

Learn Xtra



LIFE SCIENCES
GRADE 12

exam school
2012

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INTRODUCTION

Have you heard about Mindset? Mindset Network, a South African non-profit organisation, was founded in 2002. We develop and distribute quality and contextually relevant educational resources for use in the schooling, health and vocational sectors. We distribute our materials through various technology platforms like TV broadcasts, the Internet (www.mindset.co.za/learn) and on DVDs. The materials are made available in video, print and in computer-based multimedia formats.

At Mindset we are committed to innovation. In the last three years, we have successfully run a series of broadcast events leading up to and in support of the Grade 12 NSC examinations

Now we are proud to announce our 2012 edition of Exam School. From 15th October till 20th November will bring you revision lessons in nine subjects - Mathematics, Physical Sciences, Life Sciences, Mathematical Literacy, English 1st Additional Language, Accounting, Geography, Economics and Business Studies.

In this exam revision programme we have selected Questions mainly from the Nov 2011 Papers and have tried to cover as many topics as we can. Each topic is about an hour long and if you work through the selected questions you will certainly have increased confidence to face your exams. In addition to the topics and questions in this booklet, we have schedule 1½ hour live shows a day or two before you write your exams. To get the most out of these shows, we need you to participate by emailing us questions, calling in or posting on twitter, peptxt or facebook.

Since you asked us for late night study sessions and that's what we've planned! You'll find repeats of our Live shows at 10:30pm every evening. Then from midnight to 6:00 am there are revision lessons too. So if you can't watch during the day, you can record or watch early in the morning! .

GETTING THE MOST FROM EXAM SCHOOL

You must read this booklet! You'll find the exam overviews and lots of study tips and hints here. Start your final revision by working through the questions for a topic fully without looking up the solutions. If you get stuck and can't complete the answer don't panic. Make a note of any questions you have. Now you are ready to watch a Learn Xtra session. When watching the session, compare the approach you took to what the teacher does. Don't just copy the answers down but take note of the method used. Also make a habit of marking your work by checking the memo. Remember, there are usually more than one way to answer a question. If you still don't understand post your question on Facebook – you'll get help from all the other Mindsetters on the page. You can also send an email to helpdesk@learnxtra.co.za and we'll get back to you within 48 hours.

Make sure you keep this booklet. You can re-do the questions you did not get totally correct and mark your own work. Exam preparation requires motivation and discipline, so try to stay positive, even when the work appears to be difficult. Every little bit of studying,



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revision and exam practice will pay off. You may benefit from working with a friend or a small study group, as long as everyone is as committed as you are.

We are pleased to announce that we'll continue to run our special radio broadcasts on community radio stations in Limpopo, Eastern Cape and KZN. This programme is called MTN Learn. Find out more details at www.mtnlearning.co.za. You can also listen online or download radio broadcasts of previous shows. Tuning into radio will give you the chance to learn extra! Look out for additional notes in Newspaper supplements too.

Mindset believes that the 2012 Learn Xtra Spring School will help you achieve the results you want. All the best to the Class of 2012!

CONTACT US

We want to hear from you. So let us have your specific questions or just tell us what you think through any of the following:



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BROADCAST SCHEDULE

Exam School (Dstv and Toptv 319)

Time	Tues 6Nov	Thurs 8Nov
09:00	Theories of Evolution	Theories of Evolution
10:00	Human Evolution	Human Evolution
11:00	DNA and RNA	Genetics
12:00	Meiosis	Live P3 Maths (Repeat)
13:30	Genetics	DNA and RNA
14:30	Biotechnology	Meiosis
15:30	Live	Live
17:00	Theories of Evolution	Biotechnology
18:00	Human Evolution	Genetics
22:30	Live: (Repeat)	Live: (Repeat)
24:00	Theories of Evolution	Theories of Evolution
01:00	Human Evolution	Human Evolution
02:00	DNA and RNA	Genetics
03:00	Meiosis	Biotechnology
04:00	Genetics	DNA and RNA
05:00	<i>Biotechnology</i>	<i>Meiosis</i>



