selection** and survival of the species by increasing the gene pool.

Genetic Engineering

In Genetic Engineering, the genes on a DNA are altered so that a different organism results. When genes are transferred from the donor to the recipient, the DNA in the recipient cell is called **recombinant DNA** – meaning the DNA has been recombined. The recipient cell is then called a **transgenic** organism. Bacteria are often used because the plasmids can be restricted easily and the bacteria become the transgenic organism. **Bacterial plasmids** are used as vectors as well because the plasmids are used to transfer the donor DNA into a recipient organism, which becomes the new transgenic organism.
An example is **Insulin**. Humans produce the hormone insulin naturally in the pancreas. Insulin controls the blood sugar. Then the pancreas stops producing insulin, people develop a disease called diabetes, so insulin must be produced outside the body and injected intramuscularly. Biotechnology is used to produce the insulin by using the bacterium *Escherischia coli* (*E. coli*) using recombinant DNA. The process causes *E. coli* to produce the same insulin as in humans for use in people suffering from diabetes. Vaccines for syphilis, TB and hepatitis are produced in a similar manner.



Genetic engineering can be used in a positive manner to alter and improve animals and plant crops by genetically modifying them so that:

- crop plants are resistant to disease, frost and drought, produce more grains and grow faster
- sheep are modified to produce more meat and yield more and better quality wool
- cattle are modified to produce more meat and milk
- chickens are modified to produce more eggs at a faster rate

Genetic engineering is used in the medical and forensic professions like:

- Bacterial cultures are used to manufacture insulin for diabetics and other hormones used in replacement therapy.
- DNA fingerprinting.
- Manufacture of vaccines for syphilis, TB, hepatitis and many more diseases

Genetic engineering may be used in a negative manner when scientists create organisms that will harm people, animals and crops biologically. This is called **biochemical warfare,** e.g.: anthrax and the Ebola virus were created in a laboratory to be used on the “enemy” instead of weapons.

SECTION D: HOMEWORK

Learner Note: As you attempt the homework, you need to ensure that you are able to answer the questions in the allocated time frames. If you get stuck, you should refer either to the additional notes or your class teacher.

QUESTION 1: 5 minutes *(Taken from DoE Nov 2008 Paper 1)*

Since the 1980s, human insulin has been produced using genetically modified bacteria and yeast.

1.1. State THREE advantages of producing human insulin by genetic modification. (3)
1.2. Give TWO reasons why some people might be against genetic modification. (2)
[5]

QUESTION 2: 5 minutes *(Taken from IEB Nov 2009 Paper 1)*

Porphyria variegate 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.

2.1 What is a 'mutation'? (2)
2.2 What in the text indicates that *porphyria* is an autosomal condition? (1)
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)
[4]

QUESTION 3: 15 minutes *(Taken from IEB Nov 2009 Paper 1)*

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

JOHANNESBURG: Africa‟s nutrition problems could one day disappear thanks to animal cloning. This was said by one of the scientists who succeeded in Africa‟s first cloning of appearance to the public in the North West province. The calf name means „repeat‟ or „replica‟ in Zulu.

The donor cow is a South African milk-production record-holder. Producing 78 litres per day “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 Embrio Plus Centre. De la Rey and his colleague have been working on the cloning project for nearly two years. “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.

Their technique is different from normal cloning methods in that the protective covering around the egg is removed before cloning takes place. They 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. “Again we were lucky that the recipient cow did not reject the egg” De la Rey said.

By cloning it is possible to replicate the characteristics of high-quality animals and prevent the unknown variability that can occur in normal breeding. But De la Rey said that the process was currently very expensive and the procedures need more development. He said cloning could be very useful to countries in Africa where there are increasing food shortages

3.1 On what date was Futhi first shown to the public? (1)

3.2 Explain why Futhi is a suitable name for the new calf. (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)

3.4 In what way does normal cloning differ from De la Rey's method? (1)

3.5 In what organ of the recipient cow would the cloned egg develop? (1)

3.6 Futhi is just one cow. How does this make cloning useful in solving the food shortages of whole countries? (1)

3.7 The process of producing a cloned animal is difficult. Write down ONE difficulty mentioned in the article. (1)

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)
[14]

SECTION B: SOLUTIONS AND HINTS TO SECTION A

QUESTION 1

1.1 To insert the DNA ✓/nucleus of the sheep that you want to close ✓ (2)

1.2 No ✓ (1)

1.3 Dolly will have exactly the same DNA ✓ as the first donor sheep ✓/DNA of the second donor was removed and replaced (2)

1.4 Mitosis ✓ (1)

1.5 They might feel that scientists want to play God ✓ in creating new life✓
The purpose✓ of the clones might be questioned – will they be used for „spare" organs✓
The possibility of harmful micro-organisms being released either accidentally or purposely ✓ ***(Mark first TWO only)*** any (2 x 2) (4)

[10]

QUESTION 2

2. (i) Add *S. aureus* into the petri dishes ✓
(ii) Allow a few hours for bacterial growth ✓ (incubation)
(iii) Add the antibiotic ✓ in a specific area
(iv) Observe the effect of the antibiotic after several hours ✓
(v) Set up a control where no antibiotic is added ✓

(Mark any FOUR in the correct order) **[4]**

QUESTION 3

3.1 - Combating heart diseases✓ - Improving intelligence✓ (2)
(Mark first TWO only)

3.2 10 ✓ x 100 ✓ 1 800
= 0,55 ✓% (3)

3.3 The gene responsible for producing omega-3 fatty acids is located ✓
in the DNA of salmon✓/fresh mackerel/tuna
This gene is cut ✓ from the donor organism, inserted into a plasmid of a bacterium ✓
Bacteria replicate to form many copies of the gene ✓
These genes are then inserted into the cells of the zygote ✓/embryo any (4)

3.4 (a) Support - Healthier for humans to eat ✓/combating heart disease
- Mass production of healthy fat ✓
- Improves intelligence✓ (Any 2) (2)
(Mark first TWO only)

(b) Against - Cultural objection to eat meat from pigs✓
- The sucess rate is very low ✓ - Expensive procedure ✓
- No value for vegetarians ✓
- Objection to eating any genetically modified food ✓ (Any 2) (2)
(Mark first TWO only) **[13]**

QUESTION 4

4.1 (a) 13 ✓ (1)
(b) 26 ✓ (1)

4.2 Has a full set ✓of chromosomes ✓ /Diploid number of chromosomes/ complete set of chromosomes (2)

4.3 They have same/identical chromosomes ✓/genetic material / DNA from the nucleus of the somatic/body cell collected from the same frog/X ✓ (2)

4.4 Cloning ✓ (1)

4.5 (**a) In favour:**
- Producing individuals with desired traits✓✓
- Better yield ✓✓
- Resistant to diseases ✓✓
- Organisms produced in a shorter time ✓✓
- Saving endangered species ✓✓
- Producing body parts ✓✓
- Produce offspring for organisms that cannot have offspring ✓✓ (1 x 2) (2)

(Mark FIRST answer only in learner's script)

(b) Against:
- Objection to interfering with God"s ✓✓/Supreme Being"s creation/nature
- Reducing the gene pool by reducing variation✓✓/ Reduces genetic diversity
- Cloned organisms may have developmental/morphological problems✓✓
- Costly process ✓✓
- May generate more experimental waste ✓✓
- May lead to killing of clones to obtain spare body parts ✓✓
- Cruelty to animals ✓✓ (1 x 2) (2)

(Mark FIRST answer only in learner's script)

[11]

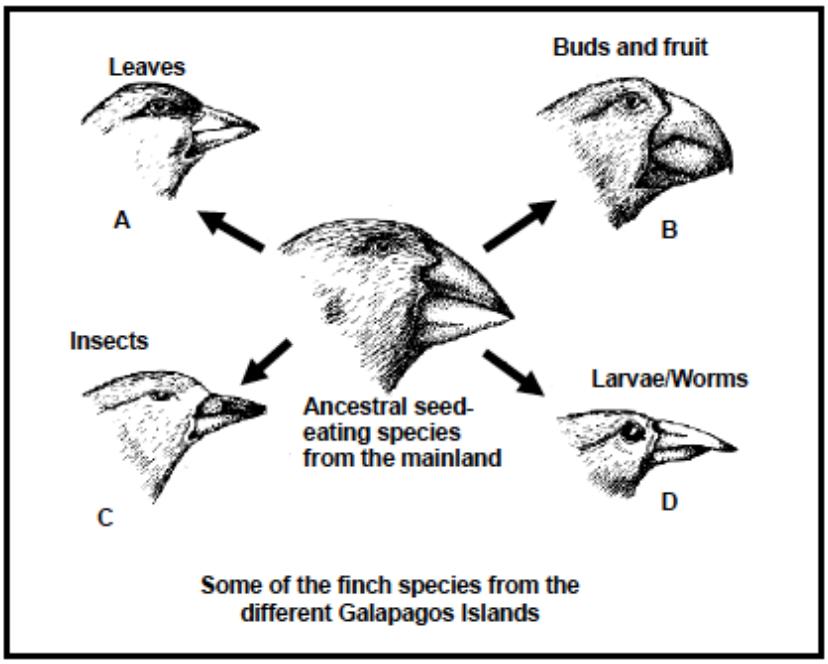
SESSION 3: TOPIC 2: THEORIES OF EVOLUTION (PART 1)

Learner Note: Evolution is a theory. Evolution is change over time. Diversity is the RESULT of this change over time. If a trait is good, the organism survives and is able to reproduce, thereby passing this good trait to the offspring. If the trait is not good/bad, then the organism dies and, therefore, does not reproduce.

SECTION A: TYPICAL EXAM QUESTIONS

QUESTION 1: **6 minutes** *(Taken from DoE Exemplar 2008 Paper 2)*

The different species of finches (A, B, C and D) below are found on different Galapagos Islands and are thought to have originated from a seed-eating ancestral species from the mainland of South America. They resemble each other with respect to their internal body structure, but differ with respect to the shapes and sizes of their beaks and hence their feeding habits.



Some of the finch species from the different Galapagos Islands

1.1. Explain what is meant by *geographical isolation of a population*. (2)
(Geographical will mean the geography of the land masses. Isolation means to be on one's own.)

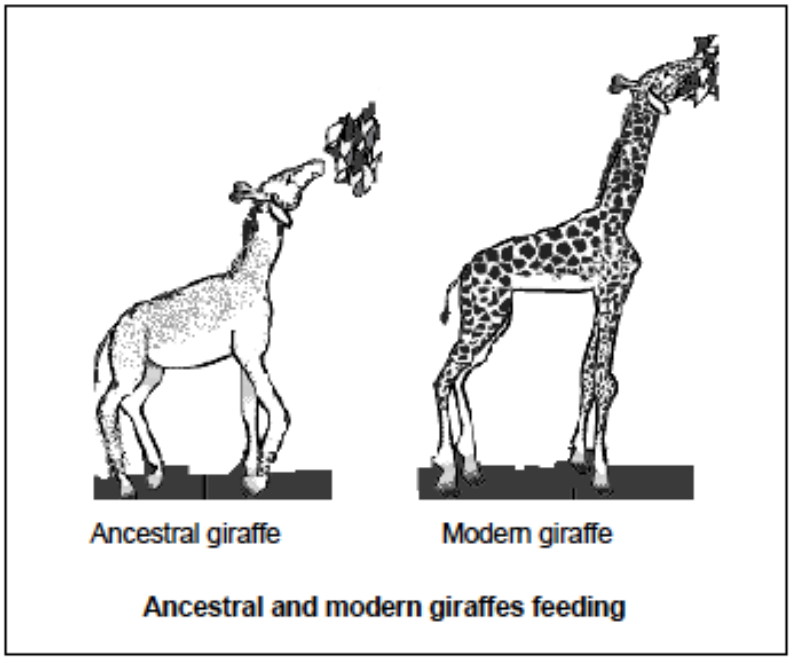
1.2. Why do you think the different finch species became adapted to eat different food types? (1)

1.3. Explain the process by which the different species adapted and evolved to eat different types of food. (5)
[8]

(Please make sure that you know Darwin's theory – Natural Selection)

QUESTION 2: **10 minutes** *(Taken from DoE November 2008 Paper 2)*

Tens of thousands of years ago, the animals that evolved into giraffes, were not as tall as modern giraffes. Over a long period of time, the necks of giraffes became longer. They could reach leaves high in the trees and reach down for water.



Ancestral and modern giraffes feeding

2.1 Describe how the long necks of modern giraffes would have been explained by the following:

(a) Darwin (4)

(b) Lamarck (4)

2.2 Explain why Lamarck's theory is not accepted. (2)

[10]

HINT: You must know Lamarck"s theory, and you should also be able to explain the difference between Lamarck and Darwin"s theories.

QUESTION 3: **20 minutes** *(Taken from DoE Additional Exemplar 2008 Paper 2)*

Since 1972, biologists Peter and Rosemary Grant from Princeton University USA have studied finch populations in the Galapagos Archipelago. The table below shows their data for one finch population on one island (Daphne Major), for a period of 7 years.

Year	1974	1975	1976	1977	1978	1979	1980
Rainfall (mm)	-	-	130	20	130	70	50
Number of finches	1 200	1 400	1 200	150	350	300	200
Small seeds (mg/m^2)	-	800	600	90	300	70	50

3.1. Use the information in the table to draw a line graph to show the number of finches from 1974 until 1980. (11)

HINT: Your clue here is in the question; you must show the number of finches and the years (time). Time **ALWAYS** goes onto the X-axis because it is the **INDEPENDENT** variable. The number of finches will be on the Y-axis because it is the **DEPENDENT** variable. Remember to do a heading for your graph and make sure that the spacing of the points on the X-axis is the same as the spacing on the Y-axis.

3.2. In which year were the largest drop in rainfall, number of seeds and number of finches recorded? (1)

3.3. Explain how the three events mentioned in QUESTION 3.2. are related to each other. (3)

3.4. When the number of finches decreased, there were still plenty of large seeds on the island. What does this tell you about the seed eating habits of the finches that died? (2)

3.5. Do you think there was a difference in the beak sizes of the dead finches and the surviving finches? Explain your answer. (3)
[20]

SECTION B: ADDITIONAL CONTENT NOTES

Introduction

Millions of species of organisms are found throughout the biosphere, from the Antarctic to the steaming hot desert. Many of the organisms are adapted to live in seawater and fresh water. Each organism type is different and shows diversity. Adaptations result in diversity allowing organisms to survive in completely different and diverse environments.

Organisms must change and adapt to survive in a specific environment. Variation and diversity is as a result of **gene mutations** which cause changes in organisms. When these changes assist the organism, they survive and the genes can be passed on to the next generation. This is called **natural selection** and can result in evolution. If the characteristics are not suitable for survival, the organism will die, resulting in the eventual extinction of the species. Conservation ensures that populations do not become extinct.

Evolutionary Theories

Evolution is **the slow process of change** where organisms acquire distinct characteristic. For many years, the common belief was that all life on earth was created over six days, as described in Genesis in the Bible, with one day representing 24 hours. This would mean that all life as we know it, has been in existence from the beginning and no changes have taken place. We are now going to take a brief look at various theories. During the 18th century, scientists began to look for scientific explanations to explain the changes that were evident in some species.

- **Jean Batiste de Lamarck**

Jean Batiste de Lamarck, a scientist during the 18th century, presented one of the many evolutionary theories. He suggested that it was the **'inheritance of acquired characteristics'** that caused change in organisms. When the organism reproduced, it passed the acquired characteristic on to the offspring. He used the giraffe to explain the theory. He stated that as the giraffe stretched its neck to reach higher leaves, so the neck grew longer with each generation. Today, we agree that Lamarck's theory is incorrect because we know that physically stretching the neck cannot alter the gene make-up of the animal. Only the genetics of the organism can cause a physical change, like the vertebral bones growing longer and bigger. Think about this: if a mother has plastic surgery to her nose, the changed nose will not be passed on to the next generation.

- **Darwin's Theory of Evolution**

Charles Darwin wrote a book called ***'On the origin of species'***, published in 1859. Darwin wrote that organisms evolve by small, gradual changes that take place over many successive generations to ensure survival. His theory rests on five principles:

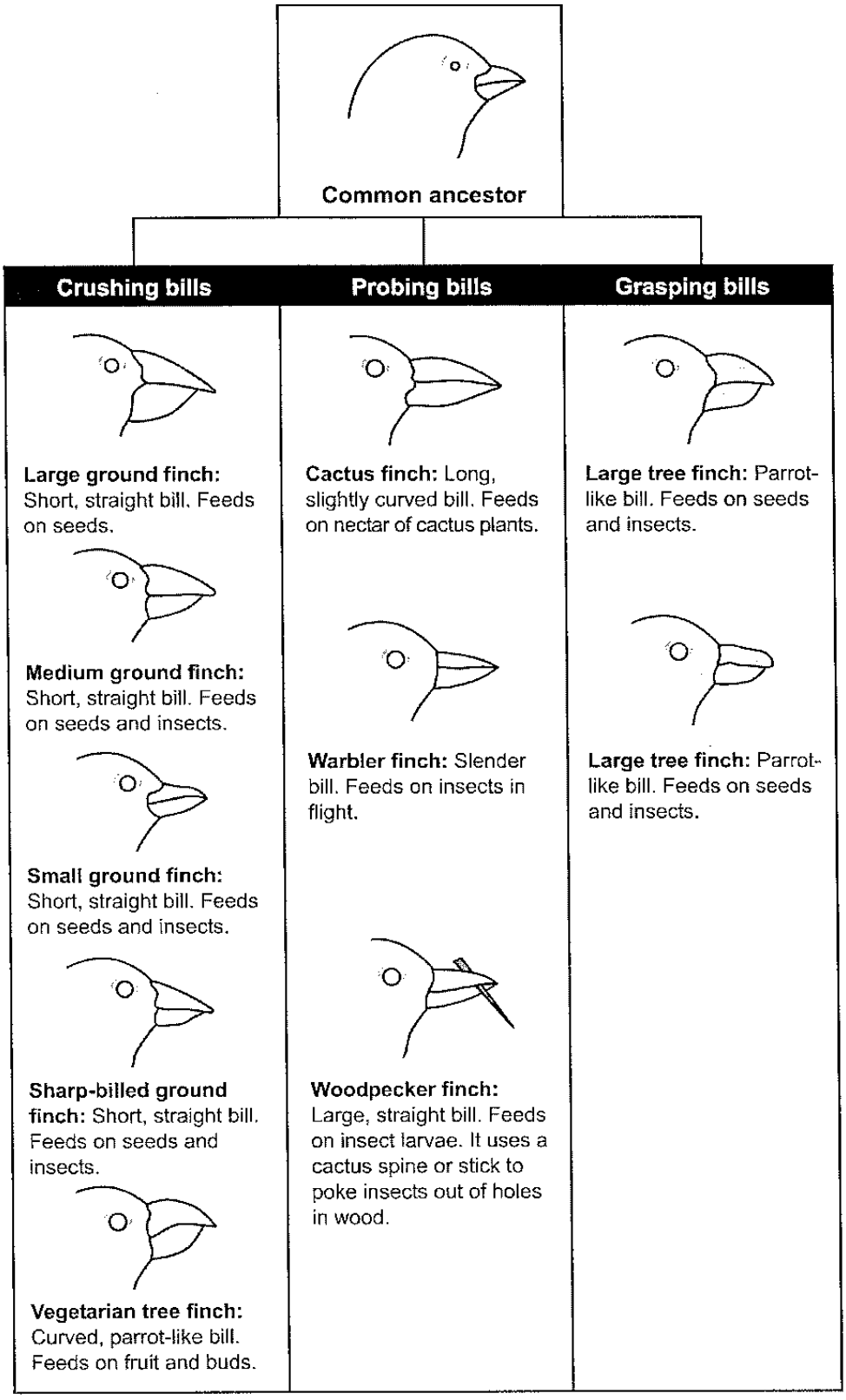
1. All species show **structural and functional variations** that affect the organism's chances of survival.
2. Each species has the **ability to reproduce** and, if the population of the species is not **controlled**, they will eventually run out of food and living space.
3. Individuals in the species that have **advantageous variations,** will survive the battle for food, mates and living space.
4. **Constant selection** of the better-adapted and stronger individuals, and the elimination of the weaker ones, result in the **evolutionary changes** that occur.
5. The stronger individuals pass their **genes** on to the **next generation**. (Survival of the fittest)

Darwin used his 5 principles to explain that the present species on earth today, are modified descendents from the species of the past.

Evolution can be explained as **the constant change that has taken place**. Darwin's book was the first theory about evolution to be published. His theory was supported by scientific evidence and was regarded as credible.

The **PROCESS** of change was called **NATURAL SELECTION**.
The combined **LONG-TERM** changes in the species were called **EVOLUTION.**

During Darwin's travels, he spent time on the **Galapagos Islands** (about 965 km west of Ecuador) where he studied the fauna and flora (plants and animals). He carefully recorded the appearance of the Galapagos finches. There are 14 species of dull, unremarkable looking birds, which evidently come from a common ancestor where each species is specialised for a specific diet and habitat. Darwin drew the conclusion that the **variation** between the finch species was due **to lifestyle and behaviour**. He suggested that this proved his theory of natural selection.



Darwin's finches on the Galapagos Islands

- **Modern Theory**

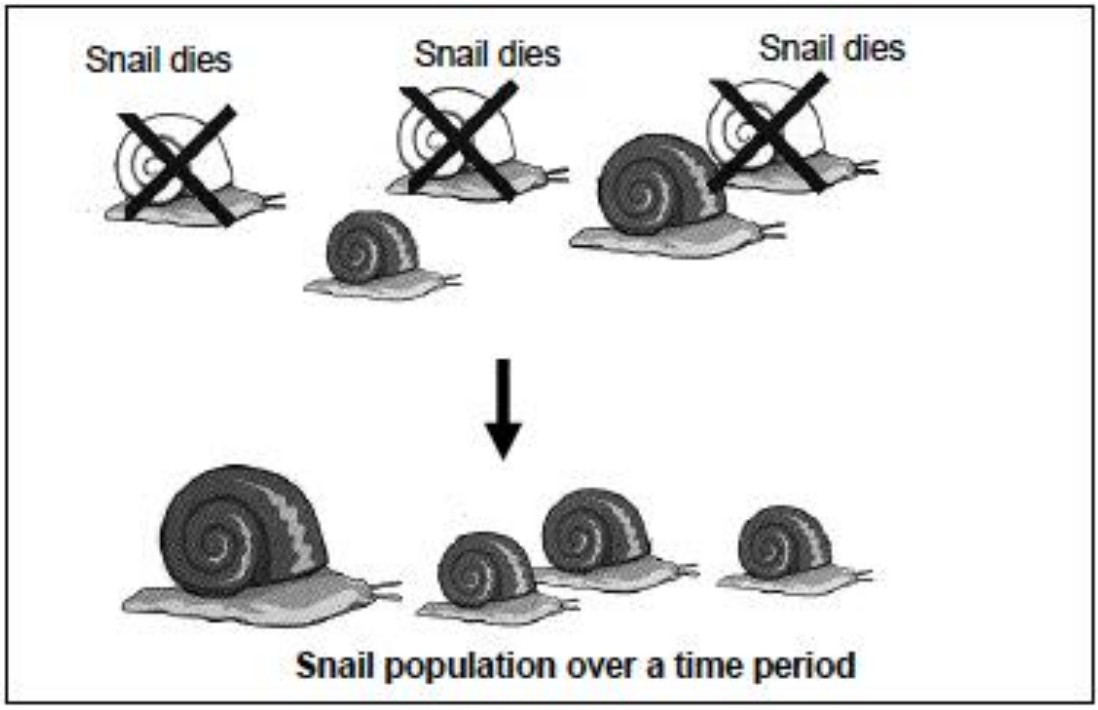
The modern theory is called **neo-Darwinian** evolution and is based on Darwin‟s principles of variation, natural selection and over-production of offspring.
Today, scientists agree that individual organisms **change to adapt** to the environment. Sometimes this process occurs when genes mutate by accident. If the mutation is good, the individual survives by natural selection and breeds so the „good‟ genes are passed on to the next generation.

SECTION C: HOMEWORK

Learner Note: As you attempt the homework, you need to be able to answer the questions in the allocated time frames. If you get stuck, you should refer either to the additional notes or your class teacher.

QUESTION 1: **8 minutes** *(Taken from DoE Preparatory Examinations 2008 Paper 2)*

Study the diagram below and answer the questions that follow.

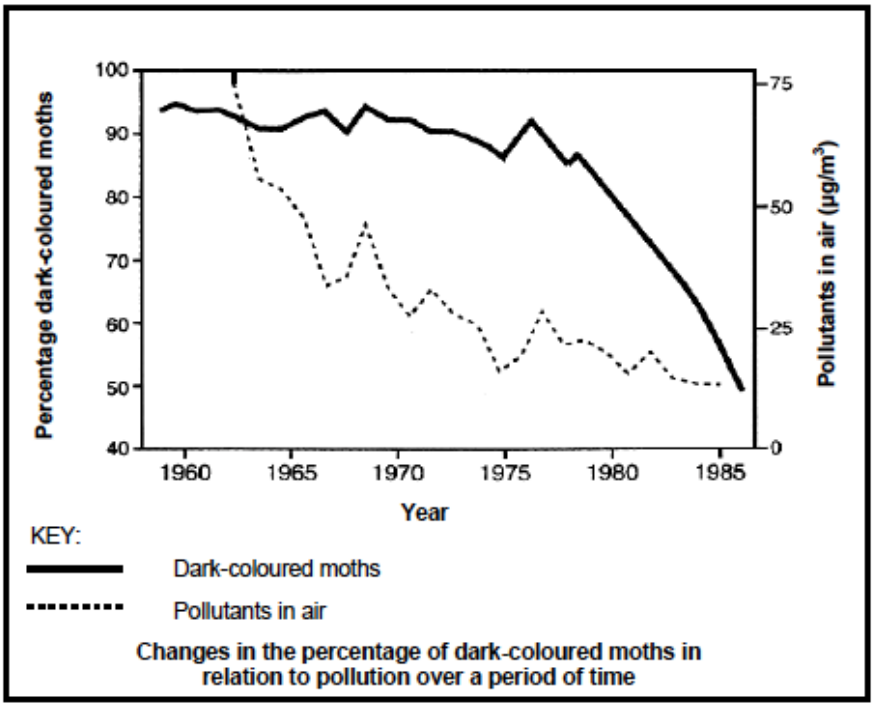


1.1. Explain the phenomenon illustrated in the diagram. (2)
1.2. Describe the observations on which Darwin based his theory of evolution. (6)
[8]

QUESTION 2: **10 minutes** *(Taken from DoE Exemplar 2008 Paper 2)*

Before the Industrial Revolution took place in Britain in the 19th century, light-coloured moths that blended with the lichen-covered bark of trees, were far more common than dark-coloured moths. However, pollution from factories killed the lichens on the trees leaving their dark bark exposed. The light-coloured moths were easily identified against the black background. The dark-coloured moths that were easily camouflaged on the dark bark, soon became far more common than the lighter varieties. Now that pollution is decreasing the light-coloured moths are increasing in numbers again.

Study the graph below that shows the changes in the percentage of dark-coloured moths.



Changes in the percentage of dark-coloured moths in relation to pollution over a period of time

2.1. What was the percentage of the dark-coloured moths in 1970? (1)

2.2. What is the general relationship between the dark-coloured moth population and pollution from 1965 to 1985? (2)

2.3. Explain the relationship mentioned in QUESTION 2.2. (2)

2.4. Briefly outline Lamarck's theory of evolution. (5)
[10]

SECTION D: SOLUTIONS AND HINTS TO SECTION A

QUESTION 1

1.1 When a geographical barrier ✓ e.g. mountain, river, sea, etc. separates a subpopulation of breeding individuals from the parent population ✓ (2)

1.2 (Less) seeds are available on the island ✓/competition for seeds available/availability of different sources of food (1)

1.3
- There was a great variety within the species because of genetic variation ✓
- leading to natural selection ✓
- Many seed-eating finches died ✓
- Those finches that were able to eat different foods/non-seed food survived in greater numbers ✓
- to pass on their genes to their offspring ✓
- Species became distinct and adapted to the specific food on that island ✓ (5)

(Mark any 5 of the above)

[8]

QUESTION 2: 10 minutes *(Taken from DoE November 2008 Paper 2)*

2.1 **(a) Darwin**
- As a result of genetic variation ✓in the giraffe population
- some giraffes have longer necks ✓ than others
- Environmental change ✓/competition for resources occurred
- causing those with shorter necks to die ✓
- and those with longer necks to survive ✓
- This is natural selection ✓/survival of the fittest
- The genes ✓/genotype for longer necks
- were passed on to subsequent generations ✓ most of which now have long necks (4)

(Mark any of the 4 above)

(b) Lamarck
- All giraffes had short necks ✓ originally
- Giraffes frequently stretched ✓/used their necks to reach
- for leaves of tall trees ✓
- necks become longer ✓
- The long necks acquired ✓ in this way could be passed on to the next generation ✓ /were inherited (4)

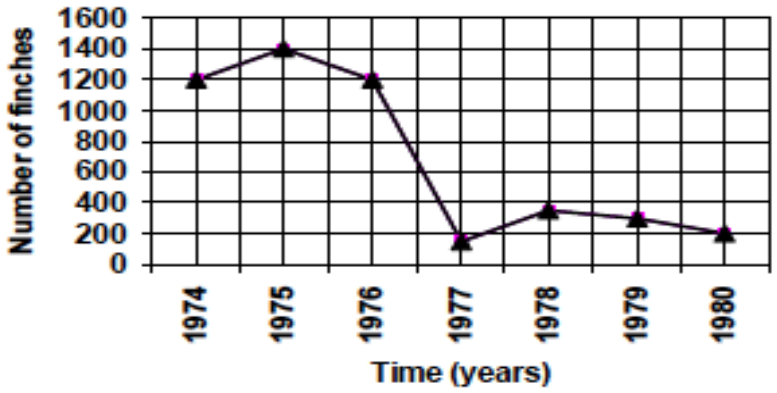
(Mark any of the 4 above)

2.2 **Acquired characteristics** ✓are **not inherited** ✓ /do not cause any change to the DNA of an organism's gametes (sperms or ova)
OR
Organisms did not evolve because they want to evolve ✓✓/
Lamarck"s theory is deterministic ✓✓ (2)

[10]

QUESTION 3

3.1. Number of finches from 1974 to 1980



Rubric for the mark allocation of the graph

Correct type of graph	1
Title of graph	1
Correct label for X-axis	1
Correct label for Y-axis	1
Appropriate scale for X-axis	1
Appropriate scale for Y-axis	1
Correct unit for X-axis	1
Plotting points	1: 1 - 2 correctly plotted 2: 3 - 5 correctly plotted 3: 6 - 7 correctly plotted
Joining of points	1

[11]

NOTE:

If the wrong type of graph is drawn, marks will be lost for "correct type of graph" as well as for the "joining of points".

3.2 1977✓ (1)

3.3 A drop in rainfall ✓causes the a drop in seeds/plants because of drought ✓ that causes a lack of seeds ✓/food for finches, therefore, less finches ✓ (3)

(Mark any of the 3 above)

3.4 These finches✓ were not able to eat the large seeds✓ (2)

3.5 Yes ✓
The surviving finches had bigger beaks to be able to eat the bigger seeds ✓
The dead finches had smaller beaks and were not able to eat the bigger seeds ✓(3)

[20]

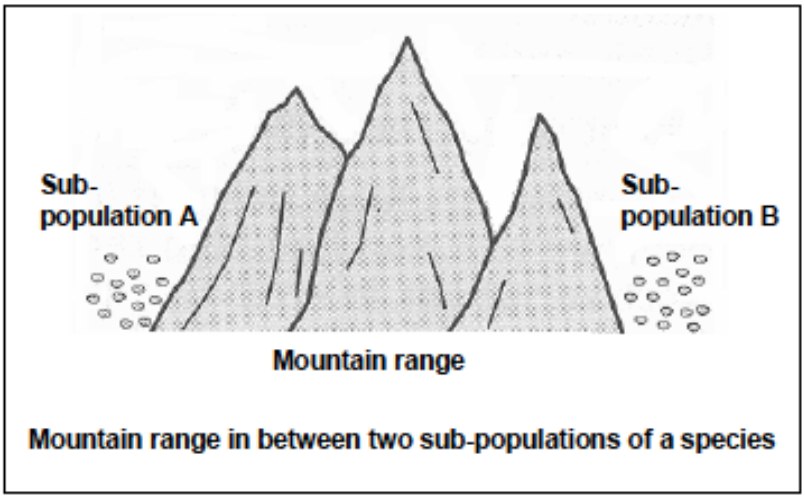
SESSION 4: TOPIC1: DIVERSITY: EVOLUTION BY NATURAL SELECTION, FORMATION OF NEW SPECIES AND EVIDENCE OF EVOLUTION

Learner Note: Please learn terms like Sympatric and Allopatric Speciation, Variation, Fixed, Neutral and Lethal Mutations, Inbreeding, Outbreeding, Artificial Selection and Natural Selection, Geographical Barriers, and link this to allopatric speciation, homologous versus analogous organs. Check the additional content notes.

SECTION A: TYPICAL EXAM QUESTIONS

QUESTION 1: 8 minutes *Taken from DoE Preparatory Examination 2008 Paper 2)*

Study the diagram below and answer the questions that follow:



Mountain range in between two sub-populations of a species

1.1. Define a *species*. (3)

1.2. Describe how sub-population B could form a new species. (6)

[9]

QUESTION 2: 9 minutes *(Taken from WC DoE September 2009 Paper 2)*

Darwin discovered two different varieties of tortoises on two different islands on the Galapagos Islands. One had a domed shell and short neck and the other one had a longer neck. The two islands had very different vegetation. One of the islands (island X), was rather barren, dry and arid. It had no grass but rather short tree-like cactus plants. On the other island (island Y), there were no cactus plants but it had a good supply of water and grass grew freely across the island. The diagrams below show the two main varieties of tortoises on the Galapagos Islands.

Tortoise A **Tortoise B**

Two main varieties of tortoises on the Galapagos Islands

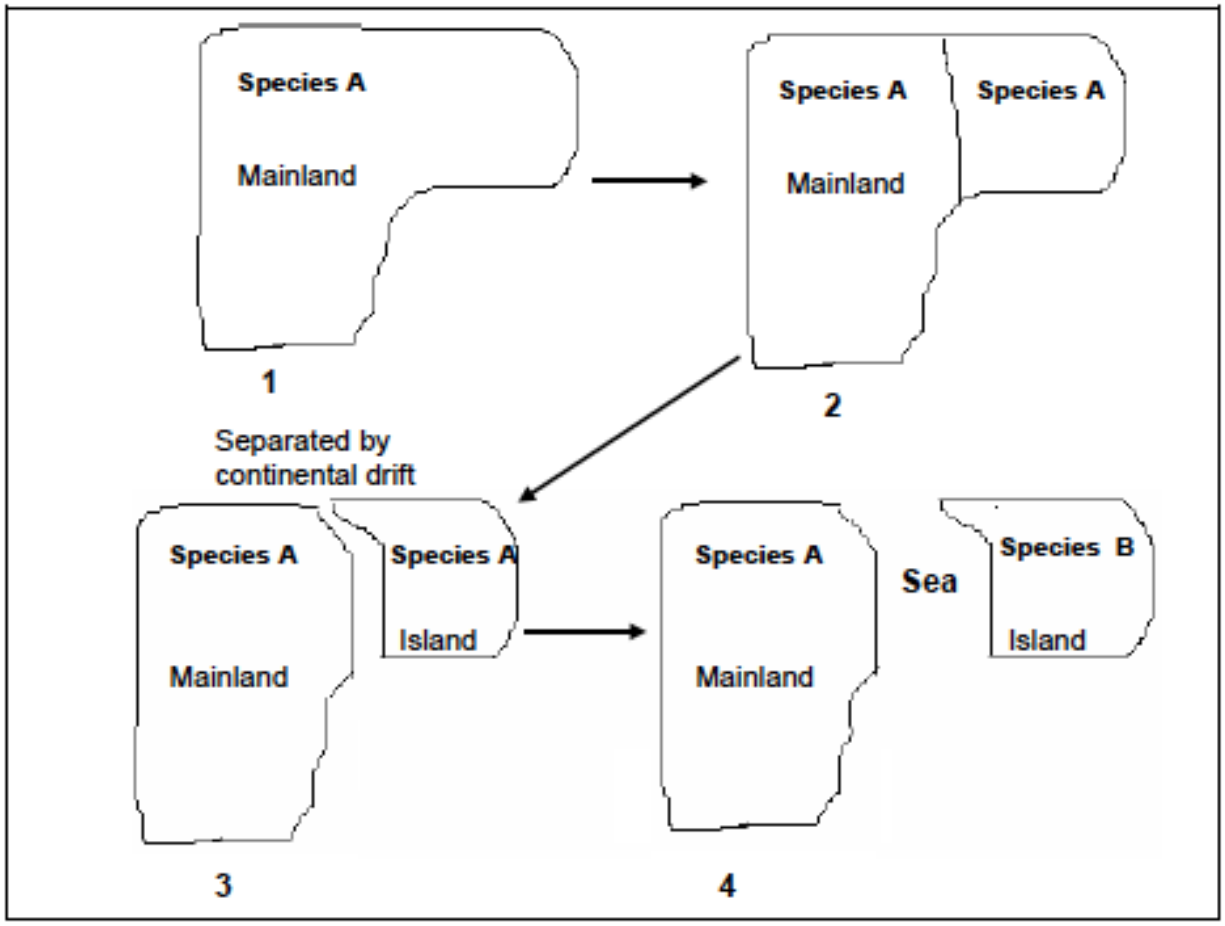
2.1. Which tortoise (A or B) would have been found on
(a) island X? (1)
(b) island Y? (1)

2.2 Explain your answer to QUESTION 2.1 (b) (2)

2.3 Describe the concept of allopatric speciation as it applies to the two tortoise types. (5)
[9]

QUESTION 3: 6 minutes *(Taken from DoE Feb/March 2010 Paper 2)*

Study the following diagrams which show different stages (1 to 4) of a process in evolution.



3.1. Name the evolutionary process that resulted from the continental drift shown. (1)

3.2. Describe how the original population of species A split to become two species as indicated in the diagrams above. (5)
[6]

QUESTION 4: 8 minutes *(Taken from DoE Exemplar 2008 Paper 2)*

The following questions are based on mutation.

4.1. Define a *gene mutation*. (2)

4.2. Name TWO factors that can cause mutations. (2)

4.3. Differentiate between *neutral* and *lethal mutations*. (4)
[8]

QUESTION 5: 8 minutes *(Taken from Additional Exemplar2008 Paper 2)*

Study the passage below and answer the questions that follow.

CHARLES DARWIN

In 1831 Charles Darwin set out on a trip around the world in the HMS Beagle. At the Cape Verde Islands, he saw the fossil remains of sea creatures in the cliffs, many metres above sea level.

The unique forms of life he found on the Galapagos Islands, such as the giant tortoises, convinced him that living organisms had evolved over many millions of years. He noticed that these tortoises were quite different from those found elsewhere in the world. Each island also had a distinct type of tortoise, differing in the shape of the shell and mating behaviour.

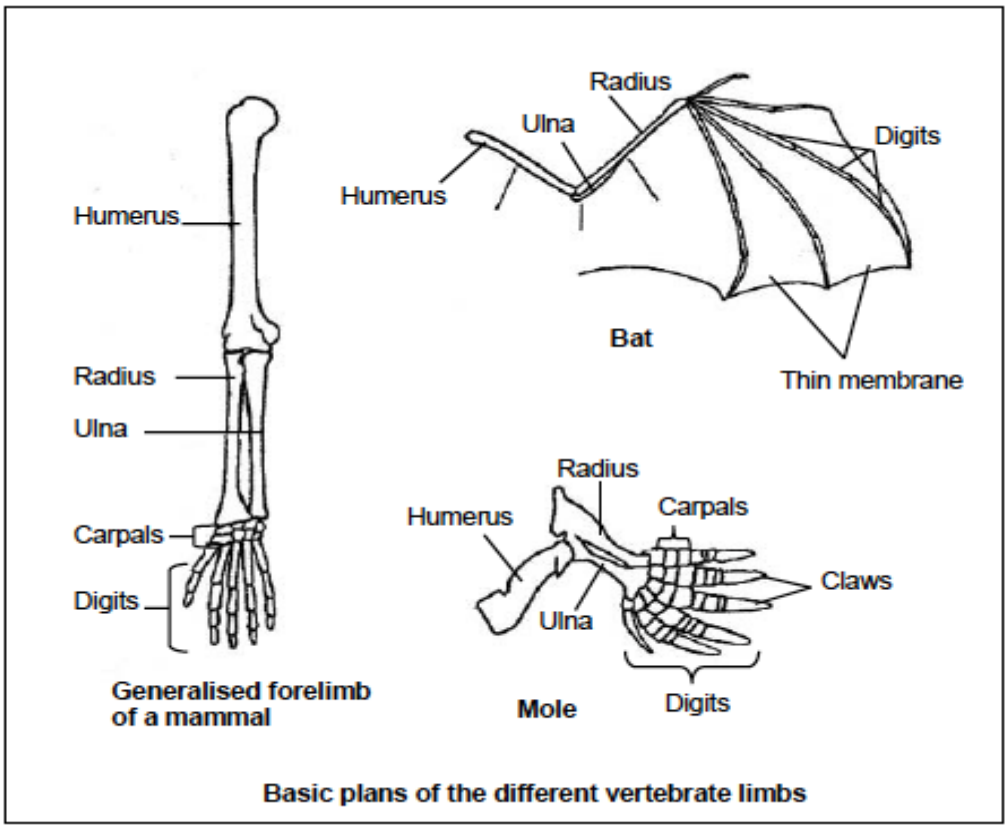
5.1. Explain how Darwin would have used the example of the tortoises to explain speciation. (4)

5.2. How do fossils provide evidence for evolution? (2)

5.3. Give ONE reason why there are gaps in the fossil records. (2)
[8]

QUESTION 6: 5 minutes *(Taken from DoE November 2008 Paper 2)*

Study the basic plans of three different vertebrate limbs shown below:



6.1. Are the above examples of homologous or analogous structures? (1)

6.2. Explain your answer to QUESTION 6.1. (2)

6.3. State ONE way in which the forelimbs of the:

a) bat are adapted for flying (1)

b) mole are adapted for digging holes (1)

[5]

QUESTION 7: 6 minutes *(Taken from DoE November 2010 Exam Paper 2)*

Read the following passage and answer the questions that follow:

> Thousands of wildebeest were migrating across the great plains of the Serengeti in Africa. Some of them were large, some small, some strong and some weak. Lions followed the wildebeest, catching and eating the slowest ones. Water was scarce and only the strongest were brave enough to stop to drink from the waterholes.

7.1. Identify ONE phrase in this passage which describes variation among the wildebeest. (1)

7.2. Explain how Darwin's idea of evolution by natural selection can be applied to this passage. (5)

[6]

QUESTION 8: 6 minutes *(Taken from various DoE exam papers)*

Various options are provided as possible answers to the following questions. Choose the answer and write only the letter (A – D) next to the question number (8.1 – 8.6).

Learner Note: Please do not to waste time when you answer multi-choice questions. Read the question, underlining the operative words, while covering the answers. Then think of the correct answer. Now uncover the answer options and check if their answer is there. If it is, then tick next to the letter. If it is not, re-read the question and try to see exactly what is being asked. Then review the answer options again to find the correct answer. Always answer Section A last - the multi-choice questions must be answered right at the end of the exam paper.

8.1. Micro-evolution is a term that describes …
- A the process by which new genera and families of organisms are formed.
- B small changes that occur in the genotypes of organisms within the same species.
- C changes that can be seen without a microscope.
- D an increase in the size of individuals of a population over a long period of time.

8.2. According to Charles Darwin, organisms that will be most successful biologically, are those that …
- A are best adapted to their environment.
- B are the largest in the population.
- C reproduce the slowest.
- D do not change.

8.3. The evidence that related species in similar biomes across the world developed from a common ancestor, is obtained from …
- A micro-evolution.
- B embryology.
- C biochemistry.
- D biogeography.

8.4. Extinction occurs….
- A. When a species is unable to survive in their environment.
- B. When only a few of a species survives.
- C. When a species goes into hiding until conditions improve.
- D. The gradual depletion of a population.

8.5. Discontinuous distribution is…
- A. When the organisms live in one area and distribute within their environment.
- B. Organisms originate on one area and disperse outward.
- C. When organisms originate in different areas and migrate towards one another.
- D. When different species are distributed evenly among one another.

8.6 Pangea is said to be…

A. The continents which made up two large masses of land.
B. The continents, which made up one large mass of land.
C. The seven continents that exist today.
D. The continents, which made up three masses of land. (6 x 1) [6]

SECTION B: ADDITIONAL CONTENT NOTES

Modern Theory

The modern theory is called **Neo-Darwinian** evolution and is based on Darwin‟s principles of variation, natural selection and over-production of offspring.
Today, scientists agree that individual organisms **change to adapt** to the environment. Sometimes this process occurs when genes mutate by accident. If the mutation is good, the individual survives by natural selection and breeds, so the „good‟ genes are passed on to the next generation.

Mutations

	Lethal	Fixed	Neutral
What is it?	The mutation is termed lethal when it will result in the **death** of the individual.	The mutation is termed a fixed mutation when it provides an organism with a better chance of survival. The mutation becomes fixed when the strongest surviving organisms carry the mutant gene and pass it on to the future generations.	The neutral mutation has no effect on the organism and is not observable. This type of mutation does not give an organism any advantage, but can assist survival **if** the environment changes, assisting the organism to adapt to the change to ensure survival.

Examples	• Somatic cell mutations result in cancer, which is lethal when in the **malignant** form. • In nature, an albino has no **camouflage** and is easy prey to predators. • Tay Sachs disease is caused by a hereditary mutant gene and occurs mainly in the Jewish communities.	• By natural selection, the **Tuberculosis bacteria (TB)** have developed a **resistance** to the antibiotics used to treat the disease, thereby producing a **new strain.** New antibiotics have had to be developed to fight the new pathogen strain. • The HIV/AIDS virus has evolved and mutated to adapt to survive in the human body. The virus slowly destroys the host but ensures that it is passed on to various other hosts, ensuring its survival.	Scientists use natural selection principals to meet the demands of the ever-increasing population. When scientists intervene to create varied species of plants and animals to meet specific needs in the form of genetic engineering, it is called **artificial selection** for example: • Cows that produce more milk • Sheep that are bred to produce more wool or meat • Wheat plants that produce more grains per spike and grow faster etc.
Genetics	In the **heterozygous** form, the mutation-causing gene will be present in the **genotype**, but not the phenotype. In a heterozygous cross, there is a 25% chance of the recessive trait showing in the phenotype.	Gene remains in a heterozygous or recessive state until it is required to assist survival. By natural selection, the gene becomes fixed. The gene may be an advantage in one environment but a disadvantage in another, e.g., **sickle-cell anaemia.**	In the heterozygous or recessive form, the gene will be present in the genotype but not the phenotype. It is passed on to offspring over many generations in the neutral state.

Artificial selection in plants and animals

Humans mimic natural selection through the process of **artificial selection** to produce plants and animals to meet needs. This is an **evolutionary mechanism** that results in:

- **new breeds** (animals)
- **new strains** (micro-organisms) and
- **new varieties** (plants).

New varieties of plants and animal breeds are produced relatively quickly by selecting parent organisms with the **desired traits**. The commercially viable organism would be homozygous for all the genes involved, whether dominant or recessive, for their desired trait.

Animals

	Inbreeding	Outbreeding
What is it?	**Inbreeding** is the mating or breeding of two **genetically related** individuals to enhance the desirable traits.	**Outbreeding** is the mating of individuals of totally **unrelated strains**. This leads to offspring that are better adapted for survival, than either of the parents. This phenomenon is termed **hybrid vigour**.
Examples:	• thorough bred racing and show jumping horses • milk producing cows • many varieties of dog breeds	• mongrel dogs are crossed from two different dog sub-species and are far stronger and hardier than highly pedigreed purebreds. • mules are a cross between a horse and a donkey and are much stronger and better suited to many more tasks than either parent.
Advantages:	Desirable traits are enhanced in the species without contamination from other species, resulting is a very pure breed. Animals with undesirable or weak traits should be culled.	When sub-species are crossed, a stronger more resilient breed results since desirable traits are bred into the species.

Disadvantages:	The gene pool becomes restricted. The strain may become **homozygous** for multiple defective traits: • certain dog breeds, like German shepherds, are vulnerable to hip dysplasia (weak hips) and congenital femur dislocation • fighting dogs, like the South African Boerboel, often become very aggressive and go mad as adults resulting in their having to be put to sleep	In some cases of cross species breeding, the hybrid may not be able to reproduce because chromosomes cannot form homologous pairs during meiosis. This will result in **hybrid sterility**, e.g., mules are unable to breed.

Natural Selection and formation of new species

- **Species:** a group of organisms that are **similar in appearance**, share the **same DNA sequences**, perform the **same mating rituals** and **interbreed** to produce viable offspring.
- **Speciation:** is the evolutionary process by which new biological species arise, due to the splitting of the lineage. Speciation by natural selection may be allopatric or sympatric.
- **Genetic diversity:** is the level of biodiversity and refers to the total number of genetic characteristics in the genetic makeup of a species.
- **Genetic divergence:** is the process of one species diverging over time, into two or more species where genetic characteristics are passed from one generation to the next. The sequence of the genes as they appear on the DNA that will differ from species to species, so when the genetics are altered, **divergence** takes place.
- **Variation:** means small changes that will assist an organism where phenotypic variation (physical appearance) is as a direct result of genetic variation.

As the **gene frequency** in the DNA changes, so new characteristics result. The changes in the DNA can result from **natural selection** and/or favourable, **fixed mutations**. The new traits and DNA composition will prevent the new species from interbreeding with the old species, due to **reproductive isolation,** and this will result in **macro-evolution.**

- **Micro-evolution:** micro = small, so small changes within a species.
- **Macro-evolution:** macro = large/big/major, so major changes over time, that will result in a new species.

Speciation results because of:

- **Allopatric speciation:** results when **geographical separation/isolation** by water masses or a mountain range creates a physical barrier between two populations. The isolated populations then undergo genotypic and/or phenotypic divergence, becoming different populations that cannot interbreed, e.g. Darwin"s finches from the Galapagos Islands. Eventually, the populations become so different that they develop into different species. Should the population then come into contact, they would have evolved so much that they are reproductively isolated and are no longer capable of exchanging genes.

- **Polyploidy:** the changes in the gene frequency that alters the chromosome number to more than two paired sets of chromosomes, e.g. **tri**ploid (3), **tetra**ploid (4), **pentra**ploid (5), **hexa**ploid (6), etc.
  It will result in infertile humans and higher animal species should the organism survive birth. Generally, it will result in miscarriage. It is for this reason that direct human relatives may not produce children legally, and it is termed incest should such a relationship occur.

- **Sympatric speciation:** is the genetic divergence of various populations from a single parent species, which leads to the creation of new species. It results when **reproductive isolation** occurs by either preventing fertilisation or by creating a degenerate or sterile hybrid. There is no geographical isolation like with Allopatric speciation.
  Reproductive isolation result because of:

    - **Behavioural isolation:** animals behave differently during mating rituals - females are not responsive, so no mating takes place.
    - **Gamete isolation:** when genes change, gametes become chemically altered, so fusion of the gametes is impossible. Should the gametes fuse, gamete isolation will prevent the recycling of the genetic material, e.g. donkey + horse = infertile mule.
    - **Seasonal isolation:** when reproduction takes place at different times of the season or year. In plants, anthers and stigma mature at different times, to prevent cross-pollination.
    - **Mechanical isolation:** when male and female reproductive parts change, making gene transfer impossible. In flowers, the stigma normally releases enzymes to stimulate the growth of the pollen tube. In this case, the enzyme will not stimulate growth, so pollen grain will not grow. In animals, the genitals change so the sperm cannot be transferred into the female, should mating be attempted.

Biodiversity - theories of human evolution and alternative explanations

Theories of human evolution are based on research and scientific evidence that support the concept of **continual change.** Sources like geology, anatomy, embryology, genetics and physiology have been used as explanations for the theories.

Geological evidence shows that the earth is estimated to be five thousand million years old. The first record of living material preserved as a **fossil,** is from the **Palaeozoic era** (540 million years ago).

- **Fossil:** the word is derived from Latin and is defined as the **imprint, traces or preserved remains** of an organism that once lived. A fossil may be plant and animal body parts as well as impressions in rocks or traces left by the organisms.
- **Age of Fossils:** Two methods that are used to determine the age of a fossil:
    - **Relative age:** sedimentary rocks are formed over a long period of time and each layer will contain the organisms that lived at a certain period of time. Each layer is covered over with a new layer of sedimentary rock and soil. Fossils found in the **upper layers will be newer** that those found lower down so the depth of the fossils will determine their relative age.
    - **Absolute age:** is accurate and is measured in years. Two techniques are used by archaeologists to determine the absolute age of a fossil:
        - **Radio-active dating:** there are radioactive elements like uranium in rocks and as these rocks age, **the uranium converts into lead**. Scientists measure the uranium and lead levels to determine the age of the fossils embedded in the rocks. This method can only be used for fossils believed to be older than 100 million years because the process of the uranium to lead conversion takes a long time.
        - **Carbon dating:** all living organisms contain a radioactive atom called Carbon-14. When the organism dies, the **Carbon-14 atom is converted into nitrogen** over time. Scientists know the rate of the conversion and the period of time this takes. Once the level of Carbon-14 is determined in the fossil, the age can calculated. This method will only be used for fossils believed to be less than 50 000 years old.
- **Fossilisation:** the process that took place to produce the fossil over a period of time.
- **Anthropology:** the study of the human race, including the different belief systems, customs and social habits.
- **Palaeontology:** the study of the earliest known periods of human existence, e.g. the Stone Age.
- **Archaeology:** the study of ancient times by examining the buried remains of buildings, tools, animal and plant fossil remains found in rock strata.
- **Archaeologist:** a scientist who digs up, studies and traces fossil remains in rock strata. Archaeologists use carbon dating to determine when the animals and plants lived. Fossils found in one stratum of rock are compared with strata from later periods resulting in a **progression of forms.** Organisms without a backbone show modifications and development into organisms that have a backbone. The archaeologists have also recorded fish that have modified into amphibians, amphibians that have modified into reptiles and in later strata, the reptiles into mammals. Fossil evidence supports these progressions.
- **Palaeontologists and anthropologists:** use information from archaeologists to record findings and determine what lead to extinction or evolutionary changes.

Evidence that evolution has occurred

- **Comparative anatomy - Anatomical evidence:** obtained from the study of the details of the structures of body parts and systems of organisms that belong to a phylum.
    - **Homologous organs:** (homo = the same) similarity of the formation of a body part or organ due to a **common** evolutionary origin, e.g. the structure of the pentadactyl limb in seals, bats and humans. The bones, muscles and nerves are arranged in a **similar** manner in a front paw, wing and arm.
    - **Analogous organs:** different structures of a body part or organ but with a similar function, e.g. lungs of mammals, trachea or air tubes of insects and gills of fish. These organs have evolved in a **different** way to meet a **common need** to obtain oxygen in mammals, insects and fish.

Physiological evidence shows that the **chemicals** found in the cytoplasm of plant and animal cells are **similar**. When studying the nucleus, the DNA and RNA are similar in plants and animals. Both groups of organisms undergo the processes of **mitosis** to produce new cells and **meiosis** for sexual reproduction. Mitochondria are found in both plant and animal cells. The process of cellular respiration and protein synthesis is the same.

SECTION C: HOMEWORK

Learner Note: As you attempt attempt the homework, you MUST stick to the time frames. If you get stuck refer either to the additional notes or your class teacher.

QUESTION 1: 6 minutes *(Taken from WC DoE September 2009 Paper 2)*

Habitat destruction is one of the ways in which humans contribute to the loss of biodiversity. A South African environmental protection agency completed the following study in a forest to find out if leaving some patches of undisturbed forest will help to preserve the bird species in that area.

In an area of forest which was being cut down for human development, the scientists left two areas (A and B) of different sizes as undisturbed habitat. They then counted the number of bird species in these areas before, and at different times after the removal of the forest around them.

The results of their investigation are shown in the table below:

TIME	NUMBER OF BIRD SPECIES	
	AREA A (One hectare patch of undisturbed land)	**AREA B (10 hectare patch of undisturbed land)**
Before removal of forest around patch	30	23
6 weeks after isolation in patch	58	30
36 weeks after isolation in patch	20	25
66 weeks after isolation in patch	18	20
96 weeks after isolation in patch	17	21

1.1 Suggest ONE reason why you think that the number of bird species caught in the two areas increased in the few weeks after the surrounding forest was cut down, compared with before. (1)

1.2 Explain why the number of bird species in each area gradually decreased to below the original levels. (2)

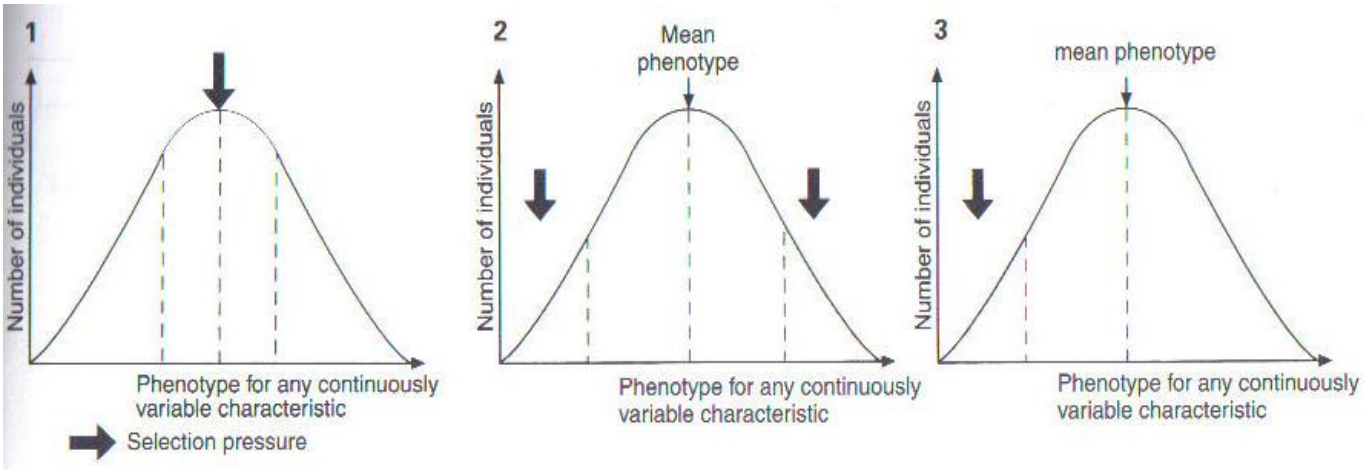
1.3 Explain what these results suggest about the usefulness of isolated patches of undisturbed habitat as wildlife reserves. (3)
[6]

QUESTION 2: 7 minutes *(Taken from St Mary's DSG September 2009 Paper 2)*

2.1. The following table compares sympatric and allopatric speciation. Put a tick in the appropriate column if the phrase applies, and a cross if it does not. (4)

	Sympatric speciation	**Allopatric speciation**
The most common type of speciation in animals		
Hybrids may result		
Occurs in populations living in the same geographical area		
Breeding is between members of the same species		

2.2. Name the selection pressure in operation in the graphs 1, 2 and 3 shown in the figures below. (3)



[7]

QUESTION 3: 8 minutes *(Taken from DoE November 2009 Paper 2)*

The shell of the banded snail, *Cepaea nemoralis*, displays a wide variety of both colour and banding (rings). Birds, such as thrushes, eat these snails. The birds break open the shells by striking the snails against a stone.

It was found that there were equal numbers of light- and dark-banded snails in a specific grassland habitat where no thrushes were found. A population of thrushes was then introduced to this grassland habitat.

An investigation was done to determine which colour snails (dark-banded or light-banded) were eaten most by the thrushes. The results are shown below:

Time (days)	Number of dark-banded shells found around stone	Number of light-banded shells found around stone
Day 1	2	1
Day 2	3	0
Day 3	5	1
Day 4	7	0
Day 5	8	1

QUESTION 4: 10 minutes *(Taken from DoE November 2008 Paper 2)*

Scientists believe that variation in populations can lead to the formation of new species.

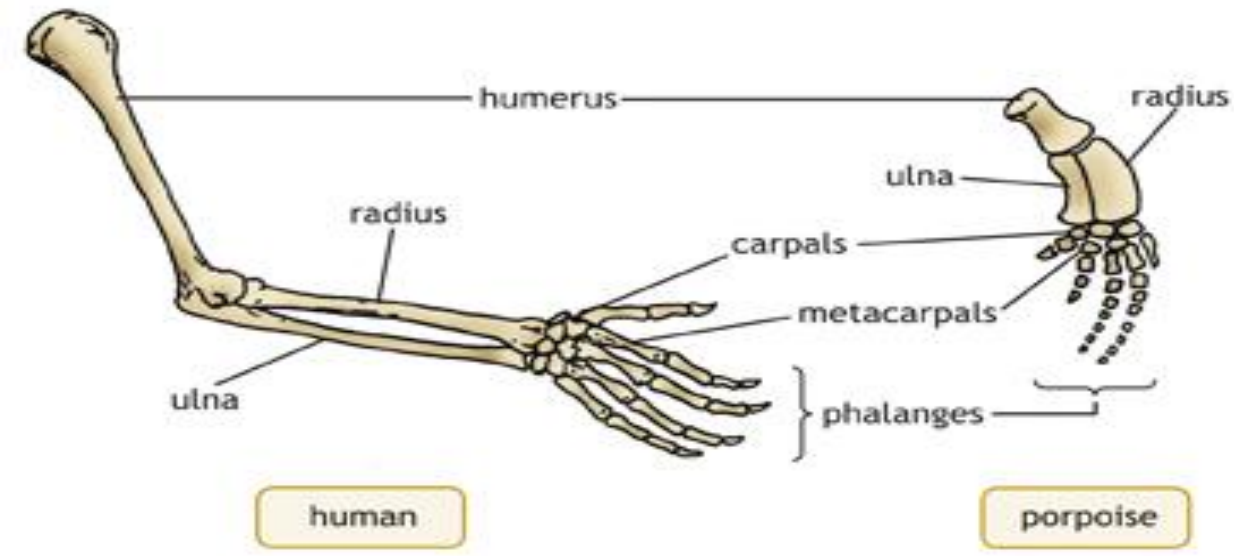
4.1. List FOUR sources of variation in populations. (4)

4.2. Explain how speciation occurs if a population becomes separated into two groups by a geographical barrier such as a mountain. (6)

[10]

QUESTION 5: 5 minutes *(Taken from St Mary's DSG September 2009 Paper 2)*

Below are the forelimbs of a human and a porpoise. Study the diagrams carefully and answer the questions that follow.



How would you use the diagram to provide evidence for evolution as a possible explanation for diversity? [5]

QUESTION 6: 5 minutes

Various possible options are provided as answers to the following questions. Choose the correct answer and write only the alphabet letter next to the number.

6.1 Which ONE of the following is an example of a pair of analogous structures?

A A whale's flipper and a bat's wing
B A bird's wing and an insect's wing
C A hawk's wing and a sparrow's wing
D A dog's leg and a horse's leg

6.2 The following is needed for new species to form….

A an extinction event
B an homologous structure
C an analogous structure
D reproductive isolation

6.3 Macroevolution is a term that describes …
- A an increase in the size of individuals of a population over a long period of time.
- B the process by which new genera and families of organisms are formed.
- C a gradual change in the number of species found in the fossil record.
- D changes that can be seen without the need for a microscope.

6.4 Which of the following is NOT a fossil?
- A *Tyrannosaurus rex* skull, 65 million years old
- B Oil formed from microorganisms, 150 million years old
- C Stone tool made by ancestors of human, 2,6 million years ago
- D 195 million-year-old dinosaur footprint imprinted in rock

6.5 The theory of evolution based on the principle of use and disuse was proposed by …
- A Darwin
- B Mendel
- C Lamarck
- D Wallace [5]

SECTION D: SOLUTIONS AND HINTS TO SECTION A

QUESTION 1

1.1 A species is one or more populations whose members actually or potentially interbreed ✓ under natural conditions, produce fertile offspring ✓ and are reproductively isolated ✓ from other such groups. (3)

1.2 Geographic speciation ✓
- Physical isolation such as mountains turns a single population into two✓
- Once two populations are reproductively isolated, they are free to follow different evolutionary paths✓
- Different geographic regions are likely to have different selective pressures ✓ such as temperature, rainfall, predators and competitors are likely to differ between two areas✓
- Thus, over time, the two populations will differentiate ✓ to the point that reunion of the two populations does not occur if contact is re-established✓
- The fate of the populations depends upon time and factors related to their different environments✓ **(Any 6)** (6)

[9]

QUESTION 2

2.1 (a) Tortoise B ✓ (1)
(b) Tortoise A ✓ (1)

2.2 Short - necked tortoise A can feed on grasses ✓ at ground level
Grasses are found on island Y ✓ (2)

2.3 Allopatric speciation occurs when new species evolve ✓ because populations are physically separated from the original population ✓
In the case of the tortoises (A and B) they were physically separated from the original mainland population ✓ and from each other on separate islands. ✓
The two island populations adapted to their particular environments ✓and changed genetically and physically (phenotype) ✓ over a long period of time became reproductive isolated ✓. **(Any 5)** (5)
[9]

QUESTION 3

3.1. Speciation ✓ (1)

3.2. The population of species A has split up into two
The sea forms a physical barrier ✓ and each group adapts to the new environmental factors ✓
Each group undergoes natural selection independently ✓ and develops separately / micro-evolution
Each group may become genotypically ✓ and phenotypically different ✓
Might prevent them from interbreeding ✓when they come into contact again/become reproductively isolated leading to the formation of a new species ✓ **(Any 5)** (5)
[6]

QUESTION 4

4.1 A mutation is a mistake ✓/alteration due to a change in the composition of DNA ✓
OR
Sudden change✓ in the structure of a gene✓ (2)

4.2 - by accident during meiosis✓
- some chemicals✓/mutagens/high energy radiation (2)
(Mark first TWO only)

4.3 **Neutral mutation** - these are of no benefit ✓ to the organism and they are not harmful **(Any 2)** (2)
Lethal mutation - they are harmful ✓/ cause the death of the individuals that inherit ✓them because natural selection selects against them ✓ **(Any 2)** (2)
[8]

QUESTION 5

5.1. During continental drift ✓ the tortoise populations were isolated/separated ✓ from the original population on different islands ✓ living under different environmental conditions ✓ and through natural selection developed into new species ✓ not able to interbreed after a period of time ✓ **(Any 4)** (4)

5.2 Fossils provide evidence of life forms that existed in the past/that are now extinct ✓ Intermediate forms of organisms ✓ have been discovered that illustrate the changing forms of plants/animals ✓ **(Any 2)** (2)

5.3 Only a few of the ancient organisms are preserved as fossils ✓ because they need to be covered soon after death otherwise they will be decomposed by bacteria ✓Only organisms with a solid and resistant skeleton ✓ are easily preserved ✓We have not found all the fossils ✓ that exist in the earth ✓
(Any 1 x 2) (Mark first ONE only) (2)
[8]

QUESTION 6

6.1 Homologous ✓ (1)

6.2 - Because the structures may have different functions ✓
- but are similar in structure ✓ suggesting a similar/common origin/ancestor (2)

6.3 (a) - There is a wing ✓ /web of skin/membrane
- Forelimb and digits are thin ✓ /light/long
(Any) (***Mark FIRST answer only)*** (1)

(b) - The bones are short ✓ /thick and, therefore, strong
- and the digits (fingers) ends in long claws ✓
(Any) (***Mark FIRST answer only)*** (1)
[5]

QUESTION 7

7.1. "some large, some small" ✓ / "some strong and some weak" (1)

7.2 - Variation in the wildebeest population ✓ * (1)

slow and weak✓, were eaten by the lions✓ and do not pass on their characteristics to their offspring✓	**OR**	some large and strong✓ survive✓ and pass on their favourable characteristics to their offspring✓	max (3)

- If this process continues from generation to generation the characteristic of the population will change ✓ * (1)

*** compulsory marks**

[5]

QUESTION 8

8.1 B
8.2 A
8.3 D
8.4 A
8.5 B
8.6 B (6 x 1) **[6]**

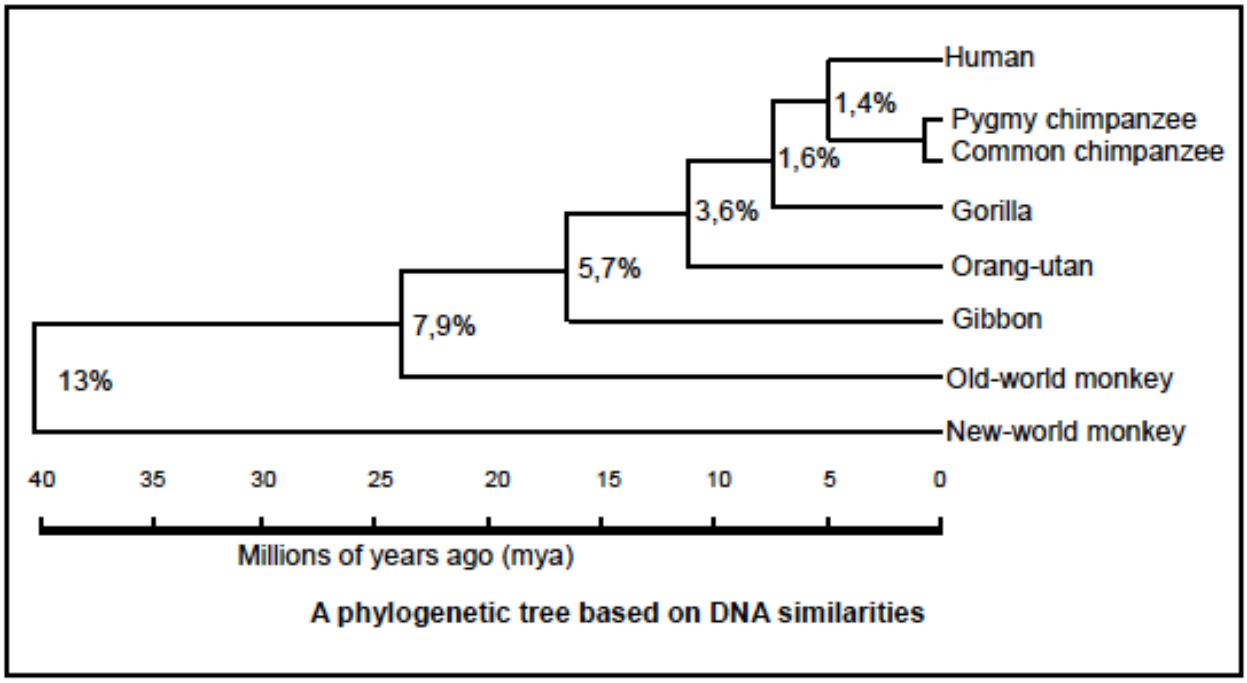
SESSION 4: TOPIC 2: DIVERSITY: HUMAN EVOLUTION, EVOLUTION IN PRESENT TIMES AND ALTERNATIVE EXPLANATIONS

Learner Note: Please review terms like Anthropology, Palaeontology and Archaeology. The Chemical and Hominid Evolution theories are important. Ensure that you know about the Cradle of Humankind, Genetic Eve, Mrs Ples, Taung Child, Little Foot, Adaptive Radiation and the Out-of-Africa and Multi-regional Hypotheses. Questions on this section of work are often comparative questions.