PREPARING FOR EXAMINATIONS

1. Prepare well in advance for all your papers and subjects. You need to start your planning for success in the final examination now. You cannot guarantee success if you only study the night before an exam.
2. Write down the date of your prelim and final exam so that you can plan and structure a study time table for all your subjects.
3. Set up a study time-table according to your prelim and final Grade 12 exam time-table and stick to your study schedule. If you study a small section every day, you will feel you have achieved something and you will not be as nervous by the time you have to go and write your first paper.
4. Your study programme should be realistic. You need to spend no more than 2 hours per day on one topic. Do not try to fit too much into one session. When you cover small sections of work often, you will master them more quickly. The broadcast schedule may help you to make sure you have covered all the topics that are in the exam.
5. When studying don't just read through your notes or textbook. You need to be active by making summary checklists or mind maps. Highlight the important facts that you need to memorise. You may need to write out definitions and formulae a few times to make sure you can remember these. Check yourself as often as you can. You may find it useful to say the definitions out aloud.
6. Practise questions from previous examination papers. Follow these steps for using previous exam papers effectively:
 - Take careful note of all instructions - these do not usually change.
 - Try to answer the questions without looking at your notes or the solutions.
 - Time yourself. You need to make sure that you complete a question in time. To work out the time you have, multiply the marks for a question by total time and then divide by the total number of marks. In most exams you need to work at a rate of about 1 mark per minute.
 - Check your working against the memo. If you don't understand the answer given, contact the Learn Xtra Help desk (email: helpdesk@learnxtra.co.za).
 - If you did not get the question right, try it again after a few days.
7. Preparing for, and writing examinations is stressful. You need to try and stay healthy by making sure you maintain a healthy lifestyle. Here are some guidelines to follow:
 - Eat regular small meals including breakfast. Include fruit, fresh vegetables, salad and protein in your diet.
 - Drink lots of water while studying to prevent dehydration.
 - Plan to exercise regularly. Do not sit for more than two hours without stretching or taking a short walk.
 - Make sure you develop good sleeping habits. Do not try to work through the night before an exam. Plan to get at least 6 hours sleep every night.



EXAM TECHNIQUES

1. Make sure you have the correct equipment required for each subject. You need to have at least one spare pen and pencil. It is also a good idea to put new batteries in your calculator before you start your prelims or have a spare battery in your stationery bag.
2. Make sure you get to the exam venue early - don't be late.
3. While waiting to go into the exam venue, don't try to cram or do last minute revision. Try not to discuss the exam with your friends. This may just make you more nervous or confused.
4. Here are some tips as to what to do when you receive your question papers: Don't panic, because you have prepared well.
 - You are always given reading time before you start writing. Use this time to take note of the instructions and to plan how you will answer the questions. You can answer questions in any order.
 - Time management is crucial. You have to make sure that you answer all questions. Make notes on your question paper to plan the order for answering questions and the time you have allocated to each one.
 - It is a good idea always to underline the key words of a question to make sure you answer it correctly.
 - Make sure you look any diagrams and graph carefully when reading the question. Make sure you check the special answer sheet too.
 - When you start answering your paper, it is important to read every question twice to make sure you understand what to do. Many marks are lost because learners misunderstand questions and then answer incorrectly.
 - Look at the mark allocation to guide you in answering the question.
 - When you start writing make sure you number your answers exactly as they are in the questions.
 - Make sure you use the special answer sheet to answer selected questions.
 - Think carefully before you start writing. It is better to write an answer once and do it correctly than to waste time rewriting answers.
 - DO NOT use correction fluid (Tippex) because you may forget to write in the correct answer while you are waiting for the fluid to dry. Rather scratch out a wrong answer lightly with pencil or pen and rewrite the correct answer.
 - Check your work. There is usually enough time to finish exam papers and it helps to look over your answers. You might just pick up a calculation, language or a spelling error. In Life Sciences make sure that all graphs and diagrams have headings and are labelled correctly.



LIFE SCIENCES EXAM OVERVIEW

STRUCTURE OF LIFE SCIENCES EXAM PAPERS

Section A

50 marks

Short answer questions which could include one word answers, multiple choice and matching column type questions.

Section B

60 marks

Two questions of 30 marks each, divided into 3-4 sub-sections

Section C

40 marks

Data Response questions

20 marks

Mini-essay

20 marks

LIFE SCIENCES PAPER 1

TOTAL MARKS: 150

3 HOURS

Life at molecular, cellular and tissue level ±90 marks

- DNA-the code of life and RNA
- Genetics & Genetic Engineering

Diversity, change and continuity ±60 marks

Evolution

Life Sciences Paper 2

Total Marks: 150

3 hours

Life Processes in plants and animals ±90 marks

- Plant responses to the environment
- Animal responses to the environment
- Human endocrine system
- Temperature regulation
- Reproduction
- Human Reproduction

Population and community ecology ±60 marks

- Population ecology
- Community Structure
- Community change over time



THEORIES OF EVOLUTION

CHECK LIST

Make sure you can:

- Distinguish between a hypothesis and a theory
- Explain and compare theories about origins proposed by Darwin, Lamarck and Wallace
- Describe and explain natural selection and compare it to artificial selection
- Describe and explain the formation of new species
- State evidence that supports the theory of evolution
- Give examples of evolution in present times

STUDY 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.