SECTION A: TYPICAL EXAM QUESTIONS

QUESTION 1: 5 minutes *(Taken from DoE Feb/March 2010 Paper 2)*

The diagram below shows a phylogenetic tree based on DNA similarities. The percentage next to each branch shows the amount of difference in the genome (DNA nucleotide sequence) of the two relevant groups.



A phylogenetic tree based on DNA similarities

[Adapted from: *Senior Biology 2*]

1.1. From the diagram, determine how long ago the chimpanzees split from the line to humans.
(HINT: Use a ruler so that you are accurate in your readings) (2)

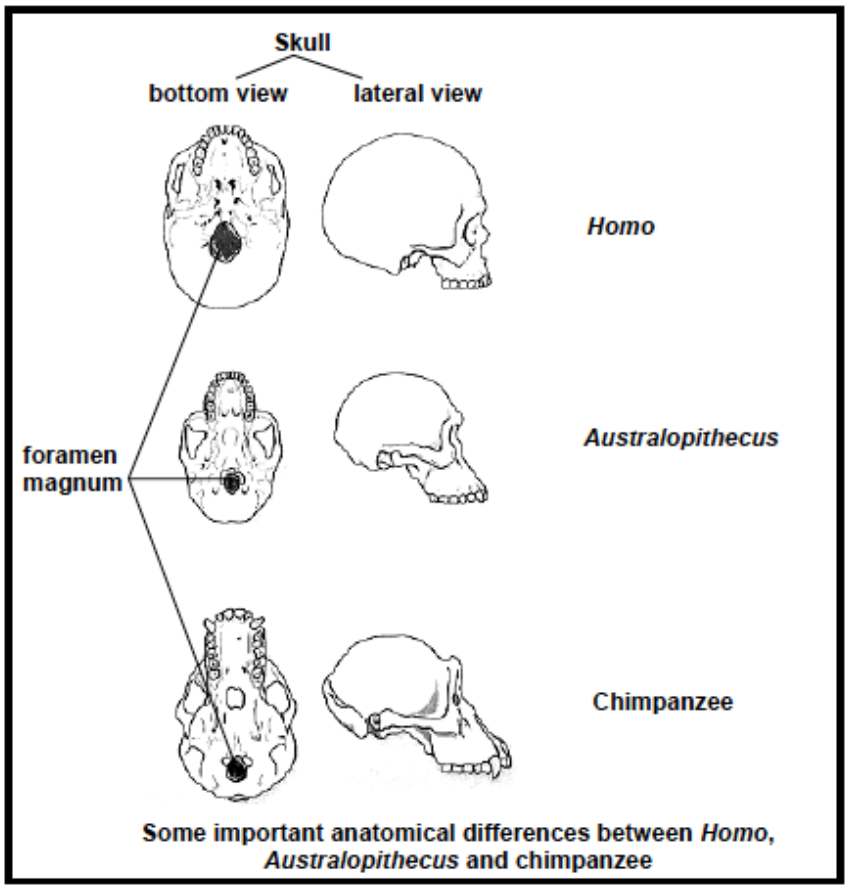
1.2. Which organism is most closely related to humans? (1)

1.3 Calculate the DNA similarity between the genome of the chimpanzee and the human. (2)

[5]

QUESTION 2: 9 minutes *(Taken from DoE Feb/March 2009 Paper 2)*

A comparison of the anatomical features of organisms has helped scientists to propose evolutionary relationships. Please study the following diagram and answer the questions that follow:



Some important anatomical differences between *Homo*, *Australopithecus* and chimpanzee

2.1. Tabulate THREE observable differences between the side view of the skulls of *Homo* and the chimpanzee.

HINT: When you are asked to tabulate, you must draw a table. You get marks for this. Always compare the same things in each point

(7)

2.2. Which ONE of the organisms (*Australopithecus* or chimpanzee) is/was a quadruped? ***(Quad means 4)*** (1)

2.3. Give ONE observable reason for your answer to QUESTION 2.2. (1)
[9]

QUESTION 3: 8 minutes *(Taken from DoE Preparatory Examination 2008 Paper 2)*

In an investigation a biotechnologist injected chimpanzee blood into a rabbit. The immune system of the rabbit recognised the chimpanzee blood protein as foreign and produced antibodies. The rabbit's antibodies were then extracted and developed as a serum.

When the serum is added to blood samples in different test tubes removed from of a variety of different animals, a precipitate forms. The more precipitate forms, the more closely related the animal is to the chimpanzee.

Study the table below that shows the percentage precipitate formed in this investigation, and answer the questions that follow.

Animal species	Percentage precipitate formed
Gorilla	Very high
Baboon	High
Monkey	Moderate
Pig	Very low

3.1. What is the composition of the serum? (2)

3.2. According to the above information, which animal is least closely related to chimpanzees? Give a reason for your answer. (2)

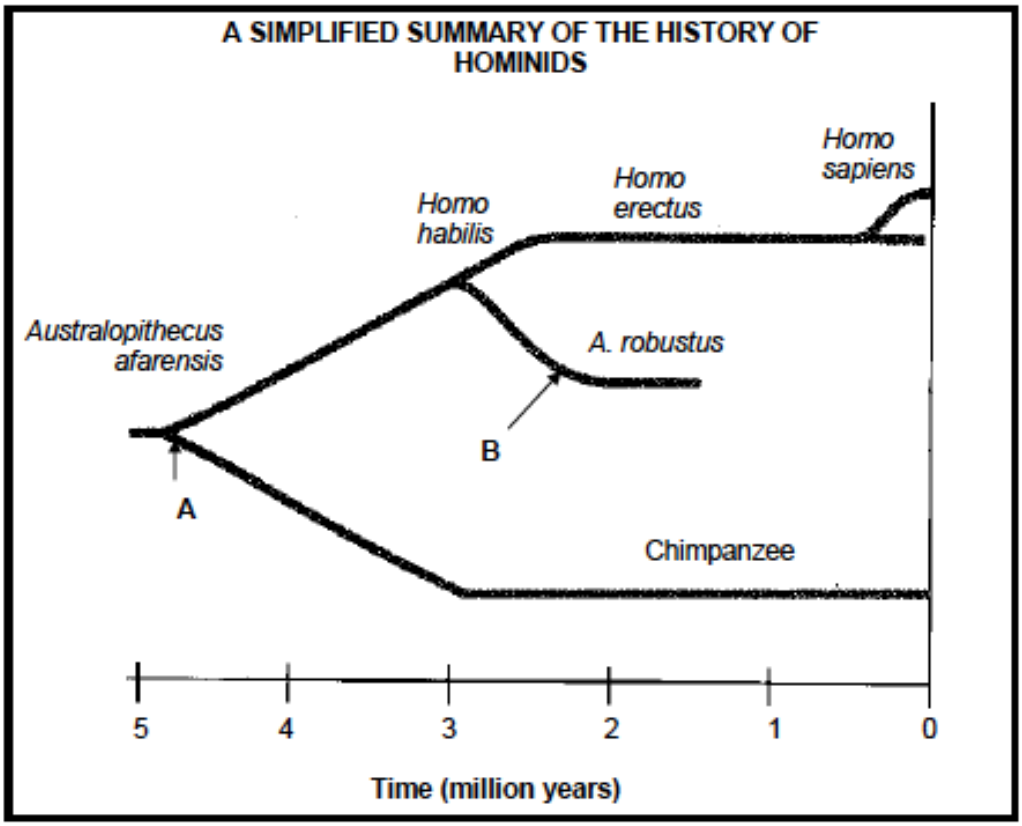
3.3. Formulate a hypothesis for the investigation above. (2)

3.4. Name TWO variables that had to be kept constant in this investigation. (2)

[8]

QUESTION 4: 13 minutes *(Taken from DoE Additional Exemplar 2008 Paper 2)*

During the study of the fossil records the following timeline of hominids were constructed. Study it and answer the questions that follow.



4.1. How many million years ago did the hominid group split (at **A**) into two groups? (1)

4.2. What is the main characteristic that caused the hominids to split into two separate groups at **A**? (1)

4.3. Which organism is thought to be the immediate ancestor of *A. robustus*? (1)

4.4. What are the common names of TWO *Australopithecus* species fossils that were discovered in South Africa? (2)

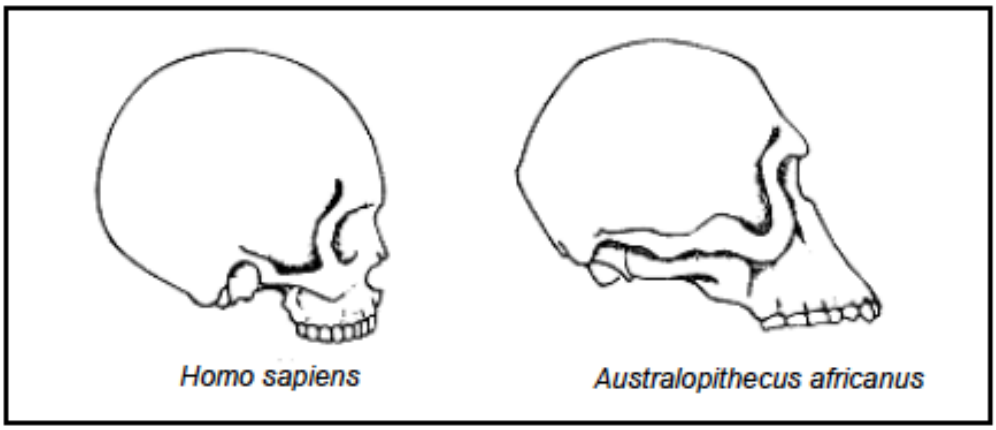
4.5. List FOUR characteristics that primates and humans have in common. (4)

4.6. Scientists accept the theory that the dinosaurs became extinct as a result of a comet or an asteroid striking the earth. Describe how this event could have led to the extinction of the dinosaurs. (5)

[14]

QUESTION 5: 10 minutes *(Taken from DoE Feb/March 2010 Paper 2)*

Study the two skulls on the next page (drawn to the same scale) and answer the questions that follow.



5.1. Tabulate THREE visible differences from the two skulls shown above that scientists have used to differentiate between *Homo sapiens* and other primates. (7)

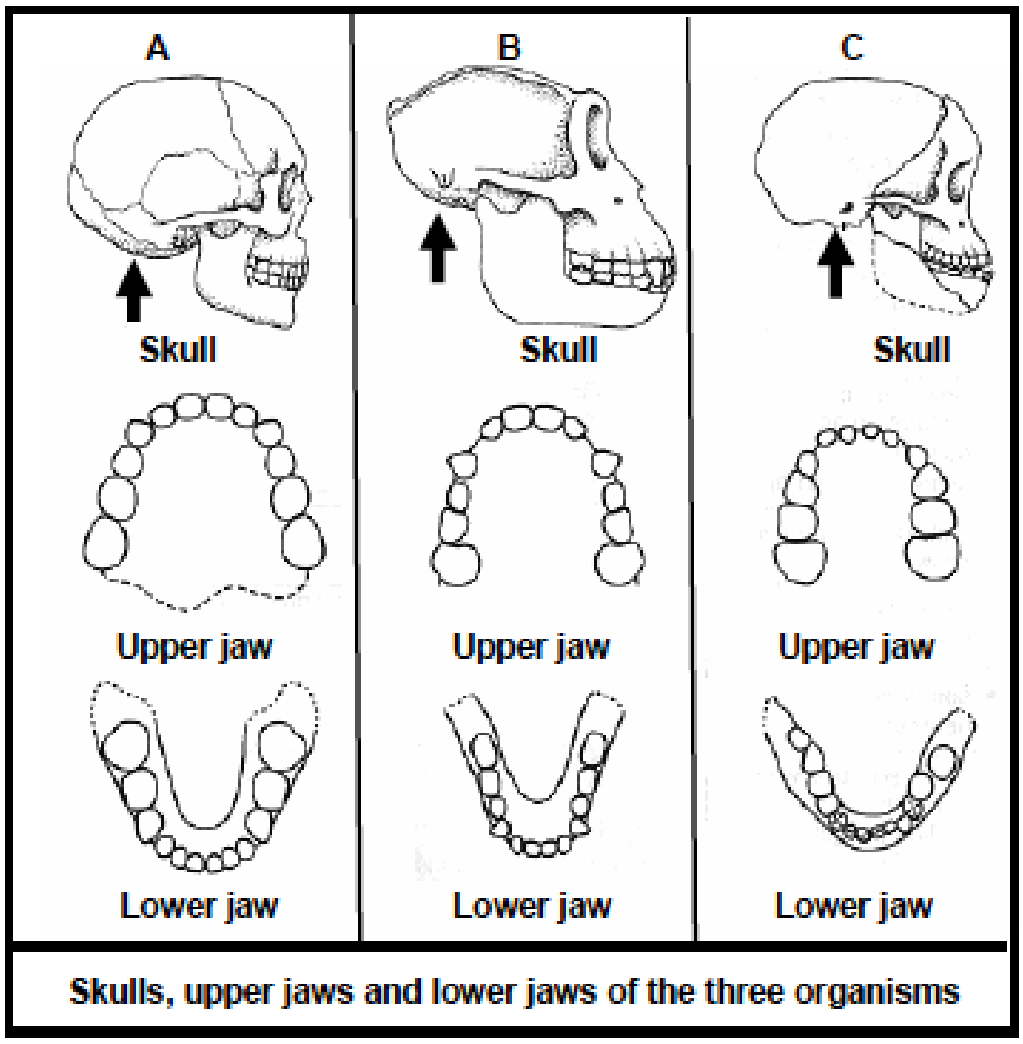
5.2. Give THREE examples of fossils of Australopithecus that were discovered in Southern Africa. (3)

5.3. Explain the importance of the discoveries of the skulls of *Australopithecus* in understanding the evolutionary development of humans. (2)

[12]

QUESTION 6: 12 minutes *(Taken from DoE Exemplar 2008 Paper 2)*

The diagrams that follow represent the skull, the upper jaw and lower jaw of three organisms: the Taung child (*Australopithecus africanus*), a modern human (*Homo sapiens*) and a gorilla (*Gorilla gorilla*). The arrow indicates the position of the foramen magnum (the opening that allows the spinal cord to connect with the brain). Study the diagrams and answer the questions that follow on the next page.



Skulls, upper jaws and lower jaws of the three organisms

6.1. Identify the organisms that are represented by each of A, B and C. (3)

6.2. Assuming that the diagrams were drawn to scale, name TWO observable differences between the skulls of organisms A and B. (4)

6.3. Which organism (A, B or C) represents a carnivore? (1)

6.4. Explain your answer to QUESTION 3.3 using features visible in the diagram. (2)

6.5. Name TWO organisms that are best adapted for walking on two legs rather than four legs, by looking at the position of the foramen magnum (indicated by the arrows). (2)

[12]

SECTION B: ADDITIONAL CONTENT NOTES

Human evolution

Scientists estimate that the earth is more than **5 billion years old**. Geological evidence indicates that simple forms of life on earth appeared 3,5 billion years ago. There are many hypotheses but none have been irrefutably proven. Archaeologists have provided **fossil evidence** to prove that relationships existed between the Early Stone Age cultures in Europe and Northern Africa. Discoveries in South Africa, Kenya and Zimbabwe have been used to prove and validate that Africa was the home of early man.

Anthropogenesis is the study of human evolution and the development of Homo sapiens as a distinct species from the ancestral superfamily, **Hominoidea.** Scientific disciplines like anthropology, primatology, archaeology and genetics are used to map out the origin of humankind.

Evidence of common ancestors for living primates, including humans

The term „*Homo*" refers to the genus and means „human". Studies of human evolution must include hominids such as the *Australopithecines*, as it is theorised that the *Homo* genus diverged (split) from them about four million years ago in Africa. Scientists have estimated that humans branched from their common ancestor with the chimpanzee about five to six million years ago. Other species of *Homo* like *Homo erectus* and *Homo neanderthalus* have all become extinct. Substantial fossil proof exists to explain hominid evolution, although it is not enough to make specific conclusions.

Scientists generally theorise that the ***Homo/Pan* split** of *Hominini* occurred over a period of 4 million years and took place about 5 to 6 million years ago. This is based on studies of the **key gene sequences** of modern humans and chimpanzees. Species that belong to the same subfamily should generally share more than 97% of their DNA. But the similarity between the **modern human genome** and the chimpanzee genome is only about 70%. When DNA segments are analysed and compared, the **genetic sequence divergence** (the process of one species diverging over time, into two or more species where genetic characteristics are passed from one generation to the next) varies significantly between humans and chimpanzees. Chimpanzee, gorilla and orangutan genomes have been sequenced and have **24 pairs of chromosomes.** Humans only have **23 pairs of chromosomes**, because the human chromosome 2 represents a fusion of two chromosomes that remained separate in the rest of the primates.

Characteristics that humans share with other primates:

- **opposable thumb** with power grip and precision grip (so we are able to hold grasp and wrap the fingers around objects while the thumb stands loose to hold around the other side)
- **bare finger tips** – for a better sense of touch
- **long arms** (primates have much longer arms than humans, to enable them to swing in trees and for a more fluid movement)
- **freely rotating arms and hands** - owing to the ball-and-socket joint at the shoulder and the gliding joint in the wrist both joints are able to rotate through 180^{o}
- **stereoscopic vision** – where two eyes are able to focus on one object and perceive depth
- **visual acuity –** eyes have an increased number of rod AND cone cells with their own nerve cells where cone cells enable us to see colour
- **large brain** when compared to body mass – allowing for intelligence and thinking patterns
- **brain centres** that are able to process information from the senses are enlarged and function well - sense of touch and sight especially
- **olfactory centre** (sense of smell) in the brain is reduced
- **few offspring –** humans and primates have longer gestation periods, less offspring and increased parental care
- **upright posture and bipedalism** (bi = two and pedal = walk, so bipedalism means walking on two legs. Primates sometimes move on two legs but often use their arms to assist them)
- **social dependency –** group cohesion and living together enjoying shared activities

Characteristics that make humans different from other primates:

- humans are always **bipedal** as we always only walk on two legs and never use our hands on the ground. Walking on two legs has implications beyond those affecting the skeleton and muscles as scientists theorise that the upright posture and subsequent changes to the nervous system resulted in the enlargement of the cerebral hemispheres.
- a human **face and skull is flat** with no prognathous (protruding jaw structure)
- **dentition** (teeth) is similar to that of monkeys and apes but different from that of older primates like the gorilla with **smaller canines** since humans do not require large canines to rip flesh to eat or for defense. Teeth are aligned into the jaws in a **gentle curve/'u' shape**
- **larger brain** than primates (brain size varies from 1200ml to 1800ml with the average size being 1400ml)
- humans have learned to communicate through **language**

Out of Africa hypothesis and evidence for African origins of modern humans

Most scientists agree that *Homo sapiens* evolved in Africa and spread outwards across the continents. Some scientists support an alternative theory that humans evolved as a single species from *Homo erectus* in Asia. Not only does fossil evidence support an African origin but so too does **Y-chromosomal DNA** and **mitochondrial DNA** research.

The *Out of Africa* hypothesis was developed by **Chris Stringer and Peter Andrews**, stating that modern *Homo sapiens* evolved in Africa about 200,000 years ago and migrated outwards to Europe and Asia, according to the **Southern Dispersal theory**.

This theory is based on genetic, linguistic (language) and archaeological evidence where researchers using mitochondrial DNA, have concluded that all were descended from one woman from Africa, called **Mitochondrial Eve**. The *Out of Africa* theory is also supported by the fact that genetic diversity is the highest among African populations. Anthropologists and palaeontologists have collected substantial evidence to prove that humans moved from **Africa** to settle in Europe and Asia, at the approximate time of the glacial period. Some underwent a process of bleaching, which resulted in the **fair-skinned, light-eyed and blonde-haired** people of Britain, Scandinavia and Germany. Note that the oldest centres of civilisation discovered, are located in Egypt, Mesopotamia and the Indus basin. The question is: why did early humans emigrate from Africa to Europe and Asia? One possible explanation is that the glacial period altered the climate in Northern Africa from very hot and dry to very cold. Food sources like plants and animals would have been severely impacted, so movement to a warmer place where there was an abundance of food took place.

The Cradle of Humankind

The Cradle of Humankind is a **World Heritage Site** first named by Unesco in 1999. It is located about 50 km northwest of Johannesburg, South Africa. Hominid remains have been excavated at the Cradle of Humankind. Many anthropologists believe that hominids lived all over Africa, but their remains are only found at sites where their bones were **preserved into fossils**, like at the Cradle of Humankind. Archaeological caves in the **Makapan Valley** show traces of human occupation and evolution dating back about 3,3 million years. There is evidence that defines the **origin and evolution** of humankind with fossils of several specimens of early hominids, dating back to between 4,5 million and 2,5 million years.

Fossil evidence:

Who found it:	Date:	What was found:	Where was it found:	Relevance:
Raymond Dart	**1924**	juvenile *Australopithecus africanus* skull called the **Taung Child**	Taung is a small town in the North West Province	The Taung Child"s skull shows that it was positioned directly above the spine, indicating an upright posture. This is a trait seen in humans, but not other primates.
Dr Robert Broom and John Robinson	**1947**	a 2,3-million year old fossil of *Australopithecus africanus*, commonly known as the famous **Mrs Ples**	Sterkfontein Caves	The uncovering of Mrs Ples provided further proof of the development of humankind and supported the findings of the Taung Child

Team: Maurice Taieb, Donald Johnson, Mary Leakey and Yves Coppens	1974	excavated 40% of a 3.2 million year old skeleton of an *Australopithecus afarensis* called **Lucy**	Hadar in the Awash Valley of Ethiopia"s Afar Depression	Lucy"s skull capacity was small like apes, but showed bipedalism like humans proving the theory that bipedalism preceded the increase of the human brain size
Dr Ronald J Clarke	1997	the near-complete 3.3 million year old *Australopithecus* skeleton called **Little Foot**	Swartkrans in the Cradle of Humankind	Also found evidence for the controlled use of fire dating back to 1 million years ago

Evolution in present times

Scientists use biotechnology and genetic engineering to artificially select desired characteristics and create new species that are beneficial to humans. Harmful species of mutated viruses and bacteria are created for **Biochemical warfare**, e.g. anthrax and ebola virus. We also find new species developing that are resistant to insecticides and antibiotics, e.g. DDT, MDR and XDR Tuberculosis. The evolutionary process is fast tracked by human intervention.

- **DDT (d**ichloro-**d**iphenyl-**t**richloroethane)
  Many years ago, mosquito breeding areas were sprayed with an insecticide called DDT to prevent malaria by killing the mosquito larvae and was initially very effective. Some insects with mutations in their **sodium channel gene** were resistant to DDT and with breeding took about 7 years for DDT to loose its effectiveness. This that the genetic trait that caused the resistance to DDT was **homozygous ressessive** and eventually resulted in the evolution of the mosquito into a new DDT resistant species. However, the impact of DDT on the environment continues because it is non-biodegradable and toxic. DDT was washed from the soil and leached into underground water and eventually the sea. The weak solution of DDT was absorbed by micro-organisms and through the food chain link, the **concentration increased** and resulted in **bio-accumulation**. Cancer and many other diseases may result in humans. In animals and birds, the **toxin accumulation** results in uncharacteristic behaviour, egg-shell thining and death. In 1972, the use of DDT was officially banned worldwide.

- **Resistant strains of TB**

  Tuberculosis is caused by a bacterium called *Mycobacterium tuberculosis* that attacks the lungs, kidneys and bones. Symptoms would include chest pains, fever, coughing, loss of weight and shortness of breath. Eventually, mucus and pus block the alveoli causing them to burst, resulting in the person coughing infected spray droplets of blood. Loss of alveoli causes lack of oxygen, resulting in physical weakness. TB is also transmitted in infected milk. The TB bacteria are destroyed when exposed to sunlight and infected people should be isolated and treated with **antibiotics** for a minimum of six months. Children are immunised with inoculations at the local clinics. The TB bacteria have evolved into **'multi-drug resistant strains'** (MDR-TB), where normal drugs are ineffective. In 2006, **'extensively drug-resistant tuberculosis'** (XDR-TB) was identified. MDR-TB tends to develop when patients miss doses of antibiotics or do not complete the full treatment. This strain seems less virulent and does not appear to dominate naturally. But XDR-TB has a much higher mortality rate than MDR-TB and does not seem to transmit in healthy populations but appears to be more prevalent in individuals who are **HIV positive**. With the XDR-TB strain, from onset of the disease to death takes approximately 15 to 20 days as this strain does not respond to any of the drugs presently available in South Africa.

Alternative explanations to evolution

Anthropologists, palaeontologists and archaeologists have uncovered evidence from fossil records that prove the theory of evolution, showing adaptation or extinction processes throughout the ages. Adaptations result in **natural selection** and **biodiversity** results. **Constant change** is brought about by the need to adapt and survive, gene mutations and human intervention. The theory of evolution is one explanation of how change has occurred over time to ensure survival. Diversity is therefore the **result of change** over time, through the process of natural selection.

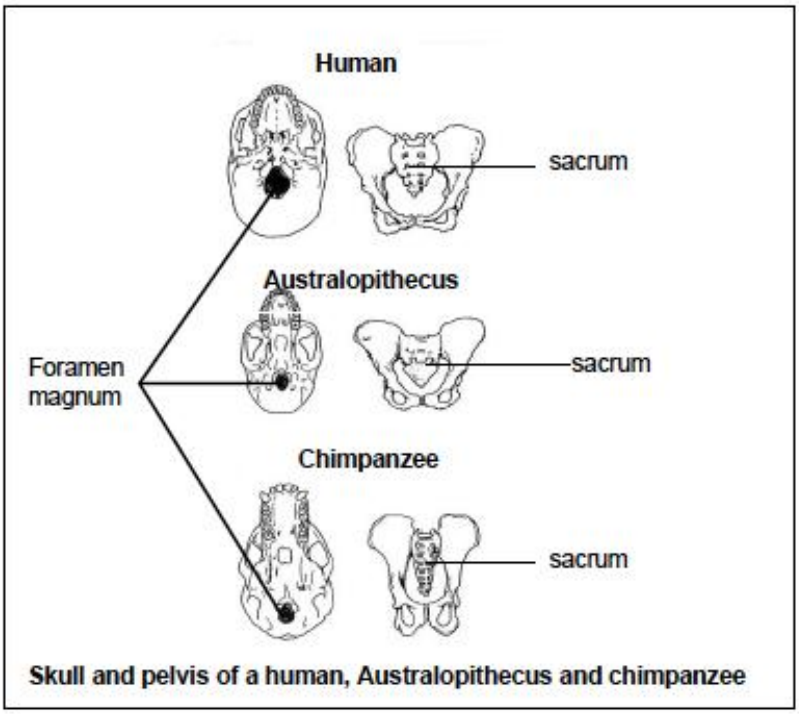
SECTION C: HOMEWORK

Learner Note: As you attempt attempt the homework, you MUST stick to the time frames. If you get stuck refer to either the additional notes or your class teacher.

QUESTION 1: 15 minutes *(Taken from DoE Preparatory Examination 2008 Paper 2)*

HINT: This question is very similar to the question in Section A. Please note how a similar question can be asked around the same topic.

The diagram below shows the skull and pelvis of three mammals. Study the diagram and answer the questions that follow.



Skull and pelvis of a human, Australopithecus and chimpanzee

1.1. Tabulate FOUR observable differences of the skull and pelvis of a human and a chimpanzee. (9)

1.2. Which organism(s) is/are bipedal? (2)

1.3. Give ONE reason, observed from the diagram, for your answer to QUESTION 1.2. (2)

1.4. State ONE visible difference between the skull of *Australopithecus* and a human. (2)

1.5. In table form show the differences between anthropology, palaeontology and archaeology. (6)

1.6. List the SIX main hominid types that form part of Hominid Evolution and discuss the variation in the formation and development of the skulls. (7)

1.7. Bipedal locomotion and upright posture is a distinctive trait of human beings. Describe FIVE advantages of bipedalism to humans today. (5)

[33]

QUESTION 2: 5 minutes

2.1. Why is the Cradle of Humankind World Heritage site an area that is regarded as universally valuable? (1)

2.2. In which Hominid type would we place the Taung child and Little Foot. (2)

2.3. Describe the „African Hypothesis". (2)

[5]

QUESTION 3: 6 minutes

The size of the cranial cavity is used to estimate the size of the brain. The size of the brain is used to roughly indicate intelligence. The table below shows the brain size of apes and humans.

Name of living or fossil primate	**Cranial capacity (in mm^3)**
Modern apes	
Gibbon	100
Orang-utan	395
Chimpanzee	400
Gorilla	510
Australopithecines	
Early forms	450
Late forms	660
Early humans	
Java man	870
Peking man	1050
Neanderthal man	1450
Modern humans	
Cro-Magnon man	1660
Living man	1450

The early *Australopithecines* lived about 3 million years ago and the late *Australopithecines* about 1,7 million years ago. It took about one million years for the size of the human brain to double.

3.1. What is the size difference between the brain of Living man and Java man? (1)

3.2. Which early humans had the same size brain as Living man? (1)

3.3. Think of possible reasons why Cro-Magnon man, who lived during the Stone Age, had a larger brain than Living man. (2)

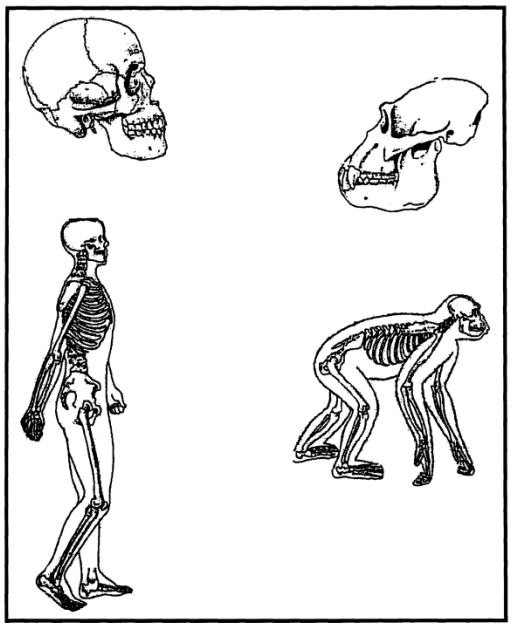
3.4. Which of the *Australopithecines* had a brain size more or less the same size as the modern apes? (1)

3.5 What type of person would have dug up and studied the different types of skulls in order to record the size of the brain? (1)

[6]

QUESTION 4: 18 Minutes *(Taken from GDE Preparatory Examination 2009 Paper 2)*

Study the pictures below on the parts of the skeletal structures of primates and answer the questions that follow:



4.1. State ONE reason why apes and humans are referred to as „hominids". (2)

4.2. Name the term used to describe the locomotion of

a) humans (1)

b) chimpanzees (1)

4.3. Suggest TWO ways in which locomotion of modern humans will be disadvantaged if they had the skeletal structure of apes and chimpanzees. (2)

4.4. Distinguish between the skeletal structure of man and the chimpanzee, other than those mentioned in Question 4.3. (5 x 2) (10)

4.5. Predict the shortcomings (challenges) the ape would experience if it had the phalanges of *Homo sapiens*. (2)

[18]

SECTION B: SOLUTIONS AND HINTS TO SECTION A

QUESTION 1

1.1 5P mya ✓✓ (2)

1.2 Chimpanzee ✓ (1)

1.3 98,6 ✓% ✓ (2)

[5]

QUESTION 2

2.1.