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. **triploid** (3), **tetraploid** (4), **pentraploid** (5), **hexaploid** (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** than 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 be 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.

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.

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 .



THEORIES OF EVOLUTION QUESTIONS

Question 1 (Nov 2011 Question 1.1.1 – 1.1.6)

Various options are provided as possible answers to the following questions. Choose the correct answer and write only the letter (A to D) next to the question number (1.1.1 to 1.1.10) in your ANSWER BOOK, for example 1.1.11 D.

- 1.1 A scientific idea that still has to be tested is referred to as a ...
- A theory.
 - B hypothesis.
 - C fact.
 - D belief.
- 1.2 Which ONE of the following can be used as evidence to support common ancestry?
- A Different DNA sequencing in different species
 - B Geographic distribution of different phyla
 - C Homologous structures of a whale's flipper and a bird's wing
 - D Analogous structures of a bird's wing and an insect's wing
- 1.3 The following statements relate to fossils:
- 1. Very few organisms end up as fossils.
 - 2. Some organisms tend to decay before becoming a fossil.
 - 3. Only soft parts of organisms preserve easily.
 - 4. Geological processes may destroy fossils.

Which of the statements above are possible reasons why there are gaps in the fossil record?

- A 1, 2 and 3 only
 - B 1, 2, 3 and 4
 - C 2, 3 and 4 only
 - D 1, 2 and 4 only
- 1.4 Which ONE of the statements below relates to biological evolution?
- A Artificial selection is essential for the evolution of species
 - B Humans have now progressed from a technological age into an information age
 - C Modern species evolved from ancestral species
 - D Genetic mutations generally cause species to die
- 1.5 *Homo habilis* ...
- A was called Handyman because he was a toolmaker.
 - B had a larger brain capacity than *Homo erectus*.
 - C was the first *Homo* species without prominent brow ridges.
 - D was the first *Homo* species to leave Africa.



1.6 The table below shows the percentage similarity of DNA of different primates compared to humans.

ORGANISM	DNA SIMILARITY (%)
Human	100
Capuchin monkey	84,2
Vervet monkey	90,5
Rhesus monkey	91,1
Gibbon	94,7
Chimpanzee	97,6

Which of the following pairs of primates are most closely related to humans?

- A Gibbon and chimpanzee
- B Gibbon and rhesus monkey
- C Rhesus monkey and vervet monkey
- D Capuchin monkey and vervet monkey

Question 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)