Homo	Chimpanzee
1. Canines not well developed ✓	1. Canines well developed ✓/form fangs
2. Less protruding jaws ✓/not prognathus	2. Protruding jaws/prognathus ✓
3. Brow-ridge less pronounced ✓	3. Heavily pronounced brow- ridge ✓
4. Proportionally large cranium ✓	4. Proportionally smaller cranium ✓
5. Proportionally shorter cheek bone ✓	5. Proportionally larger cheek bone ✓
6. No ridge at base/back of skull ✓	6. Ridge at base/back of skull ✓

(Mark first THREE only) (Any 3 x 2) 1 mark for table (7)

2.2 Chimpanzee ✓ (1)

2.3 The foramen magnum is towards the posterior/back of the skull ✓ (1)

[9]

QUESTION 3

3.1 The serum contains antibodies ✓ against chimpanzee protein✓ (2)

3.2 Pig, ✓ it only forms an very low % ✓ precipitate when the blood is exposed to serum. (2)

3.3 A high percentage✓ of precipitate formed indicates a close relationship✓ with chimpanzees

OR

A low percentage ✓of precipitate formed indicates a no ✓ relationship with chimpanzees

OR

A high percentage ✓ of precipitate formed indicates a weak ✓ relationship with chimpanzees

OR

A low percentage ✓ of precipitate formed indicates a strong ✓ relationship with chimpanzees (2)

3.4 Temperature✓, pH✓, concentration of serum√ amount of serum and blood the same✓ **(Any 2)** (2)

[15]

QUESTION 4

4.1 4,6 – 4,8 ✓ million years ago (1)

4.2 Bipedalism✓ (1)

4.3 *Australopithecus afarensis* ✓ (1)

4.4 -Little foot
-Mrs Ples
-Taung child **(Any 2) (Mark first TWO only)** (2)

4.5 Bare finger tips✓
Long arms ✓
Freely rotating arms ✓
Stereoscopic vision ✓
Eyes with cones (in addition to rods) ✓
Large brain compared to body mass ✓
Portions of brain centres that process information from hands and eyes enlarged ✓
Olfactory brain centres smaller✓
Few offspring ✓ **(Mark first FOUR only)** (4)

4.6. -Formation of large clouds of dust ✓
-blocking out the sun✓
-global cooling✓
-stopping photosynthesis✓
-no producers in food chains ✓
-food chains involving dinosaurs destroyed✓
-causing extinction **(Any 5)** (5)
[14]

QUESTION 5

5.1

	Homo sapiens	***A. africanus***
1	No prominent brow ridge ✓	1 Prominent brow ridge present ✓
2	Flat face ✓	2 Prognathous face ✓
3	More rounded skull ✓✓	3 Less rounded skull ✓
4	Teeth arranged on a gentle(round) curve ✓/more rounded upper jaw	4 Teeth arranged in a less curved way ✓/less rounded upper jaw
5	Smaller upper jaw ✓	5 Larger upper jaw ✓
6	Smaller cheekbone ✓	6 Larger cheekbone ✓
7	Deeper set eye sockets ✓	7 Shallower set eye sockets ✓

(Mark first THREE only) (3x2 + 1 for table) (7)

5.2 Little foot ✓
Mrs Ples ✓
Taung child ✓ **(Mark first THREE only)** (3)

5.3 Foramen magnum of the *Australopithecine* was towards the centre✓ indicating that these were the first bipedal hominids ✓ on Earth OR Large jaws✓ indicate a mainly vegetarian diet ✓ **(Any 2)** (2)
[12]

QUESTION 6

6.1 A - Modern human *(Homo sapiens)* ✓
B - Gorilla (*Gorilla gorilla)* ✓
C - Taung child (*Australopithecus africanus)* ✓ (3)

6.2.

Organism A	Organism B
Flat face✓	Protruding jaws✓
Chin prominent✓	Chin not prominent✓
Foramen magnum occurs towards middle of the skull✓	Foramen magnum towards the back of the skull✓
No central ridge on the cranium✓	Central ridge on the craniuml✓
Eye sockets in front of skull✓	Eye sockets on top, front part of the skull✓
Less pronounced eyebrow ridge✓	Pronounced eyebrow ridge✓

(Mark first TWO only) (2x2) (4)

6.3 B✓ (1)

6.4 It has most developed✓ canines✓ (2)

6.5 A✓ and C✓ **(Mark first TWO only)** (2)
[12]

SESSION 5: TOPIC 1: PLANT RESPONSES TO THE ENVIRONMENT
TOPIC 2: ANIMAL RESPONSES TO THE ENVIRONMENT

Learner Note: For Topic 1, make sure that you know and understand plant hormones, geotropism, phototropism and plant defence mechanisms. For Topic 2, make sure that you know and understand the nervous system and all its components, the different types of nerves and also the reflex arc.

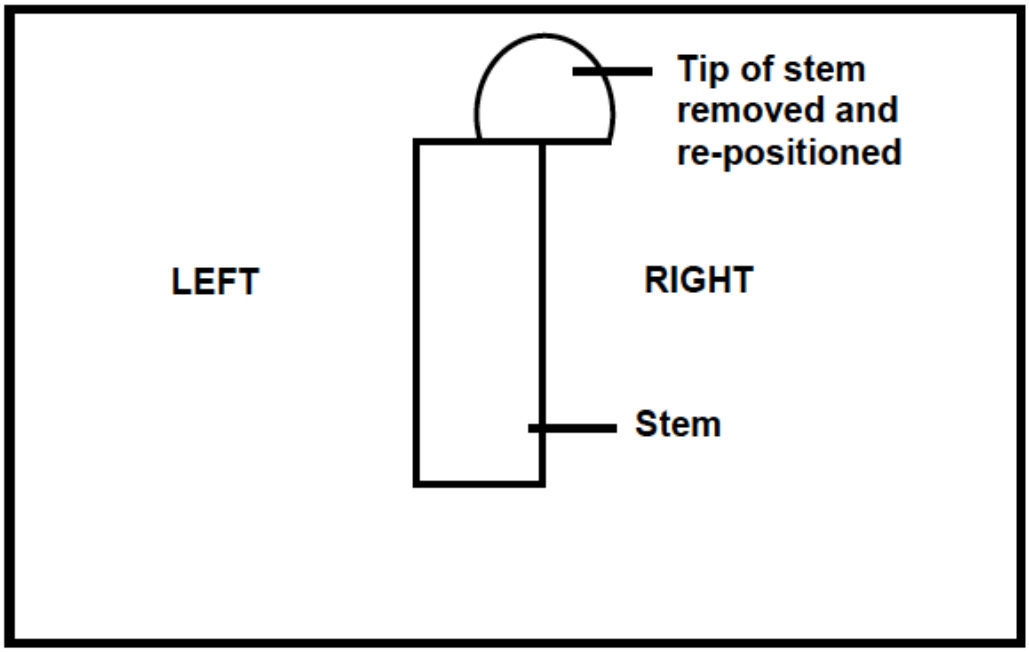
SECTION A: TYPICAL EXAM QUESTIONS

Learner Note: Please do not to waste time when you answer multi-choice questions. Read the question, underlining the operative words, while covering the answers. Then think of the correct answer. Then uncover the answer options and check if your answer is there. If it is, then tick next to the letter. If it is not, re-read the question and try to see exactly what is being asked. Then review the answer options again to find the correct answer. Always answer Section A last with the multi-choice questions that must be answered right at the end of the exam paper.]

QUESTION 1: 8 minutes (*Taken from various DoE HG Paper 2 exams)*

Various possible options are provided as answers to the following questions. Choose the correct answer and write only the letter (A – D) next to the question number.

QUESTIONS 1.1 and 1.2 are based on the following diagram.
The tip of an actively growing seedling was removed and then placed on one side of the stem as shown in the diagram below. The seedling was kept in a dark room.



1.1. The following is the expected result of the investigation:

A No further lengthening of the stem will take place
B The stem will grow straight upwards
C The stem will bend to the left
D The stem will bend to the right

1.2. This investigation could also be used to show the following:

A Negative phototropism in plants
B Geotropism in plants
C That substances which promote growth are formed at the tip of the stem
D That the tip of the stem is not necessary for the lengthening of the stem

1.3 Which of the following structures will enable a dancer to carry out dance movements?

1. Cerebellum
2. Proprioceptors
3. Hypothalamus
4. Cerebral cortex

A 1 only
B 1 and 2
C 1, 2 and 3
D 1, 2, and 4

1.4 Which of the following parts of the brain regulates appetite?

A Medulla oblongata
B Cerebellum
C Hypothalamus
D Cerebrum

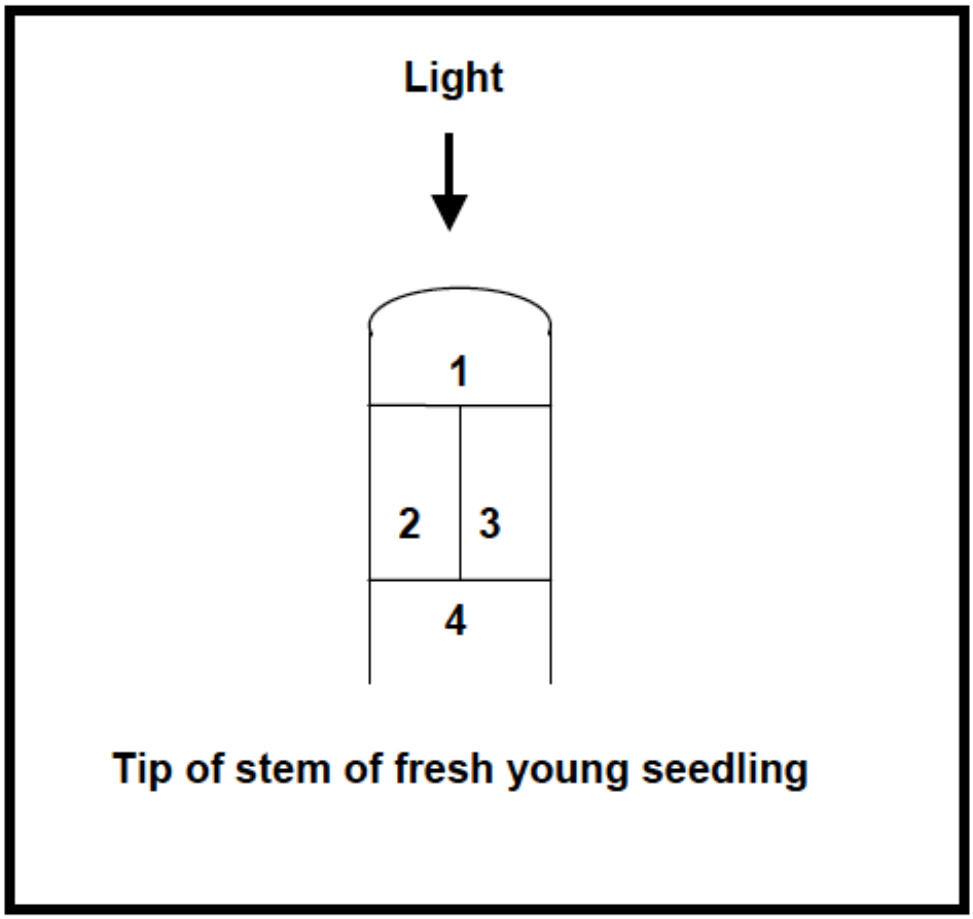
1.5 Which ONE of the following factors does NOT play a direct role in geotropism?

A Gravity
B Water
C Auxin
D Cell elongation

1.6 Regular removal of the tips of a plant causes it to become thicker because ...

A it allows the plant to develop a shape that is suitable for reproduction.
B the plant gets more light and air.
C the fruit yield of damaged plants is higher.
D apical dominance is eliminated.

1.7 Study the diagram below showing areas in the tip of a stem.



The auxin concentration will be ...

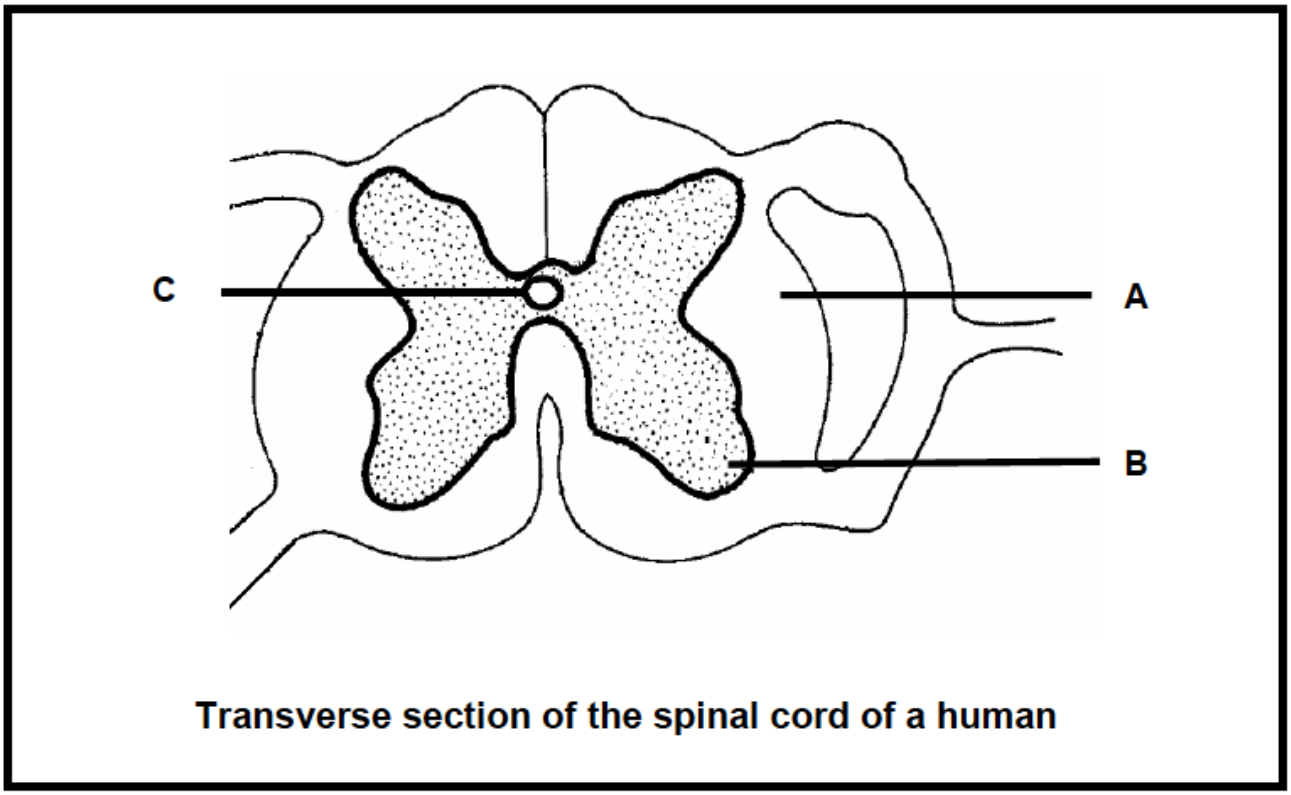
A higher at 3 than at 2.
B higher at 2 than at 3.
C the same at 2 and 3.
D the same at 1 and 4.

1.8 The autonomic nervous system controls …

A the skeletal muscles.
B the senses.
C the contraction of involuntary muscles.
D reflexes. (8 x 1) [8]

QUESTION 2: 5 minutes *(Taken from DoE May/June 2008 HG Paper 2)*

Study the diagram on the following page and answer the questions that follow.



Transverse section of the spinal cord of a human

2.1 Identify parts A, B and C. (3)

2.2 State TWO ways in which the spinal cord is protected. (2)

[5]

QUESTION 3: 8 minutes *(Taken from DoE May/June 2008 HG Paper 2)*

Answer the following questions on the nervous system.

3.1 Make a labelled diagram showing the external structure of the brain. (5)

[Always draw in pencil using clear, clean lines. Draw label lines in ink and make sure that your label lines NEVER cross each other. This will mean that you will not get marks for either of the labels. Write labels in ink.]

3.2 Name the part of the brain:

a) Where the reflex centre for swallowing is found (1)

b) Which receives impulses from the sacculus and utriculus (1)

c) Involved in reasoning (1)

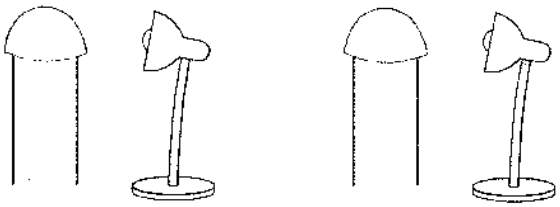
[8]

QUESTION 4: 9 minutes *(Taken from various sources)*

The experiment on the following page shows how shoots respond to light. Two shoots were used, both belonging to the same species of plant. The shoots were observed after a few days.

Shoot A

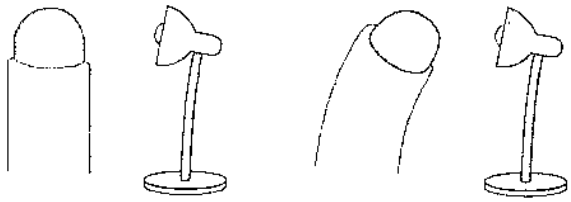
Procedure Observation



Tip of shoot covered with a tin foil cap. Seedling then illuminated from the right

Shoot B

Procedure Observation

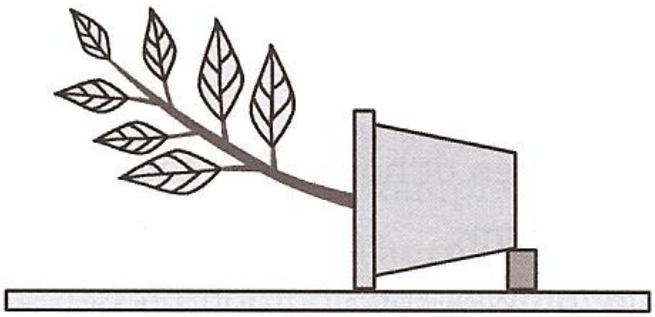


Sides of shoots covered with a tin foil sleeve. Shoot then illuminated from the right

4.1. What is the aim of this experiment? (1)
4.2. Give the results of the experiment. (4)
4.3. Name the hormone responsible for the growth of the plant as shown by shoot B in the diagram. (1)
4.4. Name three other plant hormones that play a role in the growth and development of a plant. (3)
[9]

QUESTION 5: 8 minutes *(Taken from various sources)*

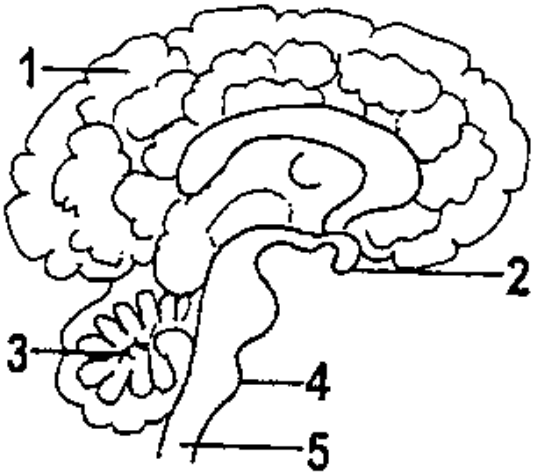
5. The pot plant in the diagram below was placed onto its side. After a day the stem started to grow upwards.



5.1. Give the term used to describe this phenomenon. (1)
5.2. Provide a definition for the term. (1)
5.3. Which chemical substance is involved in this phenomenon? (1)
5.4. What is meant by the term apical dominance? (2)
5.5. How could you apply the theory of apical dominance to grow a thick hedge around your home? (3)
[8]

QUESTION 6: **15 minutes** *(Adapted from: Taken from various DoE Exams Paper 2 exams)*

Learner Note: Please note: you must learn the diagram of the external structure of the brain very well. You must be able to provide labels and also draw the diagram yourself.



6.1. Identify parts numbered 1 to 5. (5)
6.2. Number 1 is made up of two similar halves. How are these two halves attached to one another? (1)
6.3. What type of tissue is controlled by number 3? (1)
6.4. Name TWO functions of number 4. (2)
6.5. List THREE ways in which the brain is protected. (6)
[15]

SECTION B: ADDITIONAL CONTENT NOTES

TOPIC 1: PLANT HORMONES

Growth is the increase in size of plants. Cell division occurs and the cells differentiate in order to develop. Growth and development is affected by:

- **internal factors** such as **hormones**
- **external stimuli** such as **water, light, gravity, gases and contact**.

The word tropism means „to turn". A tropism is the response to an external stimulus, causing a plant to grow towards (positive tropism) or away (negative tropism) from the stimulus.

Hormonal control in plants

Auxins are **growth hormones** found in plants. Auxins stimulate or inhibit (prevent) growth in areas. A high concentration of auxins in an area will **stimulate cell elongation** and **cell differentiation**, especially in stem tips. This results in **apical dominance -** when the growth point at the **tip** of the stem grows **upwards**. This action **inhibits** the development of auxillary buds on the lateral branches below – so they don"t grow because all the plant"s energy is used to grow **upward**. If the tip is removed the **auxillary buds** develop into lateral branches causing the plant to grow **thicker** on the sides.

Auxins cause:

- **cell division**
- formation of **adventitious roots** in cuttings
- **development** of flowers and fruit
- **abscission** (breaking off) of leaves and ripe fruit

Other plant hormones:

Gibberellins:

- cause elongation of internodes in stems
- development of flowers
- sprouting of buds
- germination of seeds

Abscisic acid:

- inhibits growth of apical buds, seeds and also roots
- regulates the abscission of leaves
- plays a role in the opening and closing mechanism of stomata (for transpiration)

Phototropism (*Photo* = light)

Phototropism is the growth movement of a plant when stimulated by light. When the stem of a plant grows towards a unilateral (one-sided) light stimulus, it is **positively phototrophic**. Auxins **stimulate cell elongation** in the stem and move to the **dark, shaded side**. Cell elongation occurs **more rapidly** on the dark side because of the higher concentration of auxins. The stem bends towards the light stimulus. Roots are **negatively phototrophic** and always grow away from light, down into the soil.

Geotropism (*Geo* = gravity)

Geotropism is the downward growth movement of a root in response to a **unilateral gravitational force**. When a root is placed horizontally (onto its side), **abscisic acid** is drawn to the lower half of the root by the force of gravity. A high abscisic acid concentration **inhibits** (prevents) root growth. Cell elongation takes place faster in the upper half of the root so cells on the upper side grow faster, causing the root to turn downwards. The root is **positively geotrophic**. Stems are negatively geotrophic because they grow away from gravity.

Plant defence mechanisms

Plants have adapted to prevent herbivores from eating them.

- **Chemical defences:** plants produce chemicals called **phytoecdysteroids** to defend against insects. The chemicals cause insects to moult prematurely, lose weight and if enough is ingested, metabolic damage and death. Cultivated tobacco plants produce **nicotine.** The leaves are eaten by insects and kills them. The leaves of mopane trees contain high levels of **tannins** making the leaves distasteful to herbivores.
- **Thorns:** this is a common term for a sharp structure found on plants for protection against herbivores. There are various types of sharp structures:
  - **Prickles** are modified extensions of the cortex and epidermis of a plant that shape into a sharp, needle-like structure, for example, rose bushes.
  - **Thorns** are modified branches or stems that form hard, pointed and sharp ends that can pierce the skin of herbivores. Examples are acacia trees, kei apple and lemon trees.
  - **Spines** are modified leaves that have a cylindrically shaped hard and sharp point, for example aloes and cacti. Spines also reduce water loss by the plant.

TOPIC 2: NERVOUS SYSTEM, NERVES AND REFLEX ARC

The nervous system: controls the functioning of all the systems in the body allowing humans to react to stimuli from their environment. The **central nervous system** controls all voluntary movements and internal organs, glands and blood vessels. It responds to information received by the brain and then responds. The nervous system can be divided into **three** systems that **coordinate** the functioning of the body namely: the Central nervous system, the Peripheral nervous system and the Automonic nervous system.

Nervous tissue

Nervous tissue consists of a complex system called **neurons** or nerve cells that are adapted to conduct and react to all **stimuli**.

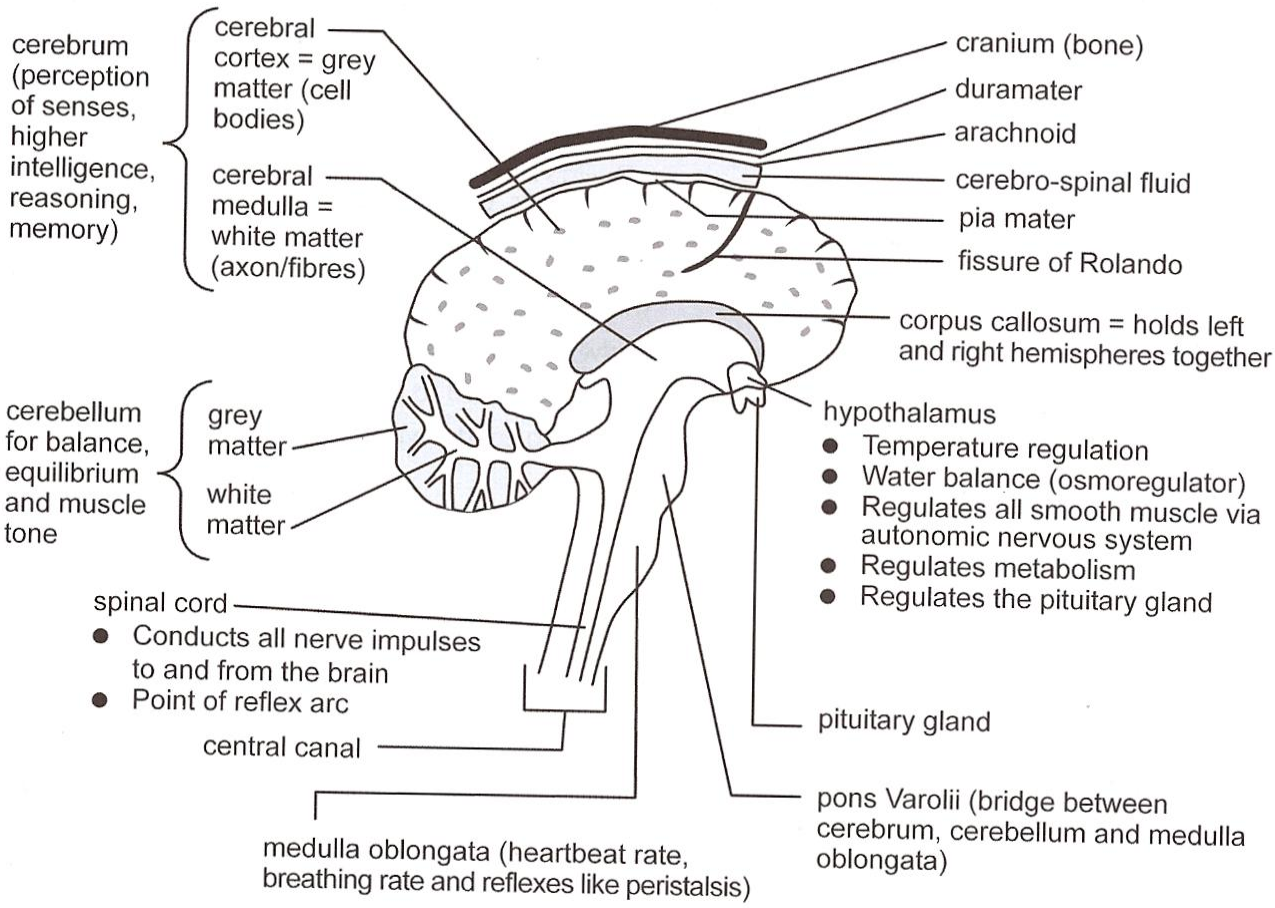
- **Sensory neurons:** They are unipolar (one pole) and bipolar (two poles). Sensory neurons always conduct impulses from the receptor *to* the CNS (spinal cord and brain).
- **Motor neurons:** They are multipolar neurons with many dendrites. Multipolar neurons always carry impulses *away* from the CNS (spinal cord and brain).
- **Connector / inter-neurons:** They connect sensory neurons to motor neurons in the spinal cord and the brain.

Transmission of nerve impulses

The synapse is the point where an impulse passes from the terminal branch of one neuron to the dendrite of the next neuron. The neurons **do not touch each other** and the gap between the two neurons is called the **synaptic gap**. Neurotransmitters carry the impulse across the synaptic gap. Once they reach the opposite side, enzymes destroy the neurotransmitters to prevent the impulse from being carried back so that the impulse can only travel in one direction.

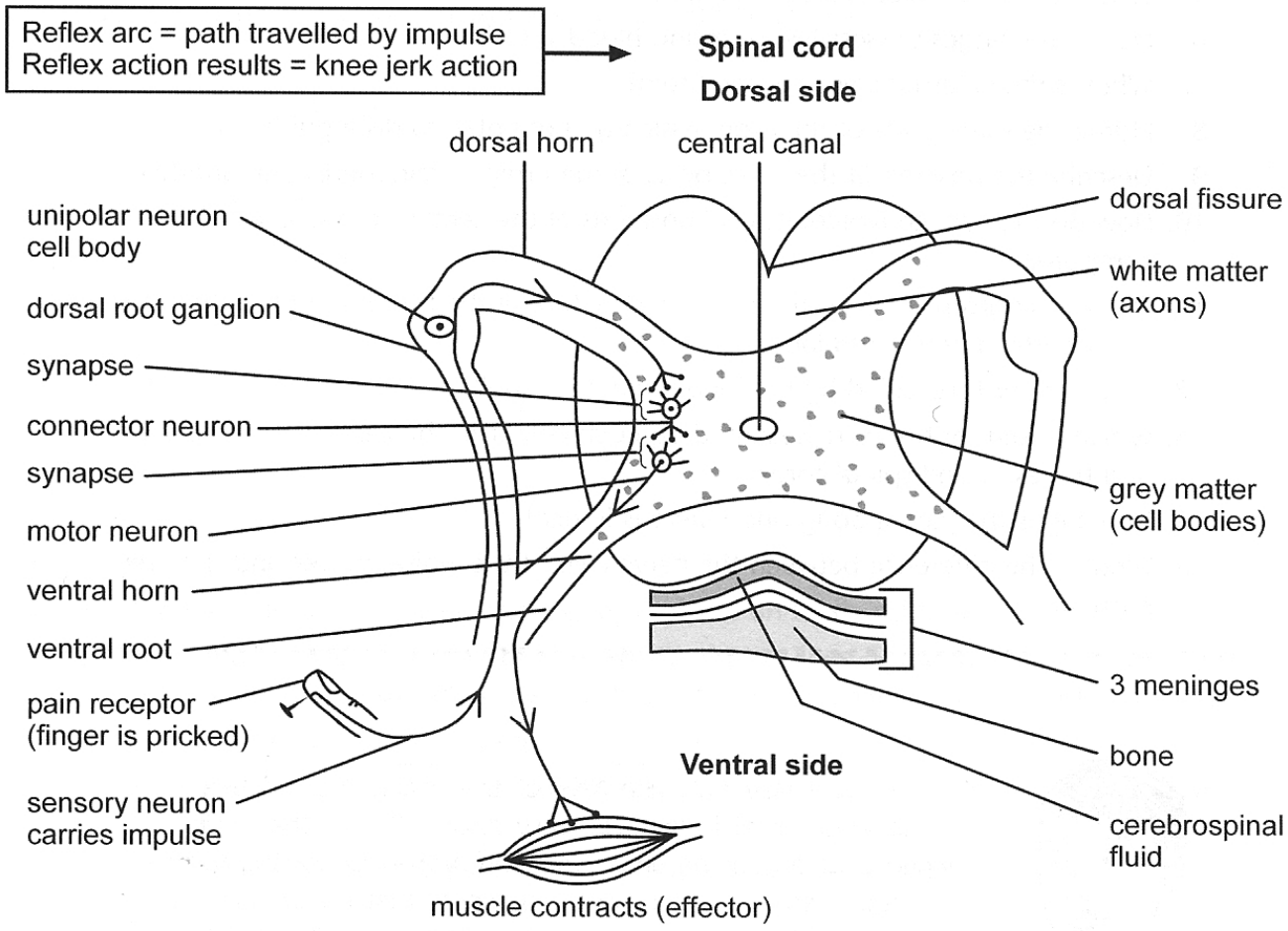
The Central Nervous System (CNS)

Brain: protected by the bones of the cranium and is surrounded by three layers of membranes or **meninges** for protection. The cortex consists of cell bodies and is called the **grey matter**. The medulla consists of the nerve fibres or axons and is called the **white matter**.



The spinal cord: protected by the **vertebrae** and **cerebrospinal fluid**. Nerves from the body parts enter the spinal cord as 31 pairs of spinal nerves. The spinal cord is the pathway for all the impulses that are conducted to and from the brain and also processes reflex actions. Sympathetic and parasympathetic nerve impulses are conducted along the spinal cord to all organs.

The reflex arc: is the path travelled by the nerve impulses and is a **rapid automatic response** to a stimulus, received by a sensory organ. The reflex arc will cause a **reflex action** allowing the body to respond very quickly to protect itself and prevent severe injury.



Effects of drugs on the central nervous system

Drugs that are legally prescribed by a doctor and are used according to instructions, are acceptable as they are used to treat illness and alleviate pain in patients. When drugs are used to **enhance performance** or as a **psychoactive** for non-therapeutic and non-medical effects, it becomes a problem. Drugs that are addictive and harmful are alcohol, amphetamines, barbiturates, cocaine and opium alkaloids. It is a criminal offence to abuse any of these drugs.

Drugs can be classified as stimulants, sedatives and opiate analgesics:

Stimulants and halosinogens (hallucinogenics): These drugs enhance the activity of the central and peripheral nervous system. Effects like alertness, wakefulness, endurance, increased heart rate, increased blood pressure and a reduction in appetite and need for sleep, are stimulated. Stimulants work by increasing the facilitation of noradrenalin and also dopamine activity, resulting in the stimulation of the central nervous system. Examples of stimulants are amphetamines, caffeine, cocaine and nicotine. Stimulants are addictive. Examples of hallucinogenics are tik, ecstacy, heroin and dagga.

- **Sedatives and hypnotics:** These are substances that depress the central nervous system. Doctors use these drugs to target specific receptors, for example to treat anxiety, to sedate a patient, as antipsychotics (tranquillisers) and for psychological problems. Sedatives work directly on the central nervous system by slowing down and blocking function. Examples are alcohol, barbiturates and nimetazepam.
- **Opiate and opioid analgesics:** These include opium and derivatives of opium like morphine, codeine and heroin. Analgesics are used to relieve pain (Greek: *an* = without and *algos* = pain) by working on the central and peripheral nervous system to inhibit the transmission and reception of pain stimuli.

The Autonomic Nervous System (ANS)

The autonomic nervous system controls many **vital activities** in the body in order to maintain homeostasis. It consists of nerves, which are connected to the hypothalamus of the central nervous system. This system functions **involuntarily and automatically**, so it cannot be controlled by the will. It is subdivided into the **sympathetic** and **parasympathetic** nervous systems that function **antagonistically**. The sympathetic nerves **stimulate** organs to prepare the body for action. The parasympathetic nerves **slow** the systems down and bring the body back to a state of rest. Each organ in the body is supplied with nerves from both systems and is termed **double innervation**. The organs are stimulated (sympathetic) or inhibited (parasympathetic) by the autonomic nervous system.
Functions regulated automatically by the autonomic nervous system include:

- the heartbeat and breathing rate (through the medulla oblongata)
- digestion and peristalsis
- pupil size
- bladder size
- sweat glands
- liver function
- amount of blood in the arteries.

Peripheral Nervous System (PNS)

The peripheral nervous system is made up of sensory cells that respond to stimuli. Sensory cells are called **receptors**. When the receptors are stimulated, the stimulus is converted into a nerve impulse. The nerve impulse is transmitted along sensory neurons to the CNS.

Diseases and disorders of the nervous system – make sure that you know the causes, symptoms and treatment of any one of the following: Alzheimer"s disease, ADD or depression.

SECTION C: HOMEWORK

QUESTION 1

State three functions of auxins in plants. [3]

QUESTION 2

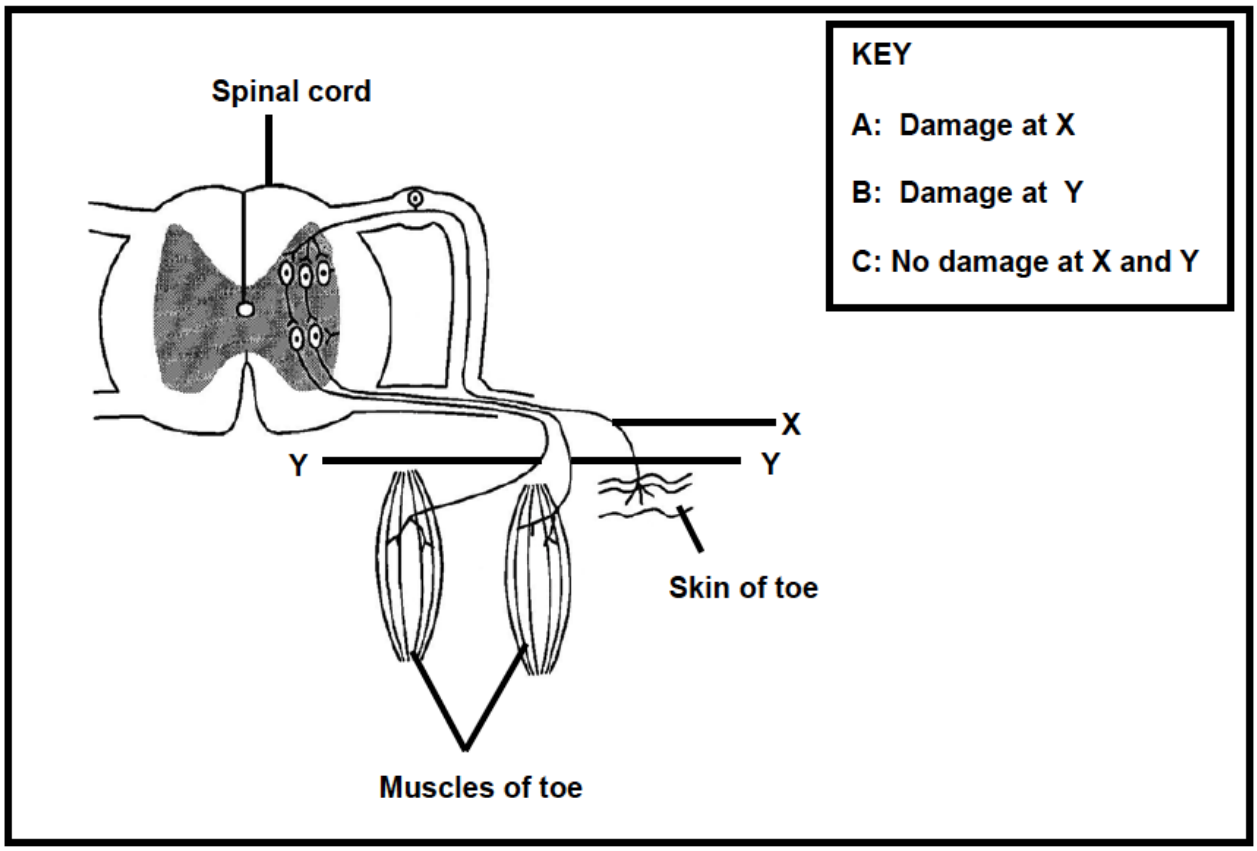
What is the advantage of phototropism in plants? [1]

QUESTION 3

Discuss how you would set up an experiment to demonstrate phototropism. [7]

QUESTION 4

Letters X and Y represent neurons that conduct impulses to and from the brain via the spinal cord. Study the diagram and answer the questions that follow.



Using the given key, write down the correct letter (A, B or C in key) of the condition that explains each of the following:

Learner Note: Remember: damage to X will mean that sensory neurons will not be able to send impulses to the CNS. Damage to Y will mean that the motor neaurons will not be able to stimulate muscles to move.]

4.1 When the skin of the toe is stimulated, the toe moves and the person knows that it is moving. (1)

4.2 The person can move the toe, but cannot feel the movement. (1)

4.3 The person can feel a pin pricking the toe, but cannot move the toe. (1)

[3]

SECTION D: SOLUTIONS AND HINTS TO SECTION A

QUESTION 1

1.1. C
1.2. C
1.3. D
1.4. C
1.5. C
1.6. D
1.7. C
1.8. C (8 x 1) **[8]**

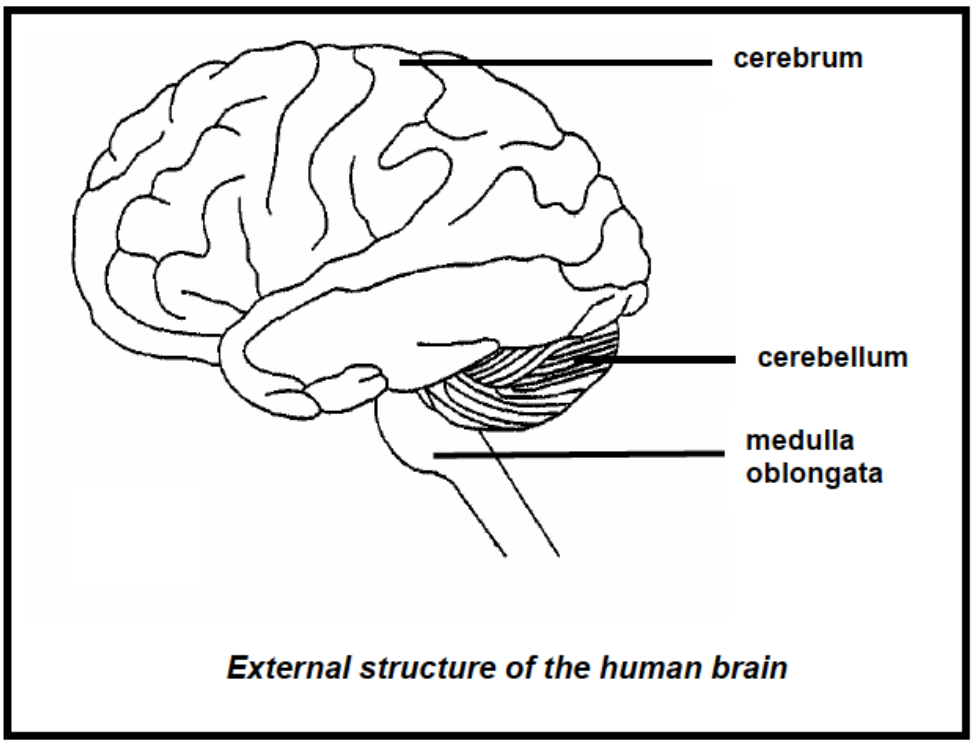
QUESTION 2

2.1 A: White matter
B: Grey matter
C: Central canal / Cerebrospinal fluid (3)

2.2 - By three meninges
- it is inside the bony vertebrae
- cerebrospinal fluids **Mark first 2 answers only** (2)

[5]

QUESTION 3



External structure of the human brain

3.1 Quality of lines in the diagram (1)
Must draw cerebrum much larger than cerebellum (1)
Three correct labels (3)

3.2 (a) medulla oblongata (1)
(b) cerebellum (1)
(c) cerebrum (1)
[8]

QUESTION 4

4.1. To demonstrate apical dominance. (1)
4.2. In shoot A the tip of the stem continued to grow upwards (2). In shoot B the tip of the stem grew towards the source of light (2) (4)
4.3 Auxin (1)
4.4. Gibberellins, abscisic acid, indole acetic acid (3)
[9]

QUESTION 5

5.1. Phototropism (1)
5.2 The growth movement of a plant when stimulated by light. (1)
5.3 Plant hormone / auxin (1)
5.4 When the growth point at the tip of the stem grows upwards ✓and development of the auxillary buds on the lateral branches is inhibited ✓ (2)
5.5. The growth point at the tip of the stem continues to grow upwards ✓and inhibits ✓the development of auxillary buds ✓on the lateral branches below. (3)
[8]

QUESTION 6

6.1. 1 cerebrum
2 pituitary gland / hypophysis
3 cerebellum
4 medulla oblongata
5 spinal cord (5 x 1) (5)

6.2. Corpus callosum (1)

6.3. Skeletal muscles (1)

6.4. Medulla oblongata contains the reflex centres which control and regulate the following:

- The breathing rate and depth
- The heartbeat rate
- Vaso-motor activity /dilation and constriction of the blood vessels
- The secretion of saliva
- Controls peristalsis **(Any two functions)** (2)

6.5.

- Bones of the skull ✓– protects against physical injury✓
- The 3 meninges ✓– added protection✓
- Cerebrospinal fluid ✓found between the aracnoid and piamater protects against friction✓ (6)

[15]

SESSION 6: TOPIC 1: THE HUMAN EYE
TOPIC 2: THE HUMAN EAR

Learner Note:
Topic 1: Knowledge and application: structure and function of the human eye, formation of the image, binocular vision, accommodation of the eye, pupillary function, short and long sightedness, astigmatism and cataracts.
Topic 2: Knowledge and application: Structure and functioning of the human ear, hearing and balance, middle ear infections, deafness, link between hearing defects and speech disorders.

SECTION A: TYPICAL EXAM QUESTIONS

Learner Note: Please do not to waste time when you answer multi-choice questions. Read the question, underlining the operative words, while covering the answers. Then think of the correct answer. Then uncover the answer options and check if your answer is there. If it is, then tick next to the letter. If it is not, re-read the question and try to see exactly what is being asked. Then review the answer options again to find the correct answer. Always answer Section A, the multi-choice questions, last.

QUESTION 1: 15 minutes *(Taken from Study and Master Grade 12 Biology)*

Various possible options are provided as answers to the following questions. Choose the correct answer and write only the letter (A – D) next to the question number.

1.1. The tough, non-elastic tissue covering the outer portion of the eyeball is the ….
A choroid
B sclera
C conjunctiva
D iris

1.2. The shape of the lens in the human eye may be altered by the contraction or relaxing of the….
A optic nerve
B muscles of the iris
C muscles of the ciliary body
D pupil

1.3. The sensation of sight in human beings originates in the ….
A yellow spot
B optic nerve
C cerebrum
D retina

1.4. The yellow spot of the human eye:

A cone cells only
B more cone than rod cells
C cone and rod cells in equal number
D rod cells only

1.5. The following are parts of the human eye:

1 cornea 2 lens 3 retina 4 iris 5 choroid

Which parts are respectively concerned with/in:

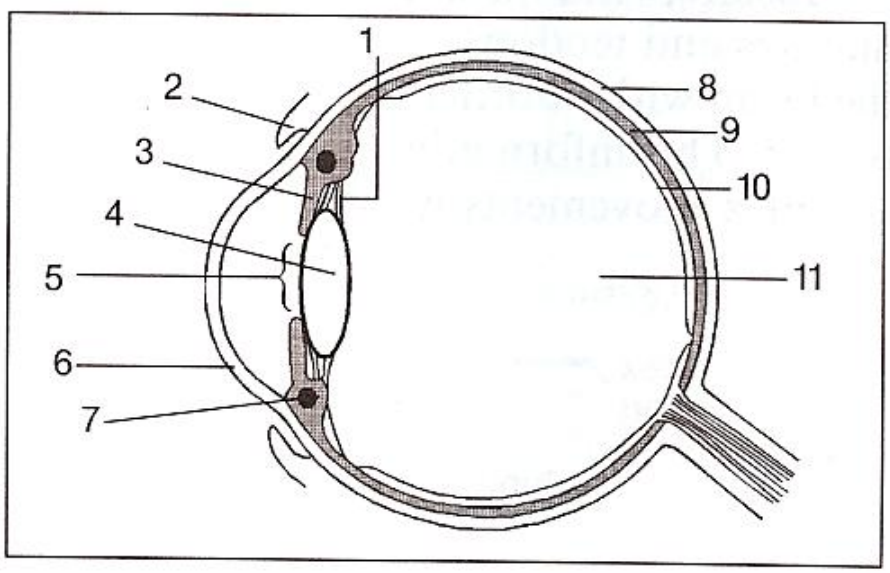
- Adjusting the focus?
- Preventing internal reflection?
- Recording changes in light intensity?

A 2, 4 and 3
B 3, 4 and 1
C 2, 5 and 4
D 4, 1 and 5

1.6. When the tension of the suspensory ligaments in the human eye is slackened, the….

A lens becomes less convex
B eye is focused for distant vision
C pupil enlarges
D lens bulges

QUESTIONS 1.7 to 1.9 refer to the diagram of the human eye.



1.7. The parts that control the amount of light rays that enter the eye are…..

A 1 and 2
B 1 and 3
C 2 and 3
D 3 and 4

1.8. The greatest convergence takes place when light rays pass through the part numbered…..

A 4
B 5
C 6
D 11

1.9. The function of part numbered 9 is to:

1. reflect light
2. change the shape of the eyeball
3. refract light rays
4. prevent reflection
5. supply the retina with nutrients and oxygen
6. absorb excess light

Choose from the options numbered 1 to 6 to provide the functions of part numbered 9:

A 1, 2, 3
B 4, 5, 6
C 2, 4, 6
D 1, 3, 5

1.10. When the tension of the suspensory ligaments in the human eye increases, the…

A lens becomes more convex
B eye is focused for distant vision
C pupil opens wide
D lens bulges

1.11. When the pupil of the human eye constricts, the receptors and effectors are respectively the….

A fovea centralis and ciliary muscle
B pupil and ciliary muscle
C pupil and radial muscles of the iris
D fovea centralis and the circular muscles of the iris

1.12. In accommodation of the human eye, the….

A pupil enlarges
B ciliary muscles are involved
C suspensory ligaments are always in a state of tension
D circular muscles of the iris contract

1.13. Images of objects less than 6m from the eye are clearly focused onto the retina, when the….

A ciliary muscles contract
B pupil widens
C muscles of the iris contract
D curvature of the lens decreases

1.14. The optical disc where the fibres of the optic nerve leave the eyeball, is the….

A yellow spot
B iris
C blind spot
D retina

1.15. Which of the following occurs when you look up from reading a book to look at a distant mountain on a clear, sunny day? The….

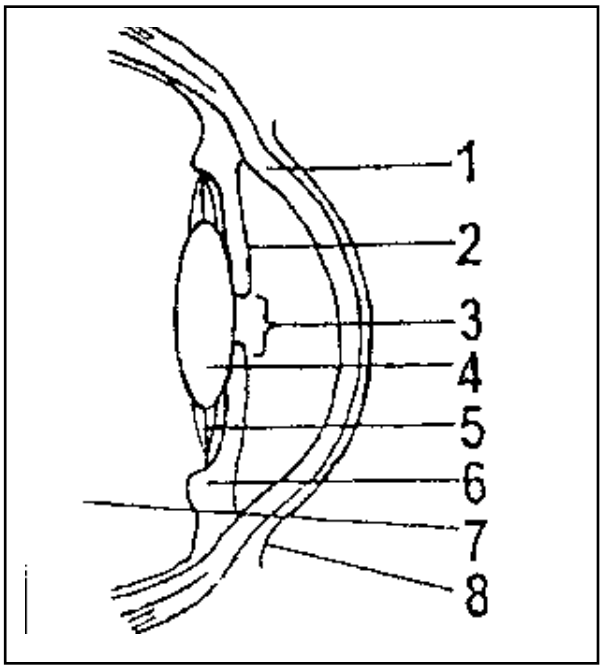
A radial muscles of the iris contract
B the pupil becomes more dilated
C the ciliary muscles contract
D the lens becomes thicker and rounder (15 x 1) [15]

QUESTION 2: 4 minutes *(Taken from DoE May/June 2008 Paper 2)*

Explain why, when a person enters a dimly lit room after being in bright sunlight, objects only become visible after a while. [4]

QUESTION 3: 18 minutes *(Taken from Bios best 2008 Grade 12 Biology)*

The diagram below represents a section through part of the human eye.



3.1. Supply labels for the parts numbered 1, 3 and 5. (3)

3.2. Supply the number and name the part that controls the amount of light that enters the eye. (2)

3.3. Mention the changes that the part names in Question 3.2 will undergo when exposed to bright light. (4)

3.4. List one function for each of parts 4 and 7. (2)

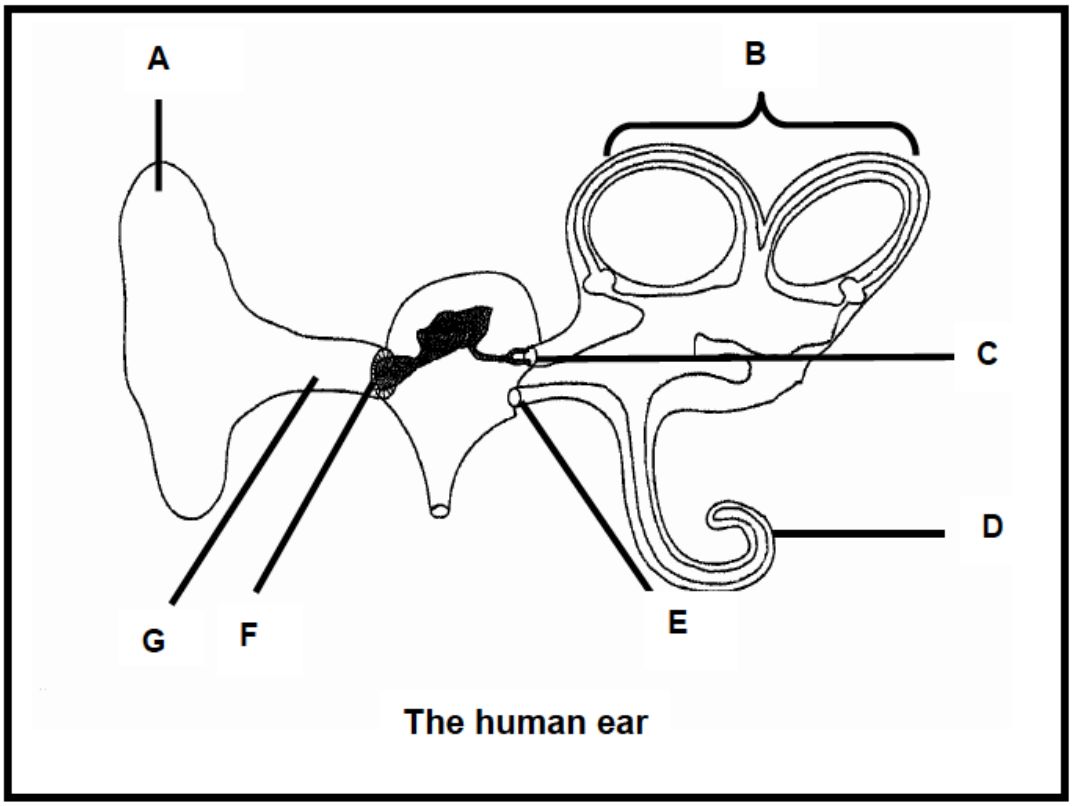
3.5. Supply the number and the name of the part that is responsible for the accommodation of the eye. (2)

3.6. Explain the changes that will take place when the part named in Question 3.5 views an object closer that 6m. (5)

[18]

QUESTION 4: 18 minutes *(Taken from DoE May/June 2008 Paper 2)*

Study the following diagram of the human ear and answer the questions that follow.



The human ear

4.1 Identify parts B and G. (2)

4.2 State the function of each of parts C and E. (2)

4.3 Explain:

a) Why you can often clear a buzzing/humming in the ear by swallowing (3)

b) Why the membrane labelled F is much larger than membrane C (2)

4.4 A dog has lost part A in an accident. Part A is replaced with a stiff, non-elastic, solid plastic structure.

a) Is the plastic structure as effective as the original ear of the dog? (1)

b) Explain your answer to QUESTION 4.4 (a). (2)

4.5 Explain how part D and the retina of the eye function in similar ways. (4)

4.6 Give ONE reason for part D being spirally shaped. (2)

[18]

SECTION B: ADDITIONAL CONTENT NOTES

TOPIC 1: THE HUMAN EYE

The eyes are organs that make it possible for us to see. How do we see?

- Light rays pass from an object to the eye, through the transparent **convex cornea, aqueous humour**, the biconvex **lens** and **vitreous humour**.
- As the light rays pass through the curved surfaces (the cornea and the lens), **light is refracted** (bent).
- The lens refracts the light rays and forms an **inverted** (upside-down) image on the retina, bringing the image into focus by making fine adjustments.
- The **rod and cone cells** (photoreceptors) are stimulated by the light rays, and convert the stimulus into impulses.
- These impulses are transmitted along the **optic nerve** across the optic chiasma (cross-over) so that impulses enter the **lower visual centres** on opposite sides of the mid-brain at the **occipital lobes**.
- Here, the upright images are interpreted for size, shape and colour of the object that was seen.

Accommodation

Seeing with two eyes = **binocular vision** (bi=two and ocular = eye) helps us to focus on one object with both eyes, and allows for a greater field of vision. A sharp image falls on each retina. The image from the left eye is always slightly different to the image from the right eye. The two images join in the brain at the occipital lobes and results in **stereoscopic vision.** This helps with **judging distance, depth and size of objects**. The eyes can change the convex curve of the lens and this changes the focal length. This process is termed **accommodation**.

Near Vision (lens is round)	Distant Vision (lens is long and at rest)
• Object is less than 6 m	• Object is further than 6 m
• ciliary muscles **contract** (causing the ciliary body to move closer to the lens)	• ciliary muscles **relax** (causing the ciliary body to pull back from the lens)
• suspensory ligaments **slacken**	• suspensory ligaments become **taut**
• tension on the lens is released	• less tension on the lens
• lens becomes more convex and **rounded** (increasing the **refractive power** of the lens)	• lens is pulled to a **longer** and thinner shape (**less convex**) (decreasing the **refractive power** of the lens)
• focal length **decreases**, bringing the object into focus onto the yellow spot of the retina	• focal length increases, bringing the object into focus onto the yellow spot of the retina

Pupillary mechanism (reflex action)

Too much light into the eye will cause damage to the retina and the photoreceptors (rod and cone cells). The **iris** controls the amount of light that enters the eye. The iris contains **circular and radial** muscle fibres that regulate the size of the **pupil.** Make sure that you learn the diagrams.

Iris = bright light	Iris = dull light/dark
• circular muscles contract – causing pupil to constrict (get smaller)	• circular muscles relax – causing the pupil to dilate (get larger)
• radial muscles relax	• radial muscles contract
• less light is allowed into the eye	• more light is allowed into the eye

Visual defects

Short-sightedness: also called **myopia** or nearsightedness. It is a refractive defect where the image focuses **in front** of the retina because the cornea is **too rounded**. Distant objects are seen as blurred. Myopia may be **genetic** or it may result when people place regular strain on their eyes by working on computers or in a job where they are required to focus closely on objects, like microscope work. Glasses and contact lenses that are concave [**)(**] are prescribed to **reduce refraction**. **Refractive surgery** may be an option, where the cornea is reshaped to flatten it and so decrease refraction. This causes the image to be focused onto the retina.

Long-sightedness: also called **hypermetropia** or farsightedness. This is a refractive defect where the image focuses **behind** the retina. The person will not be able to see objects when they are close by, as the images are blurred. This condition is caused by the following:

- An eyeball that is **too short** (genetic): This is corrected with prescription eyeglasses or contact lenses which assist to increase refraction of light by using convex lenses [**()**].
- When the lens **cannot become round** enough during accommodation: This may be genetic or it may be as a result of aging. As one ages, the ciliary muscles are unable to contract enough to cause the lens to become rounder. Eyeglasses or contact lenses are prescribed to assist to increase refraction of light by using convex lenses [**()**].
- A cornea that is **too flat**: Refractive surgery is performed in extreme cases.

Astigmatism: is an optical defect that results in blurred vision. It is caused by an **irregular curvature** of the cornea or the lens so the eye has **different focal points** that occur in different planes. Glasses and hard contact lenses correct the irregular focal points.

Cataracts: is the **clouding** of the lens when the lens cortex liquefies to form a milky white fluid. Cataracts progress over time and may result from long-term exposure to ultra-violet light, radiation, diabetes, hypertension, old age and physical trauma. Genetically, people may have a predisposition to cataracts. Cataracts must be removed surgically. Extra-capsular surgery (ECCE) can be used to remove the lens, leaving the lens capsule intact. Intra-capsular surgery (ICCE) is used when both the lens and capsule are removed. The lens is replaced with a **plastic lens** in both cases.

TOPIC 2: THE HUMAN EAR

The ears are the sense organs for **hearing and balance**

- **Hearing: mechanoreceptors** in the cochlea of the ear are stimulated by sound waves that are converted to impulses
- impulses are transmitted via sensory neurons to the auditory centre in the **cerebral cortex** of the brain where they are interpreted
- **Balance and equilibrium: ampula and macula** in the inner ear receptors that convert movement of the head into impulses
- Impulses are transmitted via sensory neurons to the **cerebellum** where they are interpreted so that we can correct the balance of the body

How do we hear?

- Sound waves move from the vibrating source in horizontal waves - humans hear sounds with a vibration frequency of between 16 and 20 000 Hz
- Sound waves are collected by the **pinna** and passed down the **external auditory canal**.
- vibrations reach the **eardrums** (tympanic membranes) which vibrate
- vibrations are transmitted to the **three ossicles** (the hammer, anvil and stirrup) in the middle ear, to **amplify** the sound
- the stirrup passes the vibration through the **oval window** to the inner ear causing wave movements in the liquid of the **perilymph**
- wave movements are transferred to the **endolymph** inside the **cochlea**
- hair cells of the **organs of Corti** (the mechanoreceptors) brush or bend against the membranes, converting the mechanical stimulus of the sound wave into an **impulse**
- impulse is passed through the **auditory nerve** to the auditory centre in the **cerebral cortex** of the brain
- the sensation of sound is interpreted and perceived
- excess vibrations are passed out through the **round window**, to prevent sound pressure and echoes

Hearing defects

Middle ear infection:

This is termed **otitis media** and refers to an inflammation of the middle ear. When the middle ear becomes infected by bacteria, there is **extreme pain** as pressure builds up behind the eardrum. The pressure is caused by pus which collects in the middle ear cavity. The **Eustachian tube** becomes blocked so **the pressure cannot be equalised** on both sides of the eardrum. In some cases, the eardrum may burst and pus drains out of the ear. Antibiotics are generally prescribed. Severe scarring of the eardrum can affect the person‟s hearing. When a person gets middle ear infections often, an Ear Nose and Throat specialist (ENT) will insert grommets into the eardrum to help to drain excess fluid out of the middle ear.

Deafness: The terms hearing impairment, hard of hearing or deafness mean that the person has a loss of the ability to detect sounds. Deafness can be as a result of a number of reasons:

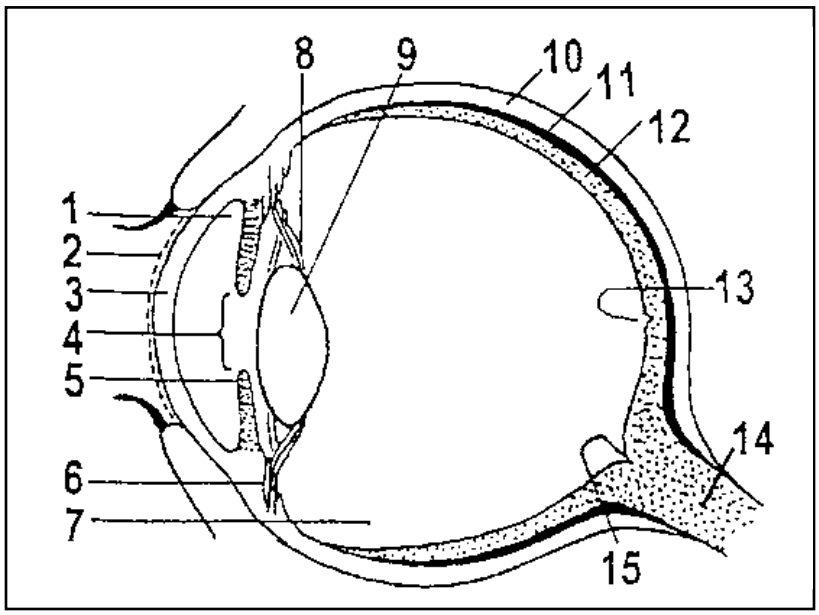
- **Sensorineural hearing loss:** This refers to insensitivity of the cochlea due to abnormalities of the hair cells of the organs of Corti. It may also be due to a lack of function of the auditory nerve system.
- **Noise-induced hearing loss:** Hearing loss that is as a result of excessive noise levels (3 000 to 6 000 Hz). Common sources of excessive noise levels include very loud music, power tools, factory machinery, working on jet engines and guns.
- **Genetic hearing loss:** Dominant and recessive genes exist that can cause partial to total impairment. A dominant gene will persist across generations even when inherited from only one parent. A recessive gene will only result in impairment when it is inherited from both parents.
- **Diseases that could cause hearing loss or impairment:** Some diseases cause damage to the physical structures in the ears. Examples of diseases are:
  - **Measles** causes auditory nerve damage.
  - **Meningitis** causes damage to the auditory nerve or the cochlea.
  - **Autoimmune disease** causes damage to the cochlea.
  - **Mumps** could result in sensorineural hearing loss in one or both ears.
  - **Foetal alcohol syndrome** has been reported to cause hearing loss in up to 65% of babies born to women that abuse alcohol.
  - **Syphilis** is a sexually transmitted disease that is transmitted from an infected woman to her unborn foetus. Studies show that up to 35% of the infected babies will eventually become deaf.
- **Physical trauma:** This is when there is **physical damage** to the eardrum, the ossicles in the middle ear, the cochlea or the brain centre that processes auditory information.

Hearing aids and cochlear implants: a hearing aid is an apparatus that is worn in or behind a person"s ear. The apparatus **amplifies sound**, so that the person is able to **hear better**. Hearing aids are generally used when hearing deteriorates gradually. A cochlear implant is a **surgically implanted electronic device** that stimulates the auditory nerves with an electronic field, inside the cochlea. Cochlear implants are used when a person has severe hearing loss or impairment. It is a very expensive procedure and requires much therapy to assist the deaf person to become accustomed to the devise.

SECTION C: HOMEWORK

QUESTION 1: 35 minutes

Study the diagram of the eye and answer the questions that follow:



1.1. Name the parts numbered 1 to 15. (15)

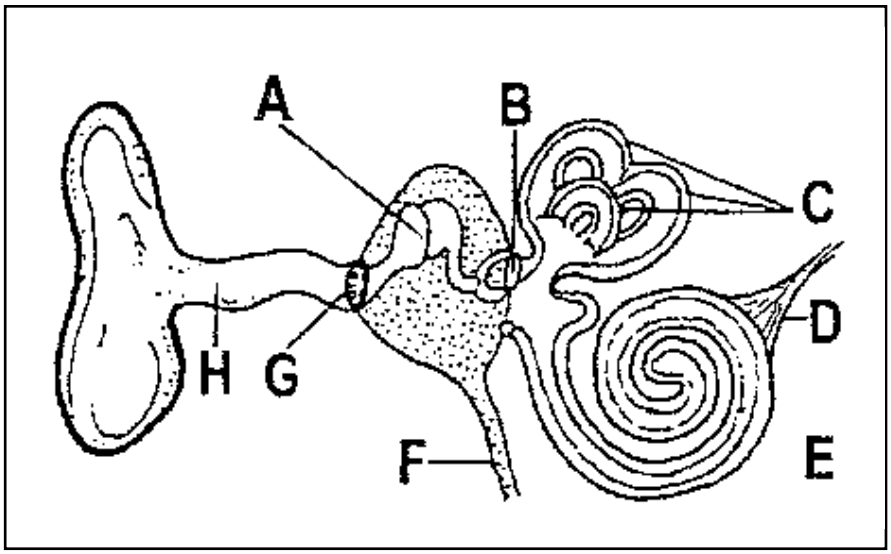
1.2. Name the functions of the iris, choroid and lens. (12)

1.3. Label, in the correct order, all those parts that would indicate the path of light stimulus from the point where it enters the eye until it reaches the brain. Provide the number and the name of each structure in order. (8)

[35]

QUESTION 2

Study the diagram below and answer the questions that follow:



2.1. State the letter and name of the part associated with each of the following statements:
a) the part that secretes cerumen (2)
b) the part that intensifies sound waves (2)
c) the part that carries impulses to the brain (2)
d) the part that is responsible for balance (2)
e) the part that ensure that the air pressure is equal on both sides of the eardrum (2)

2.2. Explain what would happen if part F were blocked. (4)

2.3. The ear is responsible for maintaining balance. Discuss this statement with regard to the process and function of the semi-circular canals, the urticulus and the sacculus. (17)

2.4. Describe the sequence of events that occurs between the entry of a sound wave into the ear canal until it reaches the auditory nerve. (14)

2.5. Briefly discuss what a middle ear infection is, and how this is solved. (10)

[55]

SECTION D: SOLUTIONS AND HINTS TO SECTION A

QUESTION 1

1.1. B
1.2. C
1.3. C
1.4. A
1.5. C
1.6. D
1.7. C
1.8. C
1.9. B
1.10. B
1.11. D
1.12. B
1.13. A
1.14. C
1.15. C (15 x 1) **[15]**

QUESTION 2

- In bright light the pupil size was small (1)
- to reduce the amount of light entering the eye (1)
- Now in dimly lit room the pupil size has to increase (1)
- to increase the amount of light entering the eye (1)

[4]

QUESTION 3

3.1. 1 = cornea ✓ 2 = pupil ✓ 3 = suspensory ligaments ✓ (3)

3.2. Number 2 ✓, the iris ✓ (2)

3.3. The radial muscles of the iris relax ✓ (1)
the circular muscles contract✓ (1)
this will cause the pupil to constrict✓ (1)
allowing less light to enter into the eye ✓ (1)

3.4. Part 4 = the lens focuses the light rays onto the retina at the back of the eye ✓ (1).
Part 7 = the viterous body / viterous humor is part of the refracting medium of the eye and helps to maintain the shape of the eyeball ✓ (1)

3.5. Number 6 = the ciliary muscles in the ciliary body ✓✓ (2)

3.6. - Releasing the tension on the suspensory ligaments so they become relaxed ✓ (1)
- The tension on the elastic lens becomes less✓ (1)
- The lens becomes rounder/more convex ✓ (1)
- This increases the refraction of light through the lens so that the image focuses on the retina ✓ (1)

[18]

QUESTION 4

4.1 B : Semi-circular canals ✓✓ (2)
G : Auditory meatus/canal ✓✓ (2)

4.2 C : Transmits pressure waves to the perilymph of the inner ear ✓✓ (2)
E: Prevents pressure build-up of sound waves / distortion /eases vibrations out of the inner ear/ absorbs vibrations✓✓ **(Any 2)** (2)

4.3 (a) -A buzzing sound is caused by a difference in the pressure between the and the middle ear ✓ (1)
- Swallowing opens / closes the Eustachian tube ✓ (1)
to equalise the pressure ✓ (1)

(b) - To amplify ✓ (1)
- Sound ✓ (1)

4.4 (a) No ✓ (1)
(b) It is not moveable or flexible ✓
for more accurate collection of sound ✓
for finding the direction ✓that the sound is coming from ✓ **(Any 2)** (2)

4.5 Both receive ✓ (1) stimuli✓ (1) and convert ✓ (1) to impulses ✓ (1)
which they send ✓ (1) through the sensory neuron✓ (1) **(Any 2 x 2)** **(4)**

4.6 Larger surface area✓ (1)
to accommodate more receptors✓ (1)
fits into smaller area / takes up less space ✓ (1)
(Any 2) **(2)**

[18]

SESSION 7: TOPIC1: CONSOLIDATION - EXAMINATION PAPER 1

Learner Note: Please stick to the time limits. Read the questions carefully and underline the operative words. Make sure that you understand what is being asked. For multi-choice questions, read the question and cover the option answers. Think about the question and think of the correct answer; then uncover the possible answers and find your answer there. If you are given possible answers that are combinations of answers, then read each option carefully and decide if it is correct or not. Correct, place a ✓ at the end of the sentence/word. If you think it is not correct, then place an X after the sentence/word. When there is a diagram**, first** label the diagram and then look at the questions that follow. If you are asked to tabulate – you MUST draw a table. Make sure that you compare the SAME characteristics each time. If you do not draw a table, you will lose marks. When asked to draw a graph, make sure that you know whether it is a line graph, bar graph, histogram or pie chart that you must draw. Always write the heading, label the x and y axes and include the units for the axis in brackets – this will already give you 4 marks. You must work fast. If you cannot remember an answer, leave space and carry on. You can always come back to that question when you are done.