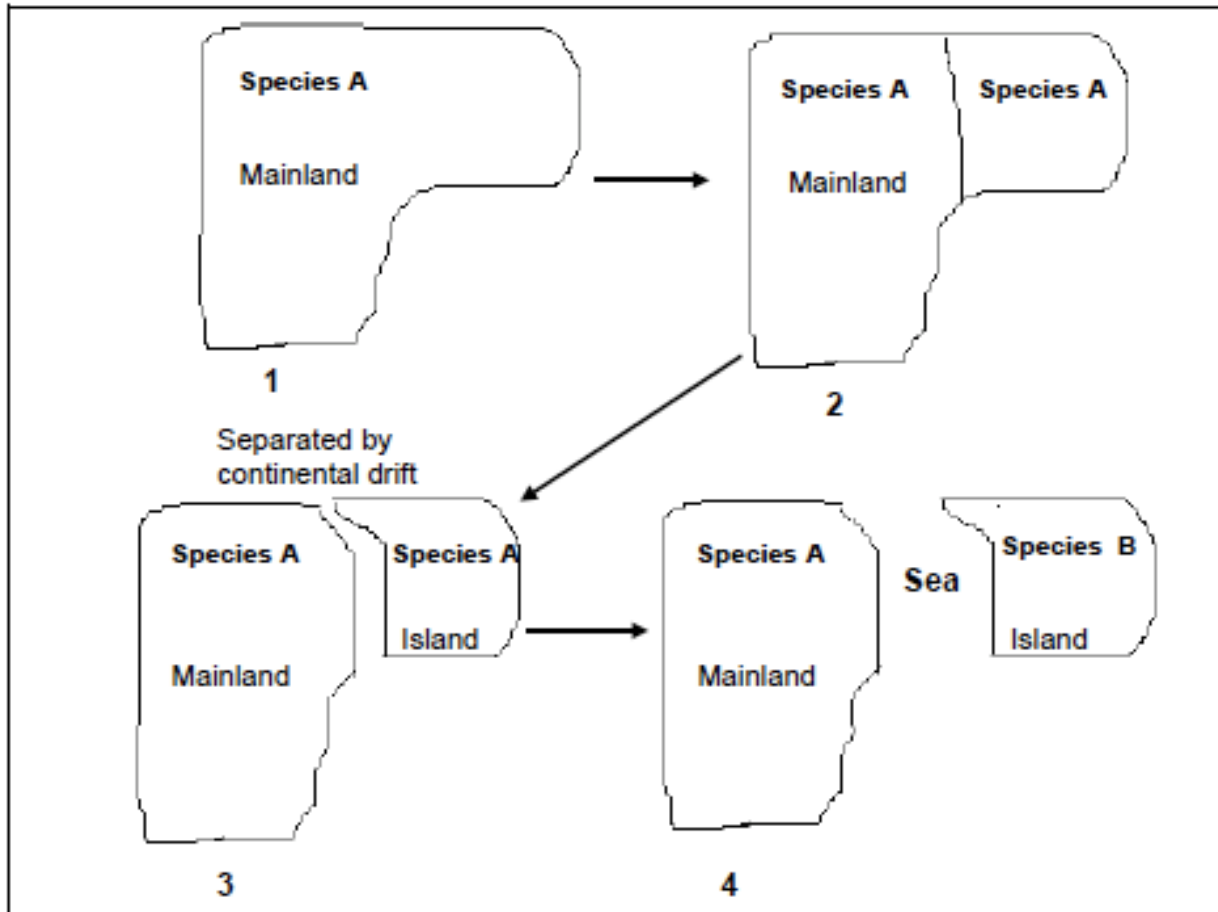
2.2 Explain your answer to QUESTION 2.1 (b) (2)

[9]



Question 3 (Adapted 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

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 (Nov 2011 Question 3.3 & 3.4)

- 5.1 The peppered-moth, *Biston betularia*, has two phenotypes for body colour, dark (blackish) and pale (whitish). The trunks of the trees on which the moths rest are black in polluted environments compared to the white trunks of trees in unpolluted environments. In both unpolluted and polluted environments, birds are the predators of the moths.

An investigation was carried out to determine the number of dark and pale peppered-moths present in polluted and unpolluted environments using a sampling technique.

The results of the investigation are shown in the table below.

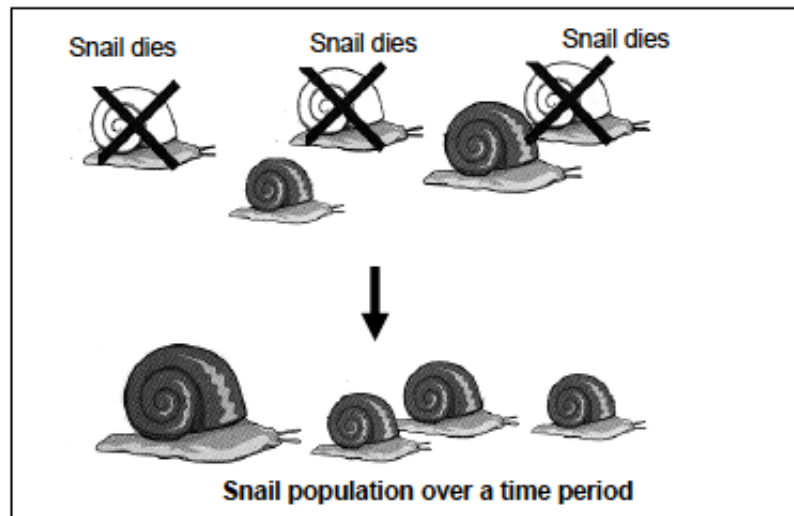
TYPE OF ENVIRONMENT	DARK MOTHS	PALE MOTHS
Polluted	150	40
Unpolluted	30	170

- 5.1.1 Formulate a hypothesis for the above investigation. (3)
- 5.1.2 Suggest THREE factors that might have decreased the validity of this investigation. (3)
- 5.1.3 Using the table and your understanding of natural selection, explain the results for the polluted environment. (4)
- 5.2 Describe how sympatric speciation occurs. (6)



Question 6

Study the diagram below and answer the questions that follow.