VERY IMPORTANT: The new exam format is as follows:

Paper 1:

- DNA – code of life and RNA
- Cell division – Meiosis
- Genetics and genetic engineering
- Biodiversity - theories of the origin of plants and animals
- Biodiversity – theories of human evolution and alternative explanations.

Paper 2:

- Population ecology, community structure and ecological succession
- Plant responses to the environment (plant hormones and tropisms)
- Animal responses to the environment – nervous system, endocrine system, thermoregulation, the human eye and ear
- General reproduction and flowers as reproductive structures
- Human reproduction

SECTION A: TYPICAL EXAM QUESTIONS

QUESTION 1: 10 minutes *(Taken from DoE Exemplar 2011 Paper 1)*

Various options are provided as possible answers to the following questions. Choose the correct answer and write only the letter (A–D) next to the question number.

1.1. In humans, the allele for brown eyes is dominant over the allele for blue eyes. The probability of two parents, heterozygous for brown eyes, having children with blue eyes is …

A 75%.
B 50%.
C 25%.
D 0%.

1.2. The nitrogenous base which replaces thymine in a RNA molecule is …

A guanine.
B uracil.
C adenine.
D cytosine.

1.3. Human blood type is determined by three different alleles known as IA, IB and i. The IA and IB alleles are codominant and the i allele is recessive.

The possible human phenotypes for blood groups are type A, type B, type AB and type O.

Blood type A and B individuals can be either homozygous (IAIA or IBIB respectively) or heterozygous (IAi or IBi respectively).

A woman with type A blood and a man with type B blood could have offspring with the following blood types:

A A and B only
B B and AB only
C O only
D A, B, AB or O

1.4. During an investigation, the DNA of an animal cell was analysed in a laboratory and the results are shown in the table below.

BASE COMPOSITION			
X	Adenine	Y	Z
30,0%	20,0%	30,0%	20,0%

Which of the following is a CORRECT identification of the bases called X, Y and Z?

	X	Y	Z
A	Cytosine	Guanine	Thymine
B	Adenine	Thymine	Cytosine
C	Thymine	Cytosine	Adenine
D	Guanine	Adenine	Thymine

1.5. Assume that plant A has an unknown genotype but shows the dominant trait. This means that plant A could be either homozygous or heterozygous for that trait. To determine which of these two genotypes apply, plant A can be crossed with another plant showing the recessive trait.

Which of the following predictions can be made by studying the offspring from such a cross of complete dominance?

A If all the offspring show the dominant phenotype, then plant A is heterozygous.
B If all the offspring show the recessive phenotype, then plant A is homozygous.
C If 50% of the offspring show the dominant phenotype and 50% of the offspring show the recessive phenotype, then plant A is heterozygous.
D If all the offspring show an intermediate characteristic, then plant A is heterozygous.

1.6. If all 18 nucleotides of a DNA strand code for amino acids, how many amino acids will be present in the polypeptide that is formed?

A 9
B 18
C 7
D 6

QUESTIONS 1.1.7 and 1.1.8 refer to the information below.

Some characteristics are controlled by more than one gene. Human skin colour is controlled by at least three genes (three different pairs of alleles). There is incomplete dominance between the allele for dark pigmentation and the allele for light pigmentation. A heterozygous individual will, therefore, have an intermediate colour. Assume that the alleles A, B and C control dark pigmentation and the alleles a, b and c control light pigmentation. A person with the genotype AABBCC would have a very dark skin colour and someone with the genotype aabbcc would have a very light skin colour.

1.7. The phenomenon whereby a characteristic is controlled by more than one pair of alleles is called …
A incomplete dominance.
B complete dominance.
C polygenic inheritance.
D dihybrid cross.

1.8. Which ONE of the following is a possible heterozygous combination of the three genes for skin colour?
A AABBCC
B AaBbCc
C aabbcc
D ABC

1.9. Study the following statements:
1 The same characteristic has more than two different alleles for the same gene.
2 The different alleles for the same characteristic are on the same locus.
3 The alleles for the same characteristic are on different loci.
4 More than one gene controls a characteristic.

The following combination of statements refer to multiple alleles:
A 1, 2, 3 and 4
B 1 and 2 only
C 1, 2 and 3 only
D 3 and 4 only

1.10. During protein synthesis, the following steps take place in order:
A DNA unwinds, transcription by mRNA, anticodons produced by tRNA, amino acids combine to form polypeptides
B DNA unwinds, anticodons produced by mRNA, transcription by tRNA, amino acids combine to form polypeptides
C DNA unwinds, transcription by mRNA, codons produced by tRNA, amino acids combine to form polypeptides
D DNA unwinds, transcription by mRNA, anticodons produced by rRNA, amino acids combine to form polypeptides

(10 x 1) [10]

QUESTION 2: **8 minutes** *(Taken from DoE Exemplar 2011 Paper 1)*

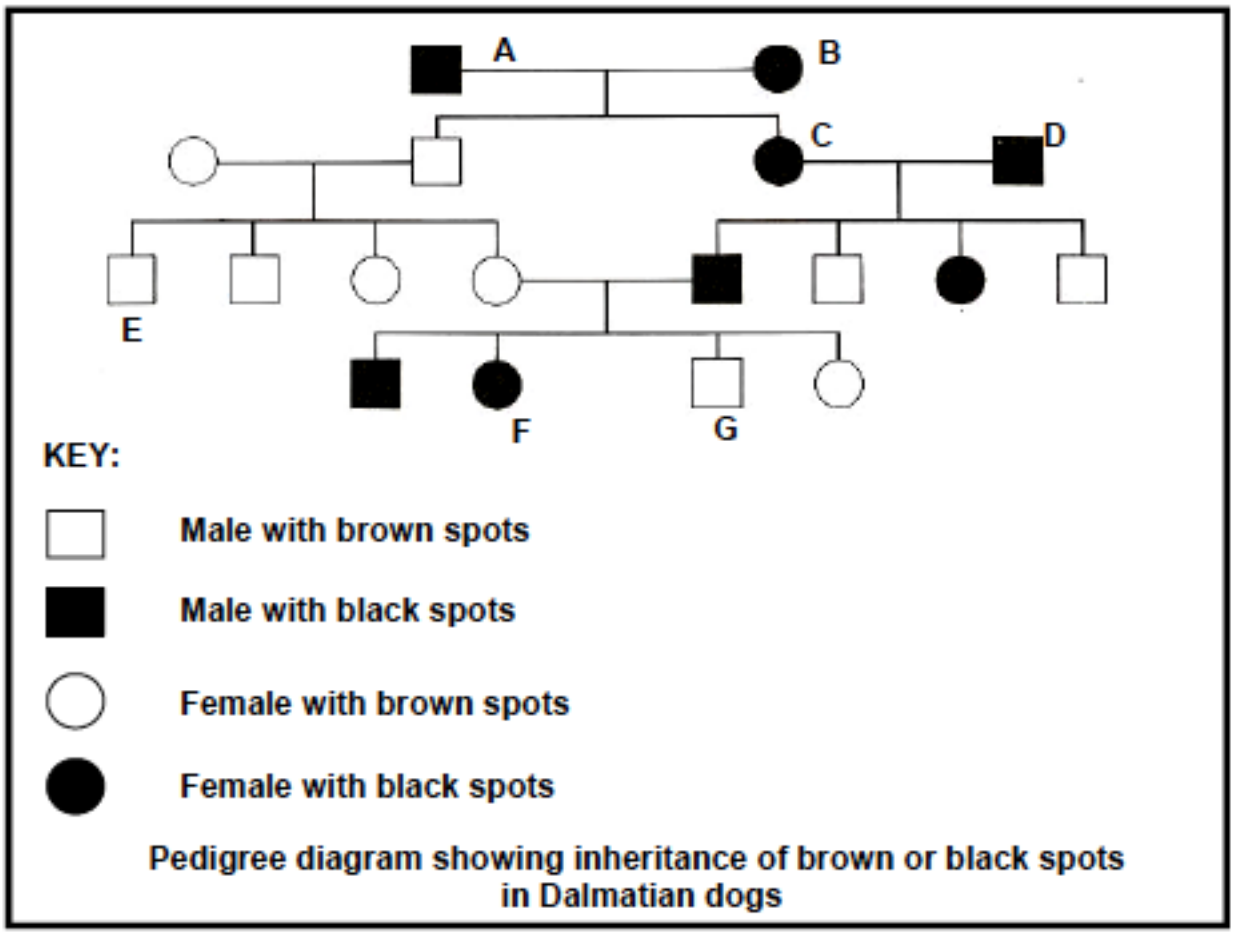
Indicate whether each of the statements in COLUMN 1 applies to A only, B only, both A and B or none of the items in COLUMN 2. Write A only, B only, both A and B or none next to the question number.

COLUMN 1	COLUMN 2
2.1 Provides genetic evidence for the 'out of Africa' hypothesis	A: Mitochondrial DNA B: DNA from X chromosomes
2.2 Organism(s) which is/are bipedal	A: Homo habilis B: Australopithecus africanus
2.3 Proposed natural selection as an explanation of evolution	A: Wallace B: Lamarck
2.4 Genetic disorder(s) which lead(s) to absence of bloodclotting factors	A: Down's syndrome B: Haemophilia
2.5 Natural shape of a DNA molecule	A: Double helix B: Single-coiled strand
2.6 Evidence for evolution	A: Biogeography B: Fossil records
2.7 Fossil(s) found in South Africa	A: Australopithecus sediba ('karabo') B: 'Nutcracker Man'
2.8 Transfer of a gene for drought resistance from one species to another	A: Cloning B: Genetic engineering

(8 x 1) [8]

QUESTION 3: **10 minutes** *(Taken from DoE Exemplar 2011 Paper 1)*

Study the pedigree diagram on the following page showing the inheritance of black or brown spots in Dalmatian dogs. The colour of the spots is determined by a gene which has two alleles. The allele for black spots (B) is dominant over the allele for brown spots (b).



Pedigree diagram showing inheritance of brown or black spots in Dalmatian dogs

3.1 Name the colour and gender of each of the following:
(a) B (2)
(b) G (2)

3.2 Name the genotype of:
(a) A (1)
(b) F (1)
(c) E (1)

3.3 If C and D have another puppy, what is the percentage probability of each of the following:
(a) The puppy being female (1)
(b) The puppy having black spots (2)
[10]

QUESTION 4: 9 minutes *(Taken from DoE Exemplar 2011 Paper 1)*

People with the phenotype known as 'hitch-hiker's thumb' are able to curve their thumb backwards without assistance so that it forms an arc shape. The allele for 'hitch-hiker's thumb' is dominant over the allele for the normal thumb.

After making their own observations, grade 12 learners formulated the following question around which they were then required to develop an investigation:

Is the 'hitch-hiker's thumb' more common than the normal thumb in a population?

4.1. Formulate a hypothesis for this investigation. (3)
4.2. State FOUR planning steps for the investigation. (4)
4.3. Name the scientist who formulated the concept of dominance after experimenting with pea plants. (1)
4.4. State TWO ways of ensuring that the findings of the investigation are reliable. (2)
[10]

QUESTION 5: 7 minutes *(Taken from DoE Exemplar 2011 Paper 1)*

Study the diagram of a phase in meiosis below and answer the questions that follow.

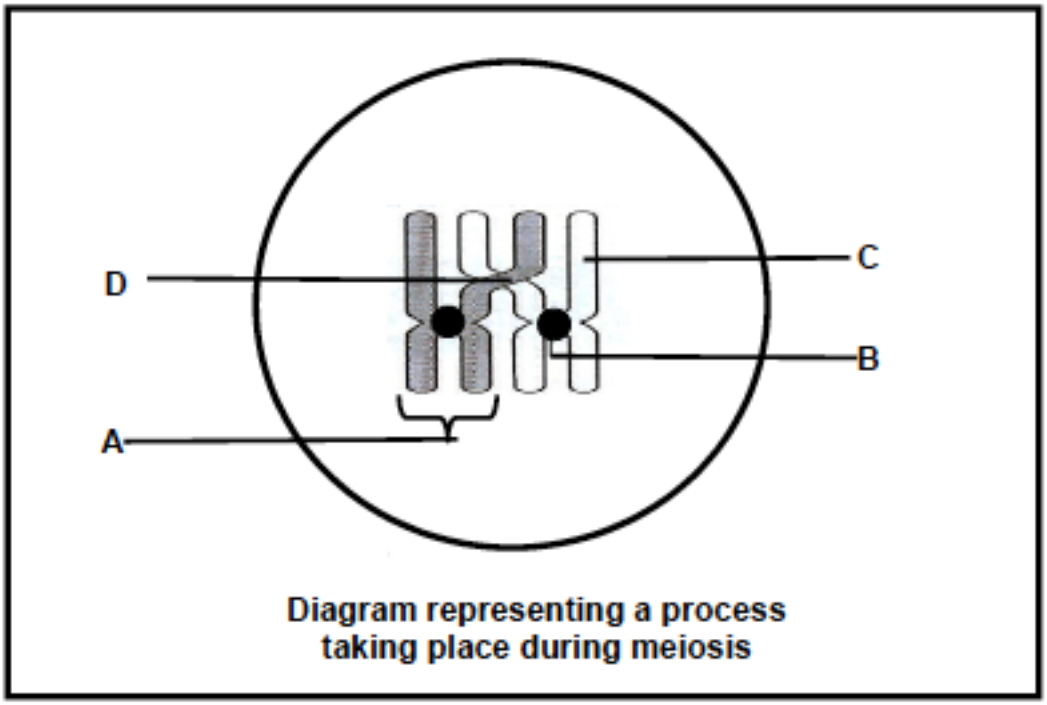
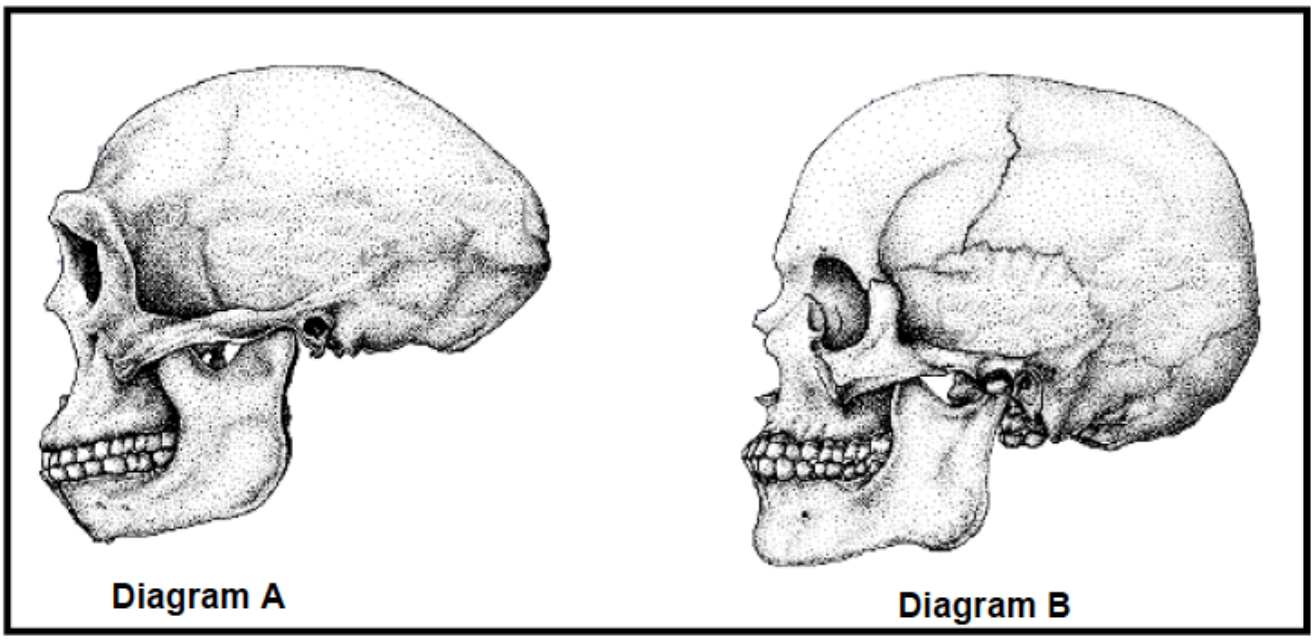


Diagram representing a process taking place during meiosis

5.1. Give labels for parts B, C and D. (3)
5.2. Name the process in meiosis that is illustrated in the diagram above. (1)
5.3. State ONE importance of the process named in Question 5.2. (1)
5.4. Draw a diagram of the structure labelled A to show its appearance immediately after the process named in Question 5.2. (2)
[7]

QUESTION 6: 12 minutes *(Taken from DoE Exemplar 2011 Paper 1)*

Diagrams A and B on the following page illustrate the skulls of Homo sapiens and Homo erectus. The diagrams are drawn to scale.



6.1. Which of the diagrams (A or B) represents the following:
(a) *Homo sapiens* (1)
(b) *Homo erectus* (1)

6.2. Tabulate TWO visible differences between the skulls in diagrams A and B that represent changes in the structure that characterises human evolution. (5)

6.3. Describe the significance of *Homo erectus* to the 'out of Africa' hypothesis. (3)

6.4. List FOUR similarities between *Homo sapiens* and other primates. (4)

[14]

SECTION B: HOMEWORK

QUESTION 1: 10 minutes *(Various sources)*

1.1. Micro-evolution is a term that describes …
A. the process by which new genera and families of organisms are formed.
B. small changes that occur in the genotypes of organisms within the same species.
C. changes that can be seen without a microscope.
D. an increase in the size of individuals of a population over a long period of time.

1.2. According to Charles Darwin, organisms that will be most successful biologically, are those that …
A. are best adapted to their environment.
B. are the largest in the population.
C. reproduce the slowest.
D. do not change.

1.3. The evidence that related species in similar biomes across the world developed from a common ancestor, is obtained from …
A. micro-evolution.
B. embryology.
C. biochemistry.
D. biogeography

.

1.4. Extinction occurs….
E. When a species is unable to survive in their environment.
F. When only a few of a species survives.
G. When a species goes into hiding until conditions improve.
H. The gradual depletion of a population.

1.5. The fossil records reflect that the first meteor collision occurred ….
A. About 5 billion years ago
B. About 8 billion years ago
C. About 3,5 billion years ago
D. About 2,5 billion years ago

1.6. Which ONE of the following is an example of a pair of analogous structures?
A. A whale's flipper and a bat's wing
B. A bird's wing and an insect's wing
C. A hawk's wing and a sparrow's wing
D. A dog's leg and a horse's leg

1.7. The following is needed for new species to form….
A. an extinction event
B. an homologous structure
C. an analogous structure
D. reproductive isolation

1.8. Macroevolution is a term that describes …
A. an increase in the size of individuals of a population over a long period of time.
B. the process by which new genera and families of organisms are formed.
C. a gradual change in the number of species found in the fossil record.
D. changes that can be seen without the need for a microscope.

1.9. Which of the following is NOT a fossil?
A. *Tyrannosaurus rex* skull, 65 million years old
B. Oil formed from microorganisms, 150 million years old
C. Stone tool made by ancestors of human, 2,6 million years ago
D. 195 million-year-old dinosaur footprint imprinted in rock

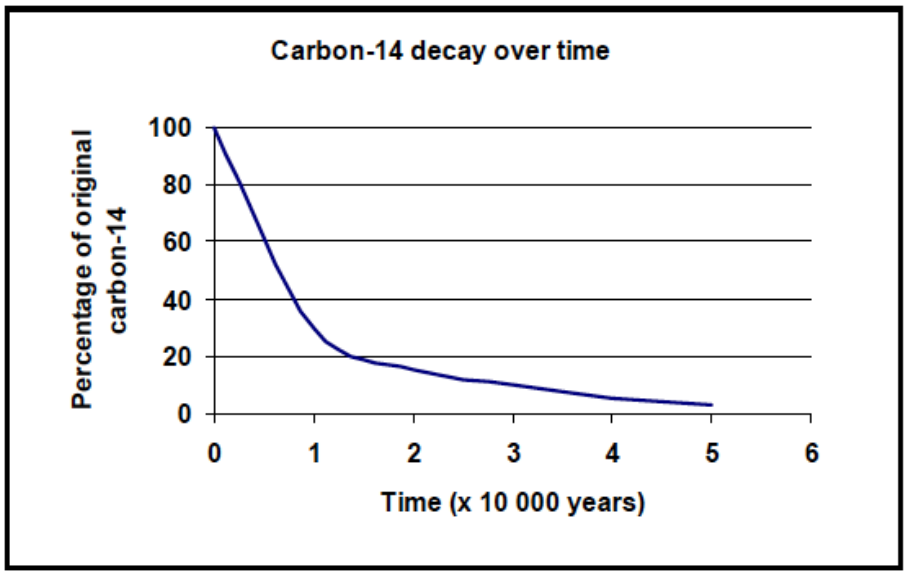
1.10. The theory of evolution based on the principle of use and disuse was proposed by …
A. Darwin.
B. Mendel.
C. Lamarck.
D. Wallace.

1.11. Structures that perform similar functions but have different evolutionary origins are called … structures.
A homologous
B homozygous
C analogous
D heterozygous

1.12. Study the following characteristics:
1. Olfactory brain centres reduced
2. Bare fingertips
3. Flat face (not prognathous)
4. Always bipedal

Which combination of characteristics makes humans different from other primates?
A 2, 3 and 4 only
B 1, 2 and 3 only
C 3 and 4 only
D 1, 2 and 4 only

1.13. One way to determine the age of a fossil is to use the rate of decay of carbon-14. The graph below shows how carbon-14 decays over time.

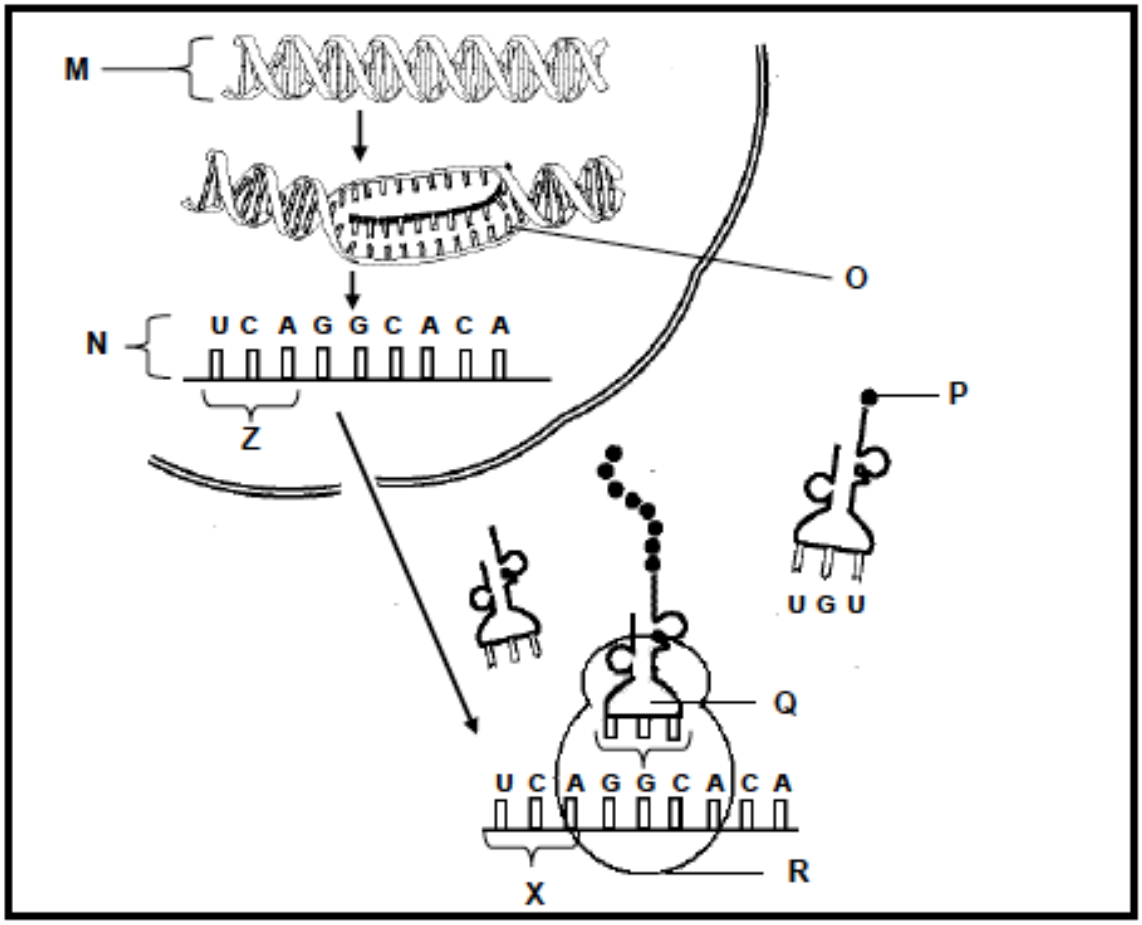


A fossil snail was found to have 30% of its carbon-14 remaining. According to the above graph, the age of the fossil is approximately …
A 5 000 years.
B 15 000 years.
C 10 000 years.
D 20 000 years.

1.14. An example of non-random mating is ....
A. artificial selection.
B. inbreeding.
C. natural selection.
D. macroevolution. (14 x 1) [14]

QUESTION 2: 12 minutes *(Taken from DoE Feb/March 2011 Paper 1)*

The diagrams below represent the process of protein synthesis.



2.1. Identify compound M and organelle R. (2)
2.2. Write down the sequence of the FIRST THREE nitrogenous bases on the DNA strand that led to the formation of Z. (2)
2.3. Name the part/stage of protein synthesis that is illustrated in O. (1)

2.4. The table below shows the base triplets of DNA and the amino acid each codes for.

Base triplet of DNA	Amino acid coded for
AGT	Serine
CCG	Glycine
TGT	Threonine
GTA	Histidine
CAA	Valine
TCC	Arginine
ACA	Cysteine

With reference to the diagram in QUESTION 2 and the table above:

(a) Name the amino acid labelled P. (2)

(b) State the base sequence of the molecule labelled Q. (2)

(c) What name is given to the triplet of tRNA bases that codes for each amino acid? (1)

(d) Describe how the composition of the protein molecule changes if the base sequence at X is UGU instead of UCA. (2)

[12]

SECTION C: SOLUTIONS AND HINTS TO SECTION A

QUESTION 1

1.1	C	1.5	C	1.9	B
1.2	B	1.6	D	1.10	A
1.3	D	1.7	C		
1.4	A	1.8	B		

(10 X 1) **[10]**

QUESTION 2

2.1	A only	2.5	A only
2.2	Both A and B	2.6	Both A and B
2.3	A only	2.7	A only
2.4	B only	2.8	B only

(8 x 1) **[8]**

QUESTION 3

3.1 (a) Female ✓black spots ✓ (2)

(b) Male ✓brown spots ✓ (2)

3.2. (a) Bb ✓ (1)

(b) Bb ✓ (1)

(c) bb ✓ (1)

3.3. (a) 50% ✓ (1)

(b) 75% ✓ (2)

[10]

QUESTION 4

4.1. Most ✓*/*fewer learners ✓in the population have the 'hitchhiker's thumb' trait ✓
OR
The number of learners ✓that have the 'hitch-hiker's thumb' ✓is the same ✓ as the number that have the normal thumb (3)

4.2. - Seek permission from participants to collect the data ✓
- Determine the sample size ✓
- Determine how to do random sampling ✓
- Train data capturers/trial collecting ensuring that all are able to identify the traits correctly ✓
- Designing a table to record the data ✓ **max 4 marks** (4)

4.3. Gregor Mendel ✓ (1)

4.4. - Repeat the investigation ✓
- Do investigation in other populations ✓
- Increase the sample size ✓ **max 2 marks** (2)

[10]

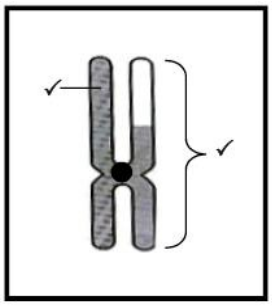
QUESTION 5

5.1. B – Centromere ✓
C – Chromatid ✓
D – Chiasma ✓ (3)

5.2. Crossing over ✓ (1)

5.3. Mixing of genetic material introduces variation ✓*/*gametes are different from each other (1)

5.4



Mark allocation:
Chromosome drawn ✓
Chromosome has shaded and unshaded part in the correct proportion ✓ (2)

[7]

QUESTION 6

6.1 (a) B ✓ (1)

(b) A ✓ (1)

6.2

DIAGRAM A	DIAGRAM B
1. Brow ridges more pronounced	1. Brow ridges less pronounced
2. Smaller cranium/brain	2. Larger cranium/brain
3. Jaw protrudes (prognathous)	3. Jaw does not protrude
4. No obvious chin	4. Pronounced chin
5. Elongated cranium	5. Shorter cranium
6. Zygomatic arch well developed	6. Zygomatic arch less developed

(Any two matching differences = 4 + 1 for table) (5)

6.3. - *H.erectus* was the first *Homo* species ✓to move out of Africa.
- Their large bodies ✓and well adapted pelvic girdles ✓made them better bipedal runners and walkers ✓over long distances than H.sapiens **Max 3** (3)

6.4. - Large brains/skulls compared to their body mass ✓
- Olfactory brain centres reduced/reduced sense of smell ✓
- Parts of the brain that process information from the hands and eyes are enlarged ✓
- Eyes in front/binocular vision/stereoscopic vision ✓
- Eyes with cones/colour vision ✓
- Freely rotating arms ✓
- Long upper arms ✓
- Elbow joints allow rotation of forearm ✓
- Rotate hands at least 180°. ✓
- Flat nails instead of claws/bare finger tips ✓
- Opposable thumbs which work in opposite direction to their fingers ✓
- Upright posture ✓
- Sexual dimorphism/distinct differences ✓
- Two teats only ✓ (Any 4) (4)

[14]

SESSION 7: TOPIC 2: CONSOLIDATION – EXAMINATION PAPER 1

Learner Note: Please stick to the time limits. Read the questions carefully and underline the operative words. Make sure that you understand what is being asked. For multi-choice questions, read the question and cover the option answers. Think about the question and think of the correct answer; then uncover the possible answers and find your answer there. If you are given possible answers that are combinations of answers, then read each option carefully and decide if it is correct or not. Correct, place a ✓ at the end of the sentence/word. If you think it is not correct, then place an X after the sentence/word. When there is a diagram**, first** label the diagram and then look at the questions that follow. If you are asked to tabulate – you MUST draw a table. Make sure that you compare the SAME characteristics each time. If you do not draw a table you will lose marks. When asked to draw a graph – make sure that you know whether it is a line graph, bar graph, histogram or pie chart that you must draw. Always write the heading, label the x and y axes and include the units for the axis in brackets – this will already give you 4 marks. You must work fast. If you cannot remember an answer, leave space and carry on. You can always come back to that question when you are done. **PLEASE do all the homework questions.**

VERY IMPORTANT: The new exam format is as follows:

Paper 1:

- DNA – code of life and RNA
- Cell division – Meiosis
- Genetics and genetic engineering
- Biodiversity - theories of the origin of plants and animals
- Biodiversity – theories of human evolution and alternative explanations.

Paper 2:

- Population ecology, community structure and ecological succession
- Plant responses to the environment (plant hormones and tropisms)
- Animal responses to the environment – nervous system, endocrine system, thermoregulation, the human eye and ear
- General reproduction and flowers as reproductive structures
- Human reproduction

SECTION A: TYPICAL EXAM QUESTIONS

QUESTION 1: **4 minutes** *(Taken from DoE Exemplar 2011 Paper 1)*

Give the correct biological term for each of the following descriptions. Write only the term next to the question number.

1.1. The pair of chromosomes in a diploid individual that have the same shape and size, and control the same set of characteristics.
1.2. The type of genetic cross where an intermediate phenotype is expressed in F1, while parental phenotypes reappear in F2.
1.3. The law that accounts for gametes having only one allele for a characteristic due to a separation of the pair of alleles during meiosis.
1.4. A ring of DNA found in bacteria that is used in the production of insulin.
1.5. A study of the transmission of characteristics from parents to offspring.
1.6. Chromosome condition of a cell resulting from meiosis, having only one set of chromosomes. (6 x 1) [6]

QUESTION 2: **12 minutes** *(Taken from DoE Exemplar 2011 Paper 1)*

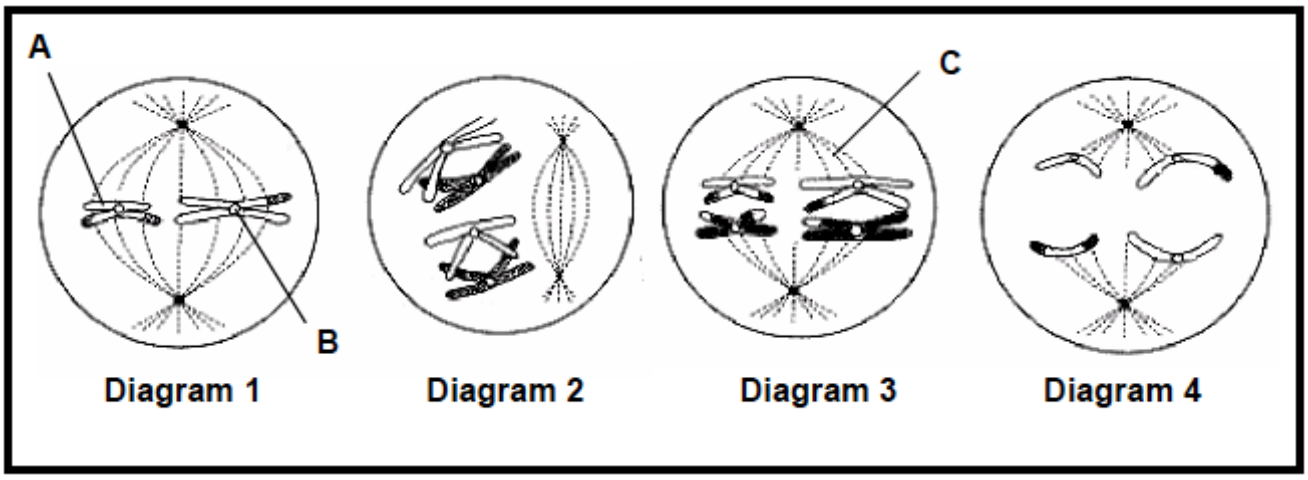
Study the genotypes and phenotypes below that show how the alleles for colour-blindness are inherited. X and Y represent sex chromosomes. A carrier does not suffer from colour-blindness but can pass the allele for colour-blindness to their children.