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

HUMAN EVOLUTION

CHECK LIST

Make sure you can:

- Interpret a phylogenetic tree to show the place of the family Hominidae in the animal kingdom
- Compare characteristics of human and primates
- Discuss changes in structure that characterise human evolution
- Use fossil evidence to describe the steps in human evolution
- Discuss the contribution of African fossils and the "Out of Africa" hypothesis
- Consider the differences of alternative explanations about origins to evolution

STUDY 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°
- **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



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- **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:

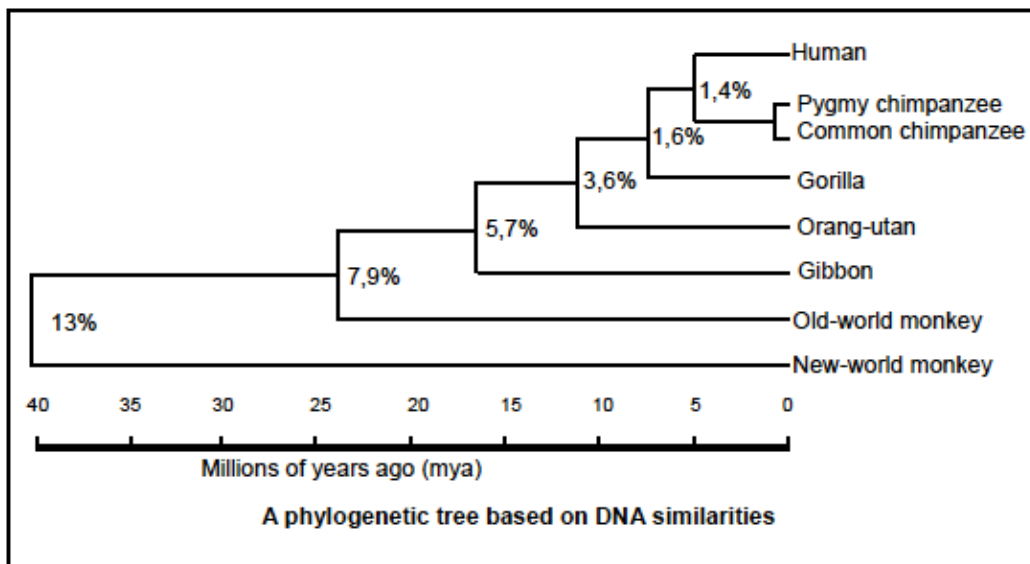
Who found it:	Date:	What was found:	Where was it found:	Relevance:
Raymond Dart	1924	juvenile <i>Australopithecus africanus</i> skull called the Taung Child	Taung is a small town in the North West Province	The Taung Child's skull shows that it was positioned directly above the spine, indicating an upright 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 <i>Australopithecus africanus</i> , 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 <i>Australopithecus afarensis</i> 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 <i>Australopithecus</i> 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
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Question 1

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.