NAME OF PERSON	GENOTYPE	PHENOTYPE
Lindi	X^BX^B	Normal female
Beauty	X^BX^b	Carrier female
Sarah	X^bX^b	Colour-blind female
Paul	X^BY	Normal male
Thabani	X^bY	Colour-blind male

2.1. State why colour-blindness is referred to as a sex-linked disorder? (2)
2.2. Is colour-blindness caused by a dominant or a recessive allele? (1)
2.3. Explain your answer to QUESTION 2.2 above. (2)
2.4. Explain why Thabani is colour-blind. (2)
2.5. Sarah and Paul marry and have two children, a son and a daughter. Represent this genetic cross by using the information in the table above to determine the genotypes and phenotypes of the son and the daughter. (6)
[13]

QUESTION 3: **14 minutes** *(Taken from DoE Feb/Mar 2011 Paper 1)*

Study the following diagrams representing different phases of meiosis:



3.1. Label structures A, B and C. (3)

3.2. Which phase is represented by:

(a) Diagram 1 (1)

(b) Diagram 2 (1)

3.3. Write down the numbers of the diagrams to show the correct sequence in which the phases occur. (2)

3.4. Tabulate THREE differences between the first and second stages of meiosis. (7)

3.5. Name and explain TWO processes/mechanisms that ensure that the gametes produced at the end of meiosis are genetically different from each other. (4)

[15]

QUESTION 4: **5 minutes** *(Taken from DoE Nov 2010 Paper 2)*

Indicate whether each of the statements in COLUMN 1 applies to A only, B only, Both A and B, or None of the items in COLUMN 2. Write A only, B only, both A and B, or None next to the question number.

COLUMN 1	COLUMN 2
4.1. Fossil(s) of *Australopithecus* found in South Africa	A: Mrs Ples B: Lucy
4.2. Similarities between *Homo sapiens* and apes	A: Opposable thumb B: Two mammary glands
4.3. Evidence from comparative embryology supporting the theory of evolution	A: Similar sequence of genes B: Presence of embryonic gill slits
4.4. Study of ancient humans and their cultural activities	A: Biogeography B: Archaeology
4.5. Possible cause(s) of mass extinctions	A: Volcanic eruptions B: Freezing of parts of the earth
4.6. Mutation(s) that influence(s) biodiversity	A: Neutral B: Lethal

[6]

QUESTION 5: 20 minutes *(Taken from DoE Exemplar 2011 Paper 1)*

5.1. The information and question below are based on natural selection.

> Antibiotics are used to kill bacteria that cause diseases. In 1972, there was an epidemic of typhoid in Mexico. Normally, an antibiotic called chloramphenicol cured it. This time the antibiotic did not work and more than 14 000 people died. Eventually, doctors found an antibiotic that did work.

Using your understanding of natural selection, explain why chloramphenicol did not control the epidemic mentioned above. (5)

5.2 Study the information below on an investigation based on artificial selection and answer the questions that follow.

> In 1965, an investigation was started to find out if artificial selection could increase the milk yield of cows. In one set of cows, artificial selection for high milk yield was carried out in each generation. This set of cows was called the SELECTED LINE. In the other set of cows, there was no artificial selection. This set was called the CONTROL LINE.
>
> Both sets of cows were kept under the same conditions. The average milk yield from both sets of cows that were born in each year from 1965 to 1990, was recorded. The results are shown in the table below.

YEAR OF COW'S BIRTH	1965	1970	1975	1980	1985	1990
Selected line: average milk yield (litre per kg)	7,2	8,2	8,8	10,0	9,7	11,0
Control line: average milk yield (litre per kg)	7,2	7,1	6,0	6,8	6,6	5,8

5.2.1. Plot line graphs, on the same set of axes, using the information in the table above. (12)

5.2.2. Calculate the change in average milk yield (litre per kg) between 1965 and 1990 for the selected line. Show your workings. (3)

[20]

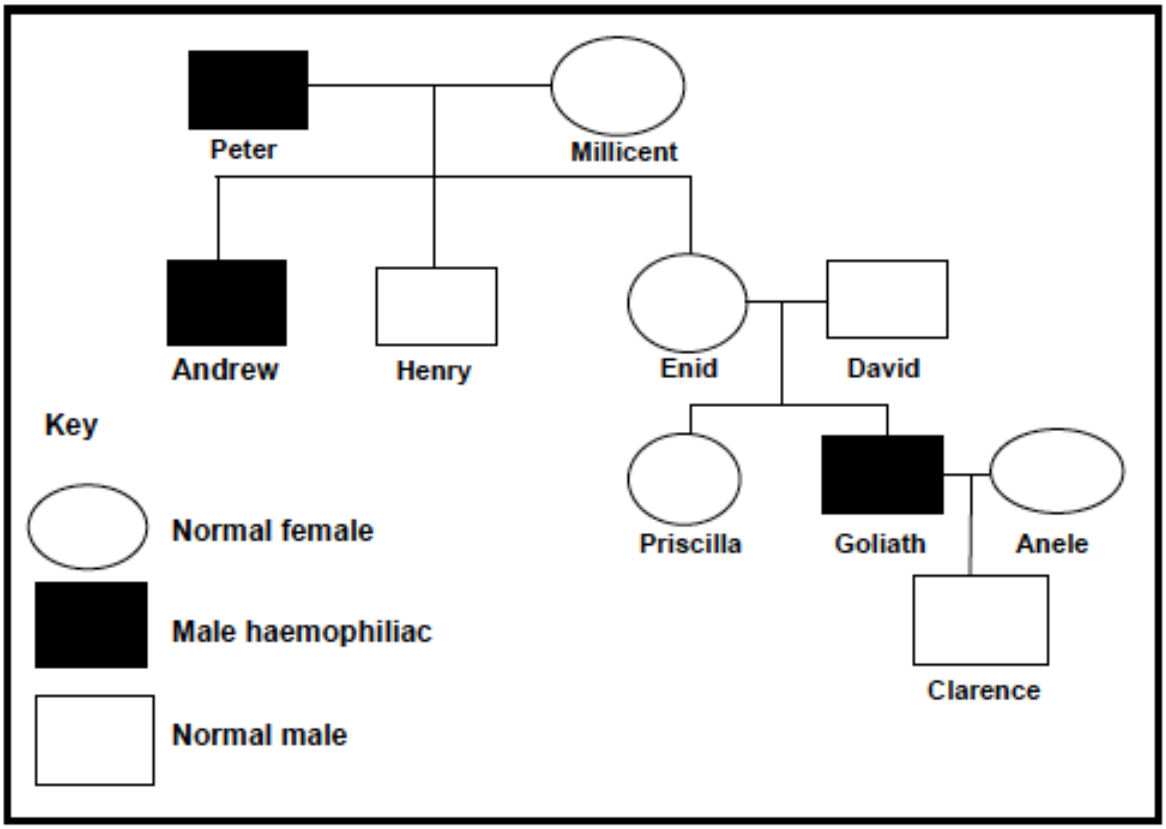
SECTION B: HOMEWORK

QUESTION 1: **20 minutes** *(Taken from DoE Exemplar 2011 Paper 1)*

Describe how proteins are formed in a cell and explain the impact of the two types of gene mutations on the formation of proteins. Content: (17) Synthesis: (3) [20]

QUESTION 2: **8 minutes** *(Taken from DoE Feb/Mar 2011 Paper 1)*

Study the pedigree diagram of a family where some individuals have haemophilia. Haemophilia is a sex-linked disorder. Use H for normal blood clotting and h for the haemophiliac trait.



2.1. From the pedigree diagram above, state the relationship between gender and haemophilia. (2)

2.2. Write down all the possible genotypes of individuals:
(a) Peter
(b) Enid
(c) Clarence (6)
[8]

QUESTION 3: **16 minutes** *(Taken from DoE Exemplar 2011 Paper 1)*

Read the passage on the following page about the evolution of wheat and answer the questions that follow.

Thousands of years ago, wheat was one of many wild grasses producing few, small seeds. The wild wheat which has a diploid number of 14, crossed in a 'genetic accident' with a natural goat grass which also had a diploid number of 14 chromosomes. A new fertile hybrid species called Emmer, which had 28 chromosomes, was produced.

Emmer had many more seeds which were also larger than the wild wheat, and the seeds were attached to the husk in such a way that they could easily be dispersed by wind.

There was a second 'genetic accident' in which Emmer crossed with another species of goat grass which had a diploid number of 14, to produce a hybrid with 42 chromosomes.

This hybrid is the present-day bread wheat with seeds that are larger in size and number than any of the species from which it was formed. This wheat can only be propagated by humans, since the seeds are attached to the husk in such a way that they cannot easily be dispersed by wind.

[Adapted from *The Ascent of Man* by J Bronowski]

3.1. How many chromosomes are normally found in the gametes of the wild wheat plant? (1)

3.2. How many chromosomes are normally found in the offspring grown from the seed of the wild wheat plant? (1)

3.3. Name and explain the mechanism that accounts for Emmer having a chromosome number that was twice that of each of the two species from which it was formed. (5)

3.4. The term 'diploid' refers to the presence of two sets of chromosomes in a cell, whereby each chromosome is present with its homologous partner.

(a) Name the general term used to describe the presence of many sets of chromosomes in cells of the present-day bread wheat. (1)

(b) Using the information in the passage above, name TWO advantages of the concept named in QUESTION 3.4 (a). (2)

3.5. Explain why bread wheat cannot grow in the wild and must, therefore, be cultivated by humans. (2)

3.6. What type of speciation occurred in the production of the hybrid wheat? (1)

3.7. Name the other type of speciation that you have studied. (1)

3.8. State ONE difference between the two types of speciation. (2)

[16]

SECTION C: SOLUTIONS AND HINTS TO SECTION A

QUESTION 1

1.1 Homologous ✓
1.2 Incomplete dominance ✓
1.3 Law of Segregation ✓
1.4 Plasmid ✓
1.5 Genetics ✓
1.6 Haploid ✓ (6 x 1) **[6]**

QUESTION 2

2.1. The genes for colour-blindness ✓is carried on the sex chromosomes ✓ (2)
2.2. Recessive ✓ (1)
2.3. The trait only shows up if it is in the homozygous ✓recessive ✓/ not in the heterozygous state. (2)
2.4. Thabani has only one X chromosome with a recessive allele ✓for colour-blindness, the Y chromosome does not carry an allele for the characteristic ✓ (2)

P_1/parent phenotype Normal x Colour-blind✓
genotype X^BY x X^bX^b ✓

Meiosis

G/gametes X^B, Y x X^b✓

Fertilisation

OR

gametes	X^b	X^b
X^B	$X^B X^b$	$X^B X^b$
Y	$X^b Y$	$X^b Y$

1 mark for correct gametes
1 mark for correct genotypes

F_1/offspring genotype $X^B X^b$ & $X^b Y$ ✓

Phenotype carrier daughter and colour-blind son✓

Parents and offspring✓/P_1 and F_1
Meiosis and fertilisation✓

Max (6)
[13]

QUESTION 3

3.1 A – Chromatid ✓/chromosome
B – Centromere ✓
C – Spindle fibre ✓/thread (3)

3.2 (a) Metaphase 2 ✓ (1)
(b) Prophase I ✓ (1)

3.3 Diagram 2, Diagram 3, Diagram 1, Diagram 4 **(Sequence must be correct)** (2)

3.4

Meiosis I	Meiosis II
- Crossing over takes place✓	- No crossing over takes place✓
- In metaphase the chromosomes align on the equator in homologous pairs✓	- In metaphase chromosomes align singly✓ on the equator
- Reduction division✓	- No reduction division✓
- During anaphase whole chromosomes✓move towards the poles	- During anaphase chromatids✓ move towards the pole

(Mark first THREE only) any 3 x 2 + 1 table (7)

3.5 **Crossing over** ✓
Pieces of chromatids /groups of genes are exchanged ✓between homologous chromosomes
Random independent assortment of chromosomes ✓
Maternal and paternal chromosomes assort themselves randomly / independently on either side of the equator during metaphase ✓ (4)
[18]

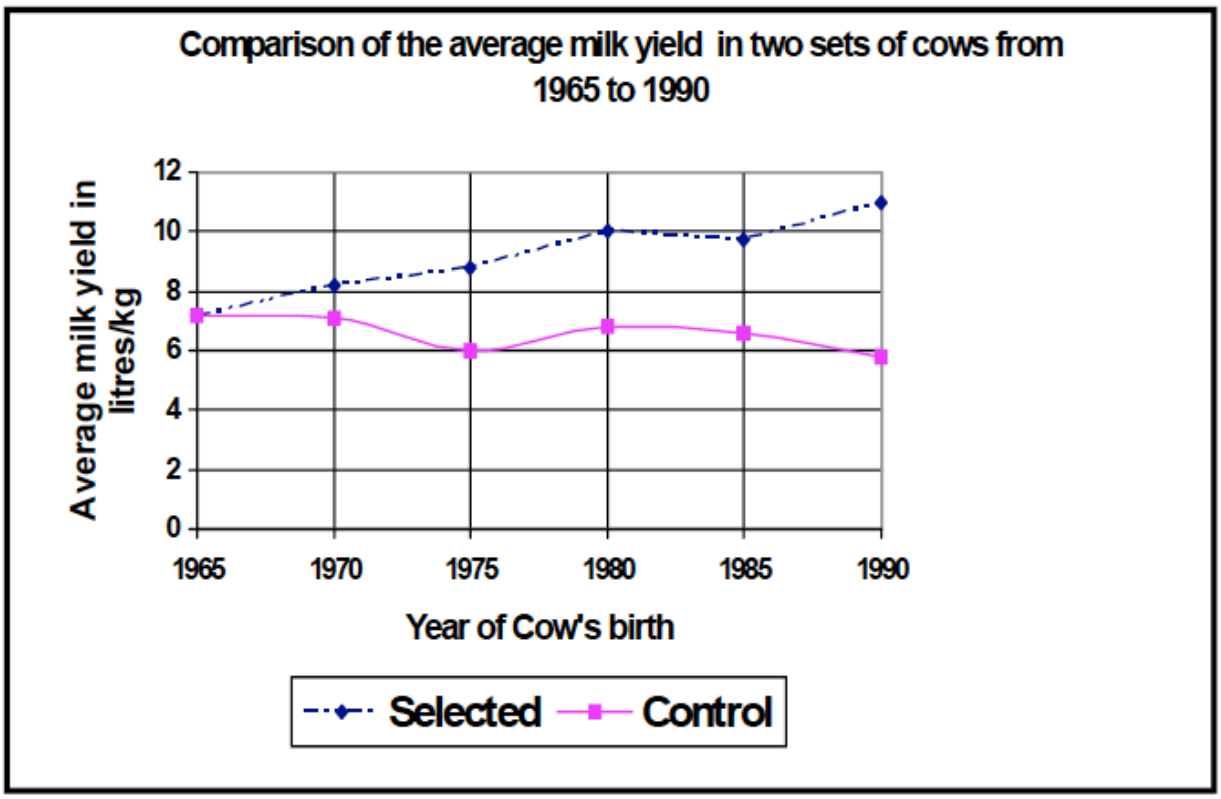
QUESTION 4

4.1. A only
4.2. Both A and B
4.3. B only
4.4. B only
4.5. Both A and B
4.6. B only (6 x 1) **[6]**

QUESTION 5

5.1 - There is a large degree of variation in the bacteria population ✓
- When chloramphenicol was first used, it killed off a large number of bacteria ✓
- But some bacteria were resistant to chloramphenicol ✓and survived ✓
- Those that survived were able to reproduce ✓
- Increasing the population of resistant bacteria ✓
- Continued use of chloramphenicol had little effect on the resistant bacteria ✓
- Hence the disease reappeared ✓ **max** (5)

5.2.1.



NOTE:
- If the wrong type of graph is drawn, marks will be lost for 'correct type of graph'
- If graphs are not drawn on the same system of axes, mark the first graph only using the given criteria.

Rubric for the mark allocation of the graph (12)

Correct type of graph	1
Caption for graph	1
Correct label for X-axis	1
Graphs labelled/key provided for 2 graphs	1
Correct label for Y-axis	1
Appropriate scale for X-axis	1
Appropriate scale for Y-axis	1
Drawing of graphs	1 – 1 to 2 points plotted correctly 2 – 3 to 4 points plotted correctly 3 – 5 to 7 points plotted correctly 4 – 8 to 10 points plotted correctly 5 – 11 to 12 points plotted correctly

5.2.2. 11, 0 – 7,2 ✓= 3,8 ✓litres/kg ✓ (3)

[20]

SESSION 8: TOPIC 1: CONSOLIDATION – EXAMINATION PAPER 2

Learner Note: Please stick to the time limits. Read the questions carefully and underline the operative words. Make sure that you understand what is being asked. For multi-choice questions, read the question and cover the option answers. Think about the question and think of the correct answer, then uncover the possible answers and find your answer there. If you are given possible answers that are combinations of answers, then read each option carefully and decide if it is correct or not. Correct, place a ✓ at the end of the sentence/word. If you think it is not correct, then place an X after the sentence/word. When there is a diagram**, first** label the diagram and then look at the questions that follow. If you are asked to tabulate – you MUST draw a table. Make sure that you compare the SAME characteristics each time. If you do not draw a table you will lose marks. When asked to draw a graph – make sure that you know whether it is a line graph, bar graph, histogram or pie chart that you must draw. Always write the heading, label the x and y axes and include the units for the axis in brackets – this will already give you 4 marks. You must work fast. If you cannot remember an answer, leave space and carry on. You can always come back to that question when you are done. **PLEASE do all the homework questions**.

Sections examined in Paper 2:

- Population ecology, community structure and ecological succession
- Plant responses to the environment (plant hormones and tropisms)
- Animal responses to the environment – nervous system, endocrine system, thermoregulation, the human eye and ear
- General reproduction and flowers as reproductive structures
- Human reproduction

SECTION A: TYPICAL EXAM QUESTIONS

QUESTION 1: **7 minutes** *(Taken from DoE Exemplar 2011 Paper 2)*

Various options are provided as possible answers to the following questions. Choose the correct answer and write only the letter (A–D) next to the question number.

1.1 Which of the following is an exocrine gland?

A Thyroid
B Pancreas
C Adrenal
D Pituitary

1.2 The ability of the lens to change its curvature is known as …

A astigmatism.
B binocular vision.
C accommodation.
D pupillary mechanism.

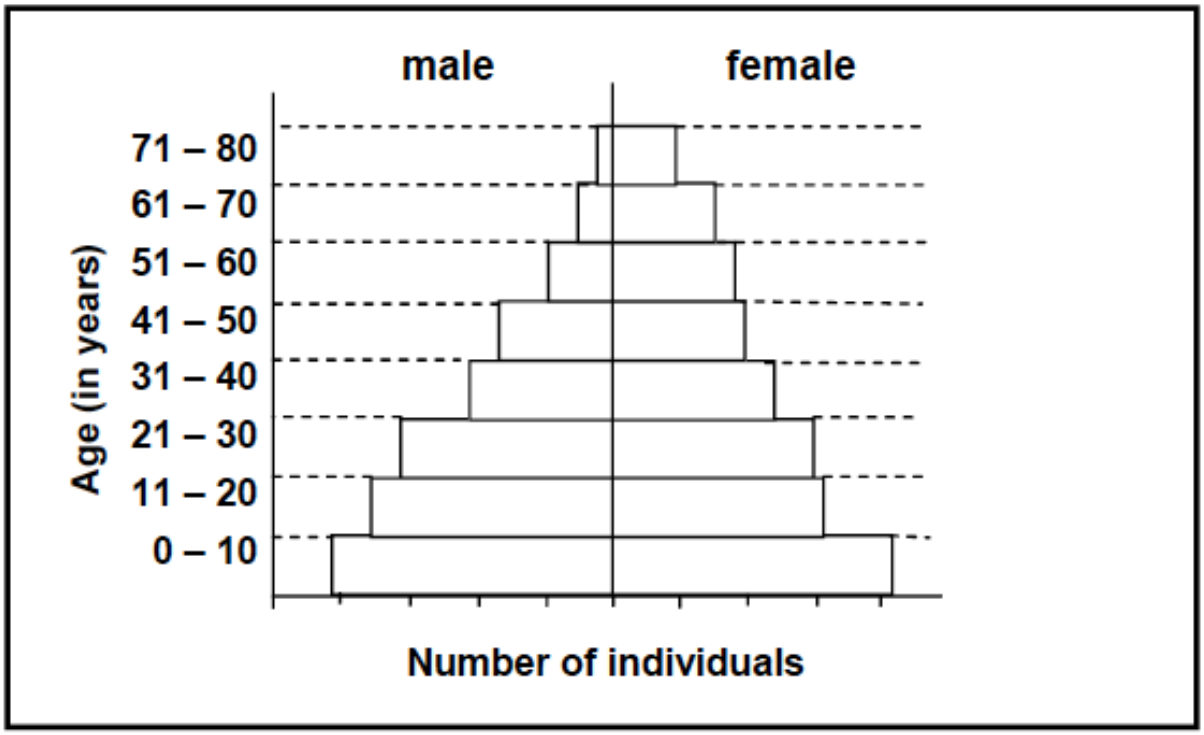
1.3 Diabetes is caused by an ...

A oversecretion of adrenalin.
B undersecretion of insulin.
C oversecretion of aldosterone.
D undersecretion of glucagon.

1.4 The net increase of a population can be determined by ...

A adding births and deaths and subtracting emigrations and immigrations.
B adding births and emigrations and subtracting deaths and immigrations.
C adding births and immigrations and subtracting deaths and emigrations.
D adding deaths and immigrations and subtracting births and emigrations.

1.5. Study the pyramid below:



A Rapidly growing population; characteristic of a developing country
B Declining population; characteristic of a developing country
C Stable population; characteristic of a developed country
D Declining population; characteristic of a developed country

1.6 Complete metamorphosis is characterised by the following stages in the life cycle of an organism:

A Egg, pupa and adult
B Egg, larva and adult
C Egg, larva, pupa and adult
D Egg and adult

1.7 The hatching of fertilised eggs in the body of the female, such that the young are born alive, is called …

A external fertilisation.
B ovipary.
C vivipary.
D ovovivipary. (7 x 1) [7]

QUESTION 2: 5 minutes *(Taken from DoE Exemplar 2011 Paper 2)*

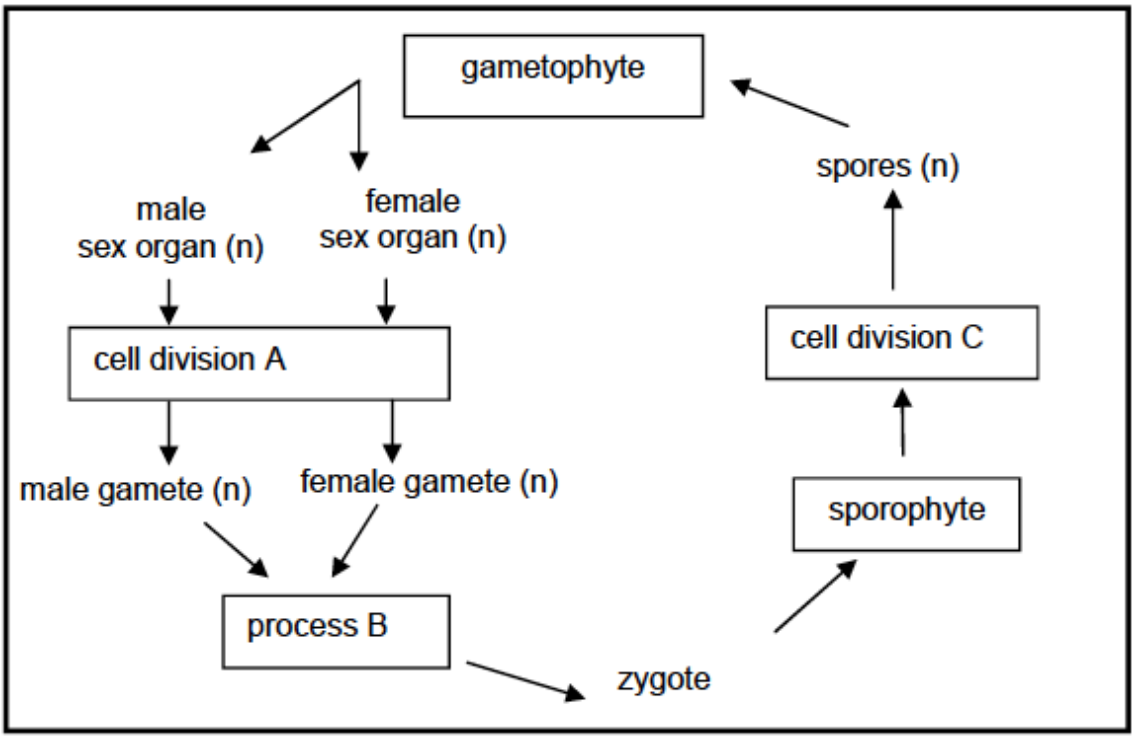
Indicate whether each of the statements in COLUMN 1 applies to A only, B only, both A and B or none of the items in COLUMN 2. Write A only, B only, both A and B or none next to the question number.

COLUMN 1	COLUMN 2
2.1. No photoreceptors	A: Blind spot B: Yellow spot
2.2. Process that reduces the chances of fertilisation	A: Contraception B: Conception
2.3. Lens of the eye is too convex	A: Hypermetropia B: Astigmatism
2.4. Used by plants as protection from being eaten by animals	A: Chemicals B: Thorns
2.5. Example of social organisation that increases the chances of survival	A: Division of labour in bees B: A herd of zebras

(5 x 1) [5]

QUESTION 3: 5 minutes *(Taken from DoE Exemplar 2011 Paper 2)*

Study the diagram of the life cycle of a plant in which the gametophyte generation is dominant, on the following page.



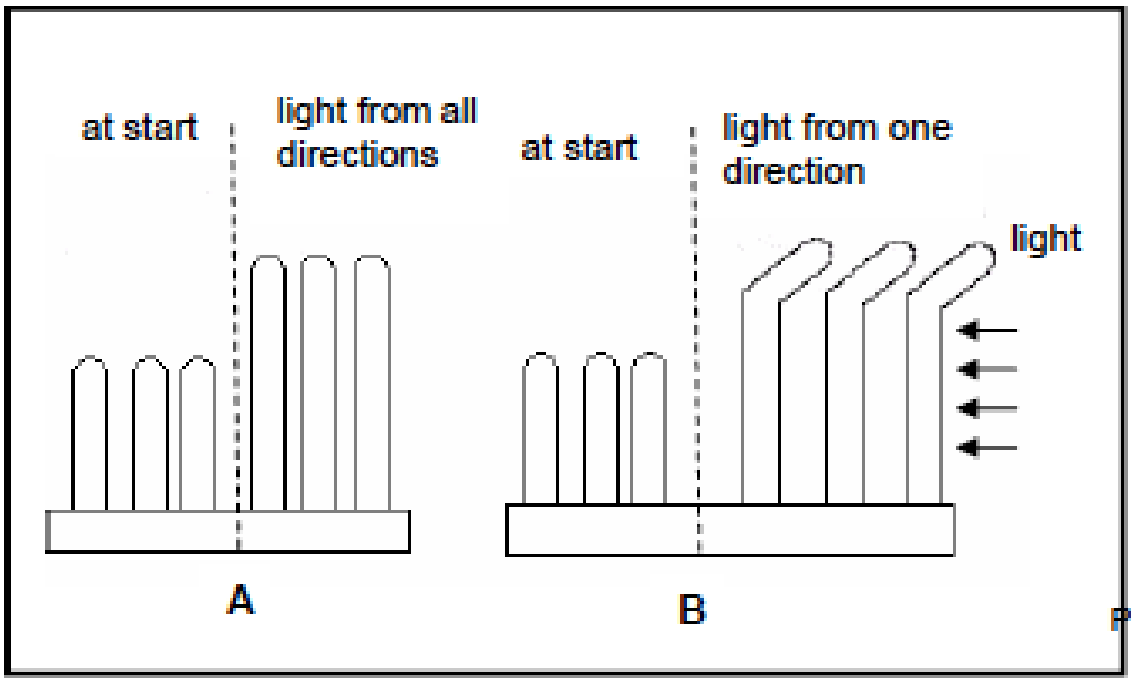
3.1. Is the life cycle represented that of moss or a flowering plant? (1)
3.2. Name the following:
(a) Cell division A (1)
(b) Process B (1)
(c) Cell division C (1)
3.3. Is the gametophyte haploid or diploid? (1)
3.4 Are seeds produced during the life cycle of this plant? (1)
[6]

QUESTION 4: 10 minutes *(Taken from DoE Exemplar 2011 Paper 2)*

A group of grade 12 learners wanted to investigate the effect of light coming from one direction on the growth of shoots. They planted some wheat seeds in two seed trays and allowed them to germinate. When young shoots appeared above the soil level, the shoots were exposed to light from all directions for three days. After three days, the trays received different treatments as follows:

Tray A: The shoots were exposed to light from all directions.
Tray B: The shoots were exposed to light from one direction only.

The diagrams on the following page show the effects of these treatments. Study them and answer the questions that follow.

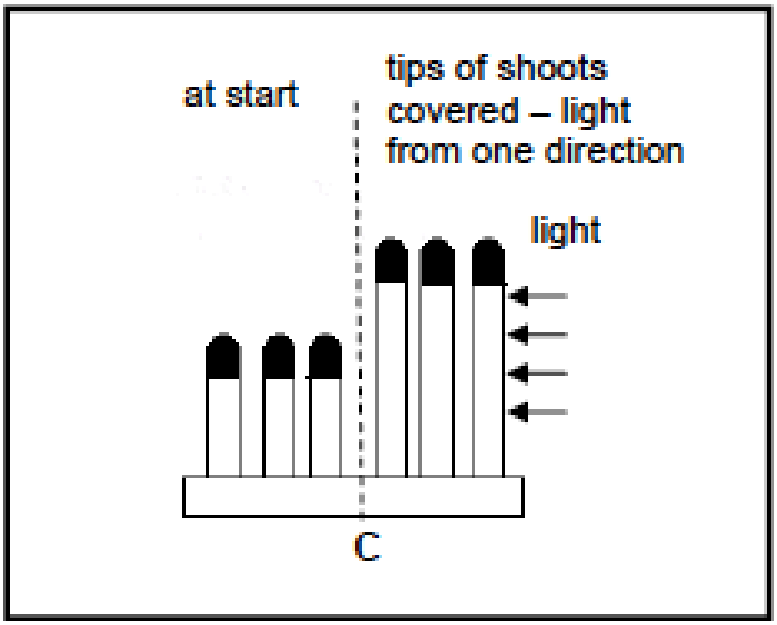


4.1. Formulate a hypothesis for the investigation above. (2)

4.2. Explain why it was important to include tray A as part of this investigation. (2)

4.3. State ONE conclusion that may be drawn from this investigation. (2)

4.4. A third tray (C) was set up in a similar way to tray A and tray B. The tips of the shoots were covered with aluminium foil. The diagram below shows the appearance of the shoots at the start, and after being exposed to light from one direction only.

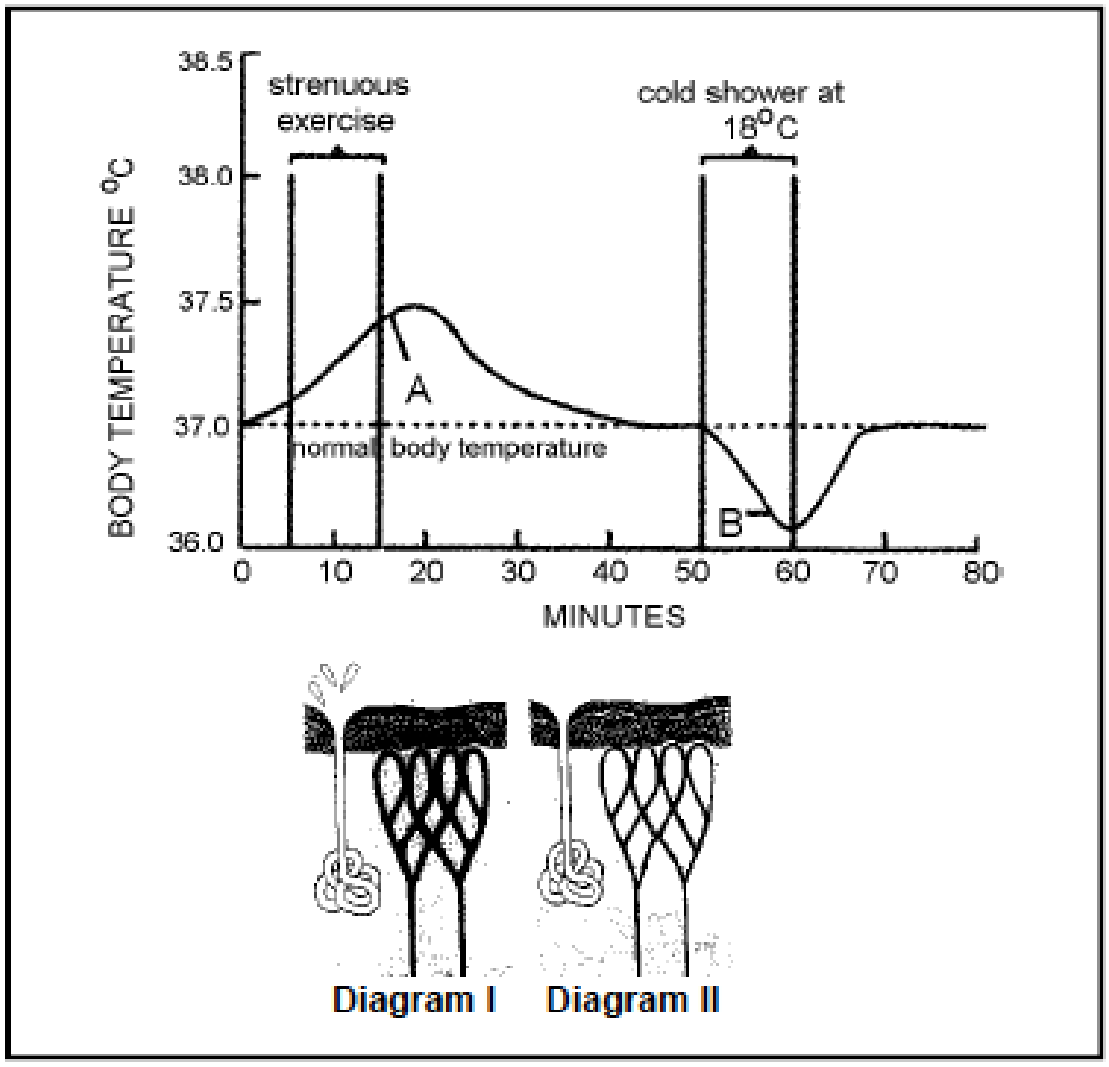


What conclusion can you draw from the results obtained in tray C? (2)

4.5. Name ONE use in agriculture of the following:
(a) Auxins (1)
(b) Gibberellins (1)
[10]

QUESTION 5: 7 minutes *(Taken from DoE Exemplar 2011 Paper 2)*

The graph below shows the effect of strenuous exercise, followed by a cold shower, on the body temperature of an athlete.



5.1. Which part of the brain responds to the temperature changes that occur at A and B on the graph? (1)
5.2. What was the maximum temperature reached? (1)
5.3. For what period of time did the person engage in strenuous exercise? (1)
5.4. Why should body temperature not be allowed to fluctuate too much? (2)
5.5. Which diagram (I or II) would represent the condition of the skin after 15 minutes? (1)
5.6. Explain your answer to QUESTION 5.5. (2)
[8]

QUESTION 6: **8 minutes** *(Adapted from DoE Exemplar 2011 Paper 2)*

In an investigation to find the number of African potato plants in a field of area 6 000 m^2, three plots were selected, each with an area of 10 m^2. Plot 1 contained three, and the other plots contained seven, and two African potato plants, respectively.

6.1. What indirect method was used to estimate the population size? (1)

6.2. How should the plots be selected to obtain a reliable estimate? (1)

6.3. Estimate the total number of African potato plants in the field. Show all your workings. (3)

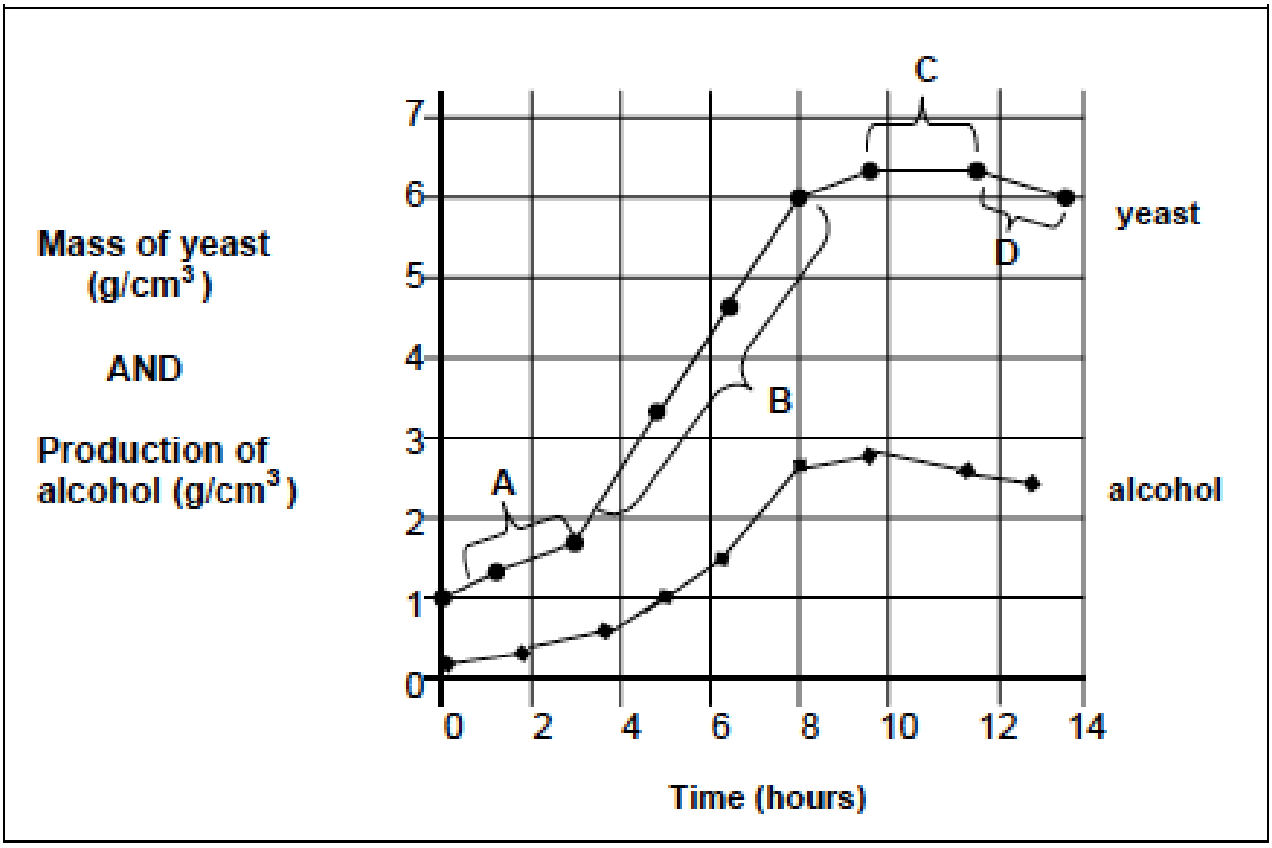
6.4. Name ONE other indirect method that will be more appropriate to estimate the number of buck in a game reserve. (1)

6.5. Name TWO advantages of projecting the future size of the human population. (2)

[8]

QUESTION 7: **11 minutes** *(Taken from DoE Exemplar 2011 Paper 2)*

The graph below illustrates the growth of yeast (*Saccharomyces sp.)* and the amount of alcohol it produces. The quantity of yeast was not measured by the number of yeast cells present, but by the mass of the yeast cells (g) per cm3.



7.1 Identify the phase of growth at C. (1)

7.2 Explain the shape of the graph at:

(a) A (2)

(b) B (2)

7.3 Using the graph, state the carrying capacity for yeast in this environment. (2)

7.4 State the general relationship between the growth of yeast and the production of alcohol. (2)

7.5 Explain the decrease in the yeast population in the last two hours. Give TWO reasons. (2)

[11]

SECTION B: HOMEWORK

QUESTION 1: 8 minutes *(Taken from Study and Master Grade 12 – old syllabus)*

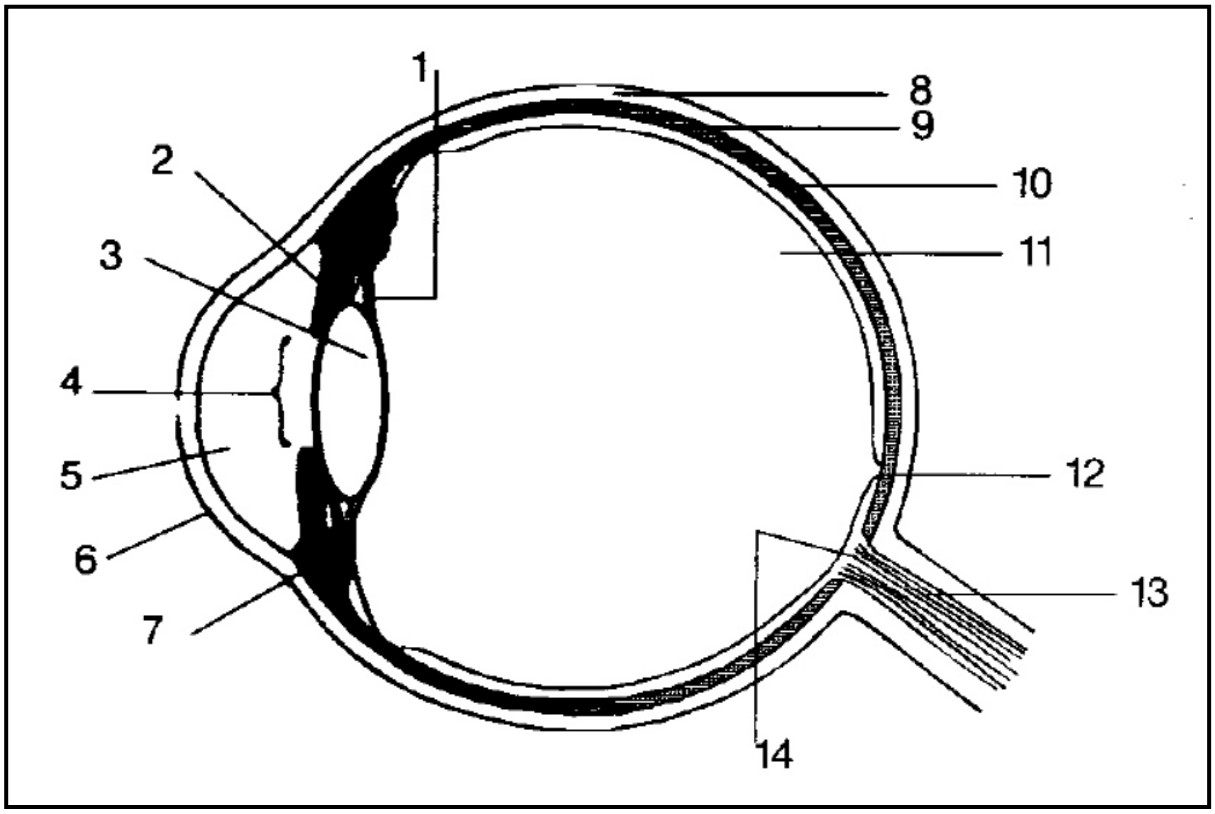
For each of the phrases in Column 1, state whether it applies to A only, B only, both A and B or none in Column 2. Write down A only, B only, A and B or None.

Column 1	Column 2
1. Site of olfactory receptors in the human body	A Ear B Eye
2. Conducts impulses to the auditory centre of the brain	A Organs of Corti B Cochlea
3. Refracting medium of the eyeball	A Cornea B Lens
4. Fluid present in the middle canal of the inner ear	A Perilymph B Endolymph
5. Play a role in the perception of gravitational pull	A Ampullae B Maculae
6. Play a role in the perception of gravitational pull	A Semi-circular canals B Proprioreceptors
7. Assist in concentrating light rays on the fovea centralis	A Ciliary muscles B Cornea
8. In dim light the radial muscles contract	A Pupillary mechanism B Eye accommodation

(8 x 1) [8]

QUESTION 2: **30 minutes** *(Modified from Study and Master Grade 12 –old syllabus)*

Study the diagram of the human eye and answer the questions that follow:



2.1. Write down the number and the name of the layer:
  a) giving colour to the eye (2)
  b) that prevents the reflection of light rays in the eye (2)
  c) which contains rod and cones (2)

2.2. Write down the number and name of the structure:
  a) mainly responsible for the refraction of light rays. (2)
  b) where the clearest image of the object is formed. (2)

2.3. Write down the numbers and names of FOUR parts which refract light rays in order, as they pass through the eye. (4)

2.4. Write down the number and name of the layer which changes light energy into nerve impulses. (2)

2.5. Write down the number and name of the layer of the structure which controls the amount of light entering the eye. (2)

2.6. Explain the process and functioning of the structure named in QUESTION 2.5 when there is bright light. (4)

2.7. Explain the process that takes place in the eye when we focus on an object that is closer that 6m. (8)

[30]

SECTION C: SOLUTIONS AND HINTS TO SECTION A

QUESTION 1

1.1. B
1.2. C
1.3. B
1.4. C
1.5. A
1.6. C
1.7. D (7 x 1) **[7]**

QUESTION 2

2.1. A only✓
2.2. A only✓
2.3. None✓
2.4. Both✓/A and B✓
2.5. Both✓/A and B✓ (5 x 1) **[5]**

QUESTION 3

3.1. Moss (1)
3.2. (a) Mitosis (1)
(b) Fertilisation (1)
(c) Meiosis (1)
3.3. Haploid (1)
3.4. No (1)
[6]

QUESTION 4

4.1 Shoots ✓will grow towards ✓the light
OR
Shoots ✓will grow away ✓from the light
OR
Light has no ✓influence ✓on the shoot (2)
4.2 It is the control ✓- To verify the results of the experiment ✓To allow for one variable only. (2)
4.3 Shoots grow ✓towards the source of light ✓. (2)
4.4 The auxins ✓that make the shoot to grow towards the light is in the tips of the shoots ✓. (2)
4.5 (a) Apical dominance ✓
(b) Tall growth of a plant/stimulate seed germination ✓ (2)
[10]

QUESTION 5

5.1 Hypothalamus ✓ (1)

5.2 37,5 ^{o}C ✓ (1)

5.3 10 (1) minutes

5.4 Most human activities is controlled by enzymes ✓and enzymes require optimum temperatures to function ✓ (2)

5.5 Diagram I ✓ (1)

5.6 Blood vessels dilated ✓ to bring more blood to the surface and more heat will be lost ✓ (2).

OR

Increased sweat production ✓which will cool down the body ✓ (1)

[8]

QUESTION 6

6.1 Simple sampling ✓ (1)

6.2 Randomly ✓ (1)

6.3 Average number per plot 3+7+2 ✓= 12 /3 ✓) = 4 ✓ (3)

6.4 Mark recapture ✓ (1)

6.5 Planning for schools ✓
Housing needs ✓
Provision of resources ✓
Creating employment ✓
Medical service ✓ **(Mark first TWO only)** (Any 2 options) (2)

[8]

QUESTION 7

7.1 Equilibrium ✓/ stationary ✓ (1)

7.2 (a) Slow growth ✓due to:
time necessary for the population to acclimatise ✓/
the time needed for individuals to locate mating partners/
or time to produce offspring (2)

(b) Increasing growth ✓due to very few limiting factors ✓ (2)

7.3 6,3 ✓g/cm^3 ✓ mass of yeast at phase C (2)

7.4 As the yeast population grows ✓the production of alcohol increases ✓ (2)

7.5 - Population reached carrying capacity ✓/environment cannot support any further increase due to a shortage of resources ✓

OR

- Increased concentration of alcohol created toxic conditions ✓ which started to kill of the yeast cells ✓ (2)

[11]

SESSION 8: TOPIC 2: CONSOLIDATION – EXAMINATION PAPER 2

Learner Note: Please stick to the time limits. Read the questions carefully and underline the operative words. Make sure that you understand what is being asked. For multi-choice questions, read the question and cover the option answers. Think about the question and think of the correct answer; then uncover the possible answers and find your answer there. If you are given possible answers that are combinations of answers, then read each option carefully and decide if it is correct or not. Correct, place a ✓ at the end of the sentence/word. If you think it is not correct, then place an X after the sentence/word. When there is a diagram**, first** label the diagram and then look at the questions that follow. If you are asked to tabulate – you MUST draw a table. Make sure that you compare the SAME characteristics each time. If you do not draw a table you will lose marks. When asked to draw a graph – make sure that you know whether it is a line graph, bar graph, histogram or pie chart that you must draw. Always write the heading, label the x and y axes and include the units for the axis in brackets – this will already give you 4 marks. You must work fast. If you cannot remember an answer, leave space and carry on. You can always come back to that question when you are done. **PLEASE do all the homework questions**.

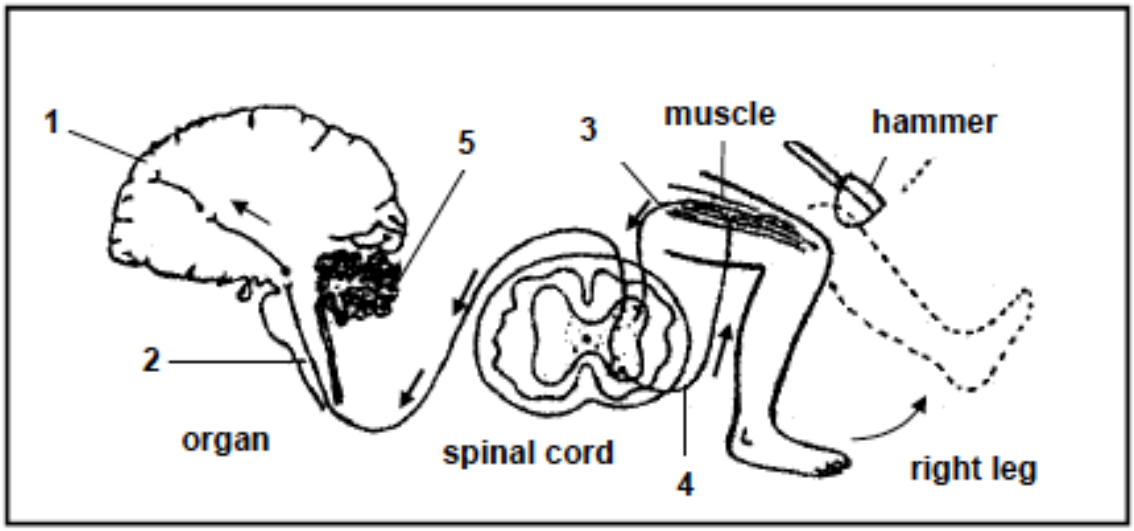
Sections examined in Paper 2:

- Population ecology, community structure and ecological succession
- Plant responses to the environment (plant hormones and tropisms)
- Animal responses to the environment – nervous system, endocrine system, thermoregulation, the human eye and ear
- General reproduction and flowers as reproductive structures
- Human reproduction

SECTION A: TYPICAL EXAM QUESTIONS

QUESTION 1: 5 minutes *(Taken from DoE Exemplar 2011 Paper 2)*

The diagram below shows the human brain (longitudinal section), spinal cord (transverse section) and the right leg.



Four options are provided as possible answers to the following questions. Choose the answer and write only the letter (A–D) next to the question number.

1.1 Which part of the brain is indicated by 1?
- A Cerebrum
- B Medulla
- C Cerebellum
- D Hypothalamus

1.2 Which ONE of the following is a function of the part of the brain numbered 2?
- A Perception of sensations
- B Centre for control of breathing
- C Maintenance of equilibrium and balance
- D Centre for regulation of body temperature

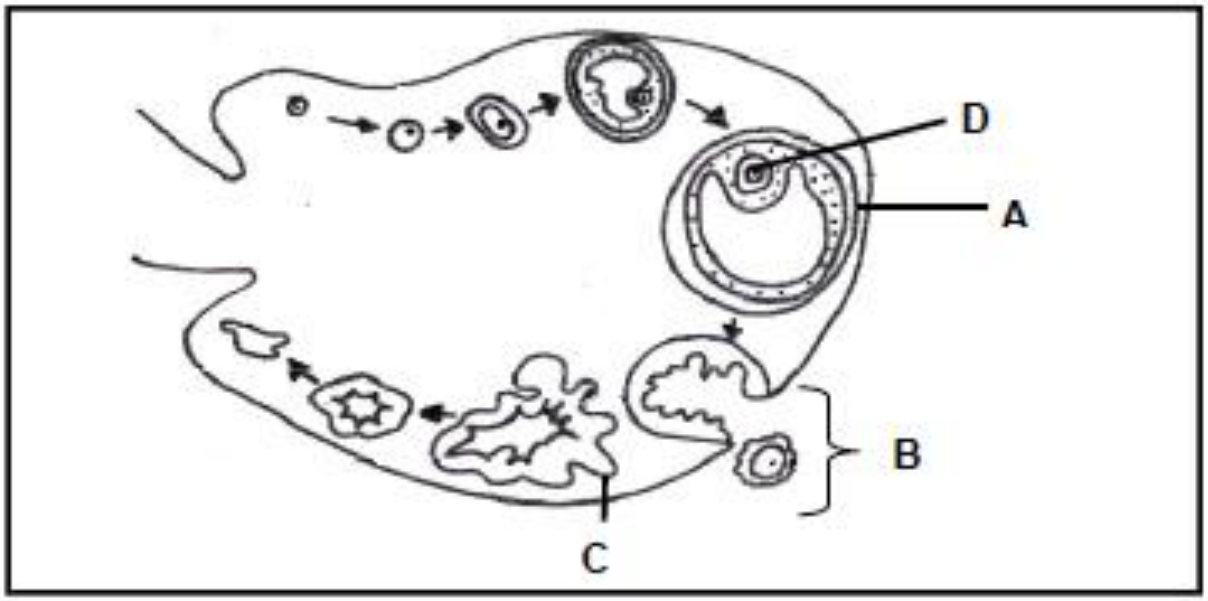
1.3 Under normal circumstances, which numbered part coordinates the movements of the legs?
- A 2
- B 3
- C 4
- D 5

1.4 Which ONE of the following comparisons between 3 and 4 is FALSE?
- A 3 is a sensory neuron, while 4 is a motor neuron.
- B 3 leads from the receptor, while 4 leads to the effector.
- C 3 enters the dorsal root, while 4 leaves through the ventral root.
- D The cell body of 3 is located in the spinal cord, while that of 4 is found outside the spinal cord.

1.5 Which ONE of the following is FALSE about the role of the brain and spinal cord involved in the action in the diagram?
- A The brain is aware of the tap on the knee with the hammer.
- B An effector is stimulated to bring about a response.
- C The spinal cord receives sensory impulses from the knee.
- D The brain receives sensory impulses from the spinal cord and sends motor impulses to the leg muscles. (5 x 1) [5]

QUESTION 2: **14 minutes** *(Taken from DoE Exemplar 2011 Paper 2)*

Study the diagram below showing the sequence of events of the development of an ovum in a 28-day cycle, and answer the questions that follow.



2.1. Identify the following:

(a) Follicle labelled A (1)

(b) Structure labelled C (1)

(c) Process shown at B (1)

(d) Hormone responsible for the formation of part A (1)

(e) Hormone responsible for the formation of part C (1)

2.2. What type of cell division resulted in the formation of part D? (1)

2.3. If the events shown above took place in a 28-day cycle, state whether fertilisation took place during this period. (1)

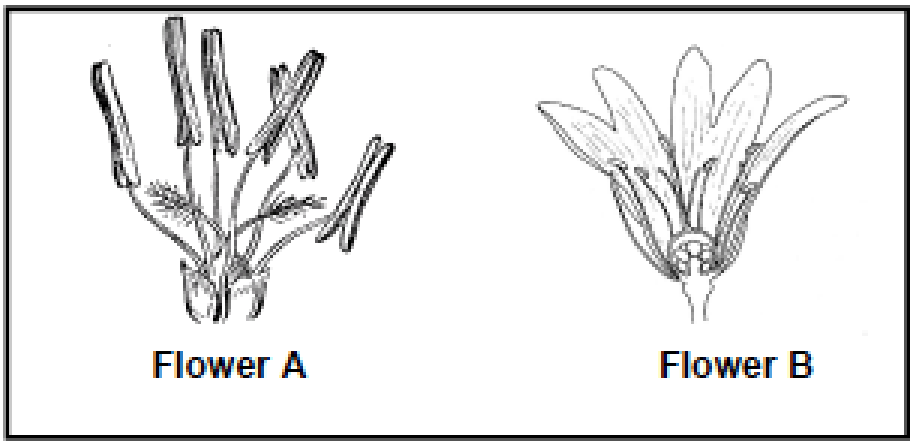
2.4. Explain your answer to QUESTION 2.3. (3)

2.5. Explain HOW and WHY the production of FSH is inhibited when fertilisation takes place. (4)

[14]

QUESTION 3: 6 minutes *(Taken from DoE Exemplar 2011 Paper 2)*

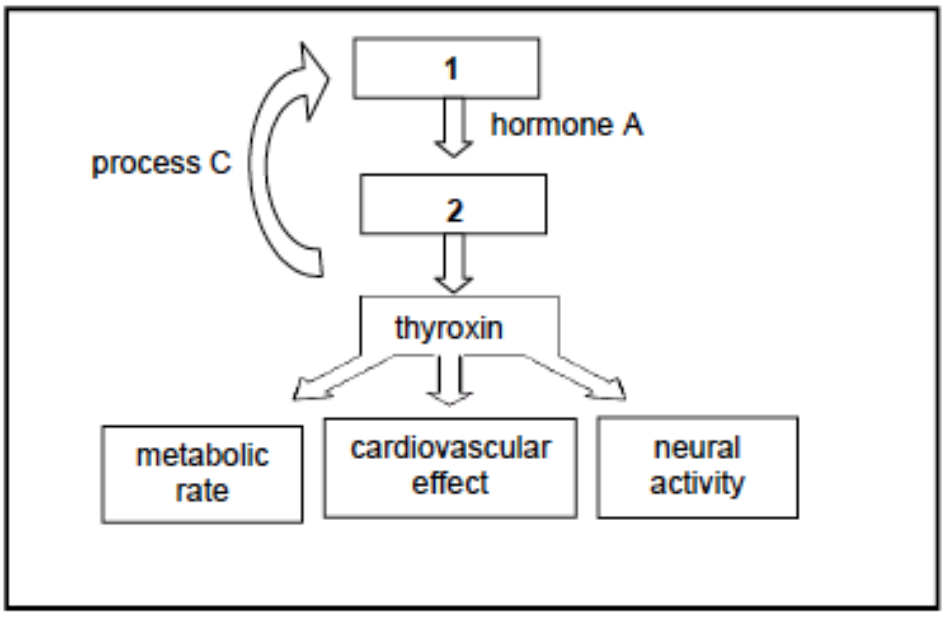
Study the diagrams below showing the structure of two flowers, and answer the questions that follow.



3.1. Define pollination. (2)
3.2. Which flower (A or B) is wind-pollinated? (2)
3.3. Provide TWO visible reasons for your answer to QUESTION 3.2. (2)
[6]

QUESTION 4: 7 minutes *(Taken from DoE Exemplar 2011 Paper 2)*

Study the diagram below and answer the questions that follow.



4.1. Give labels for the glands numbered 1 and 2. (2)
4.2. Name hormone A. (1)
4.3. Describe the negative feedback mechanism that operates when the thyroxin level in the blood is too high, as indicated by process C. (4)
[7]

QUESTION 5: **13 minutes** *(Modified from DoE Exemplar 2011 Paper 2)*

Study the diagram below and answer the questions that follow.

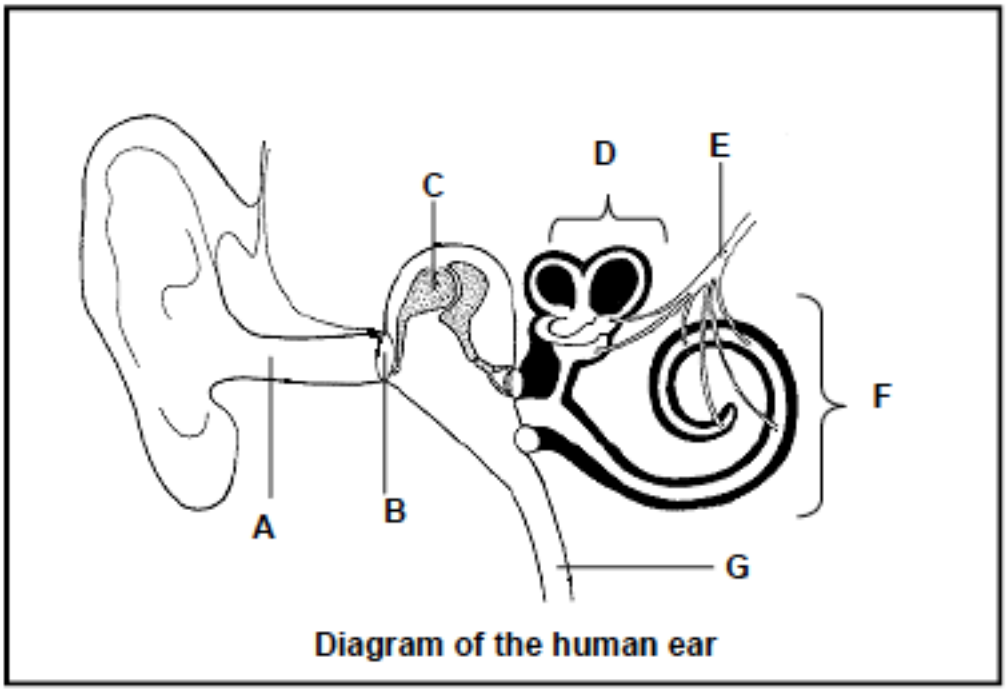


Diagram of the human ear

5.1. Identify the parts labelled B, C and F and name ONE function of each. (6)
5.2. Explain how the pinna of the ear is suited for its function. (2)
5.3. Name TWO functions of G. (2)
5.4. Write the letter of the part which:
(a) contains receptors for balance (1)
(b) channels sound waves (1)
(b) transmits impulses to the brain (1)
[13]

QUESTION 6: **20 minutes** *(Taken from DoE Exemplar 2011 Paper 2)*

Using examples, describe predation, competition and symbiosis, explaining how each interaction influences the population size of the organisms involved.

Content: (17)
Synthesis: (3)
[20]

SECTION B: HOMEWORK

QUESTION 1: 9 minutes *(Taken from DoE Exemplar 2011 Paper 2)*

Read the article below on elephant culling.

TOO HUNGRY, TOO DESTRUCTIVE, TOO MANY: SOUTH AFRICA TO BEGIN ELEPHANT CULLING

An elephant herd at the Kruger National Park has 20 000 elephants, 5 000 more than is sustainable. Ecologists say the animals‟ huge appetites and fondness for „habitat re-engineering‟ – reducing forests to flatland by uprooting trees and trampling plants – is the main problem.

Culling of the excess elephants is seen as an advantage in that it generates revenue for the communities from the sale of ivory and other elephant products. It will also provide meat to the local communities. Alternatives to culling include contraception and relocation of entire elephant families. The removal of fences between the Kruger National Park and parks in neighbouring Mozambique will eventually help with migration into less congested areas.

The 1998 figure of 8 000 elephant increased to 10 000 in 2008 and it is expected to reach 34 000 by 2020

Adapted from *The Guardian* February 2008

1.1. Give the main reason mentioned above in support of the culling of elephants. (1)
1.2. Name TWO alternatives to culling proposed above. (2)
1.3. Draw a bar graph to show the change in the elephant population from 1998 to 2020. (6)
[9]

QUESTION 2: 10 minutes *(Taken from DoE Exemplar 2011 Paper 2)*

Give the correct biological term for each of the following descriptions. Write only the term next to the question number.

2.1. Type of vision made possible by two eyes with different, but overlapping, visual fields.
2.2. The permanent movement of individuals of a population out of a defined area.
2.3. The layer of the eyeball which is pigmented and which prevents internal reflection.
2.4. Development of a community over time where species in one stage are replaced by other species.
2.5. The total count of all individuals in a population.
2.6. The role of a species within the structure and functioning of an ecosystem.
2.7. Fluid that protects the embryo against injury and temperature changes.
2.8. The tube leading from the testis to the urethra in males.
2.9. Part of the nervous system consisting of a sympathetic and parasympathetic section.
2.10. The type of development whereby offspring are incapable of moving around soon after hatching. (10 x 1) [10]

SECTION C: SOLUTIONS AND HINTS TO SECTION A

QUESTION 1

1.1. A
1.2. B
1.3. D
1.4. D
1.5. D (5 x 1) **[5]**

QUESTION 2

2.1. (a) Graafian follicle✓ (1)
(b) Corpus luteum ✓ (1)
(c) Ovulation ✓ (1)
(d) FSH ✓ (1)
(e) LH ✓ (1)
2.2. Meiosis ✓ (1)
2.3. No ✓ (1)
2.4. If fertilisation occurred ✓the corpus luteum ✓would stay intact ✓and not be destroyed (3)
2.5. If fertilisation occurs high levels of progesterone enters the blood ✓
The high levels of progesterone inhibits the production of FSH ✓
Low levels of FSH stop the development of an ovum inside a Graafian follicle ✓
No ovulation occurs when the individual is pregnant ✓ (4)
[14]

QUESTION 3

3.1. Pollination is the transfer of pollen ✓from the anther to the stigma ✓ of the flower
3.2. Flower A ✓ (1)
3.3. Large anthers ✓ (1)
No petals ✓ (1)
Large feathery stigma ✓ **(Mark first TWO only)** (Any 2) (2)
[5]

QUESTION 4

4.1 1 – pituitary gland ✓
2 – thyroid gland ✓ (2)
4.2 Thyroid stimulating hormone ✓/ TSH (1)
4.3 High thyroxin concentration in the blood will stimulate the pituitary gland ✓to secrete less TSH. ✓
The lower level of TSH will make the thyroid gland ✓secrete less thyroxin ✓
which will decrease the level of thyroxin in the blood ✓ (Any 4) (4)
[7]

QUESTION 5

5.1 B - tympanic membrane ✓to vibrate and transfer the sound wave to the ossicles / hammer ✓
C - malleus/hammer ✓ to vibrate and transfer the sound to the anvil ✓/ amplify sound✓
F – cochlea ✓to convert the stimulus of the sound waves into an impulse ✓ (6)

5.2 Pinna has many ridges ✓ to direct the sound waves along the auditory canal ✓
Extends outside the head / large flaps / funnel shaped ✓to trap sound waves ✓
(Mark first two answers only) (Any 2) (2)

5.3 Maintain air pressure on both sides of the eardrum ✓
To drain fluid from the middle ear into the throat ✓ (2)

5.4 (a) D ✓ (1)
(b) G ✓ (1)
(c) E ✓ (1)
[13]

QUESTION 6

Predation
A predator captures and kills other animals (prey) for its food (1)
Example: Lions that capture and feed on antelopes (1)
Prey population will decrease and the predator population will increase (1)

Competition
Interspecific competition
Happens when large numbers of organisms of different species depend on same resources. (1)
Example: Flour beetles (1)
One species will decrease in population size while the other will increase (1)
OR
Intraspecific competition
Happens between organisms of same species that share the same available resource. (1)
Example: Owls competing for same resources. Stronger owls will survive (1)
The owl population will decrease (1)

Symbiosis is the close association between two organisms so that one or both benefit (1)

Parasitism (1)
One organism benefit (parasite) while the other is harmed (host) (1)
Example: Tapeworm and humans (1)
The host organism‟s population size will decrease and the parasite population Increase (1)

Mutualism (1)
Symbiotic relationship between two organisms in which both benefit (1)
Example: Bacteria and roots of leguminous plants (1)
Both populations will increase (1)

Commensalism (1)
Symbiotic relationship between two organisms in which one benefits without harming the other. (1)
Example: Sharks and sucker fish/Remora (benefit) (1)
The population size of the organism that benefits will increase in size (1)

Content: (any 17)

ASSESSING THE PRESENTATION OF THE ESSAY

Marks	Description
3	All three interactions discussed with no irrelevant information
2	Two interactions discussed with no irrelevant information **OR** two interactions discussed with little irrelevant information
1	One interaction discussed with little or no irrelevant information **OR** two interactions discussed with little irrelevant information
0	Not attempted/nothing written other than question number/no correct information

Synthesis: (3)
[20]