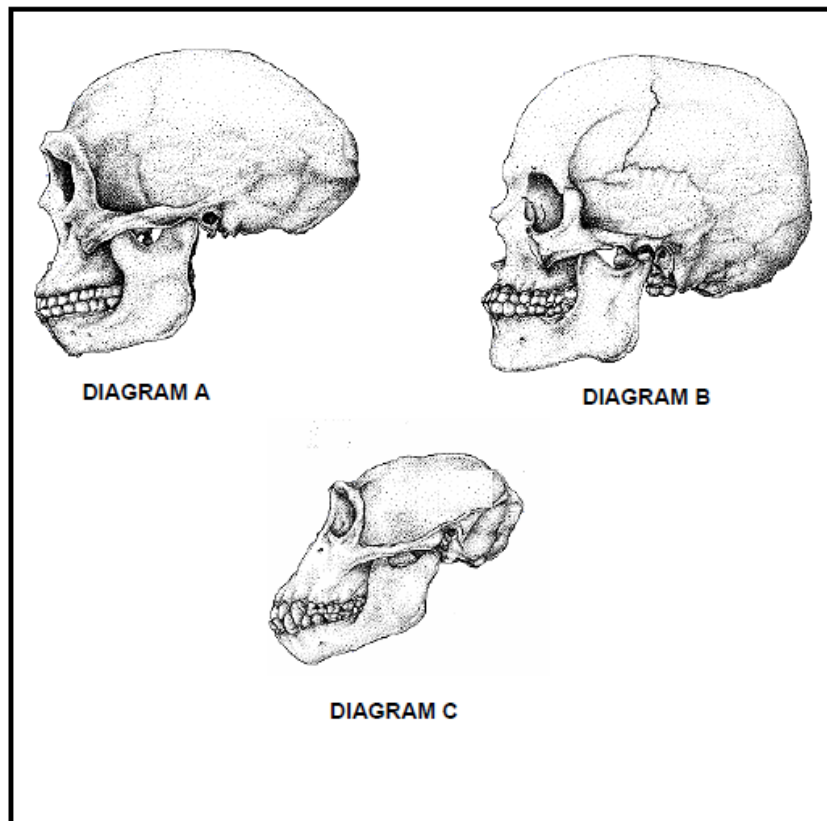


[Adapted from: Senior Biology 2]

- 1.1. From the diagram, determine how long ago the chimpanzees split from the line to humans. (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 (Nov 2011 P1 Question 3.1)

DIAGRAMS A, B and C below illustrate the skulls of Homo sapiens, Homo erectus and Pan troglodytes (chimpanzee). The diagrams are drawn to scale.



2.1 From the DIAGRAMS (A, B and C), name the species that appeared on Earth as follows:

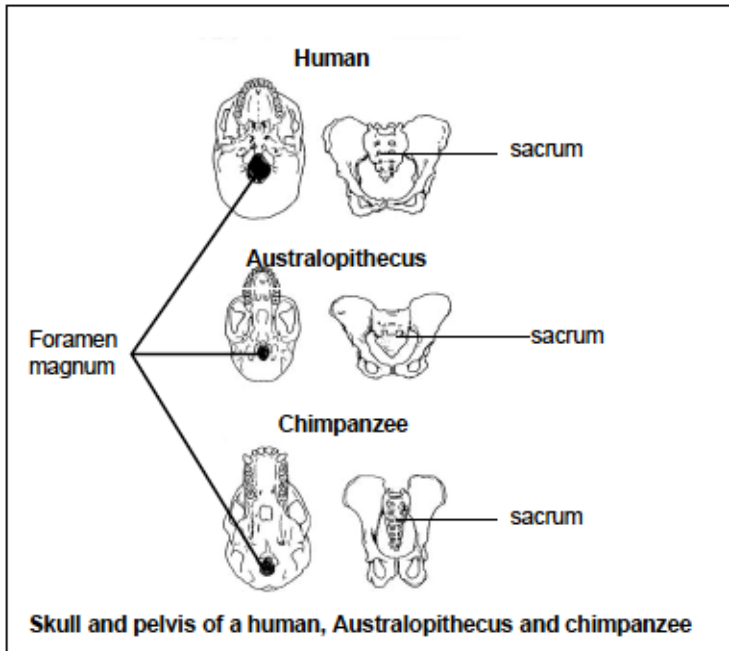
- (a) First
- (b) Second
- (c) Third (3)

2.2 Tabulate THREE visible structural differences between DIAGRAM A and DIAGRAM B that illustrate evolutionary trends in human development. (7)



Question 3

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

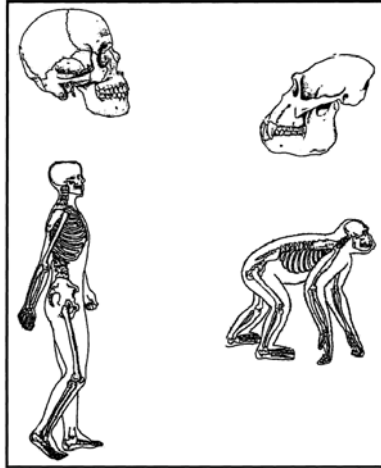


- 3.1. Tabulate FOUR observable differences of the skull and pelvis of a human and a chimpanzee. (9)
- 3.2. Which organism(s) is/are bipedal? (2)
- 3.3. Give ONE reason, observed from the diagram, for your answer to QUESTION 3.2. (2)
- 3.4. State ONE visible difference between the skull of Australopithecus and a human. (2)



Question 4

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

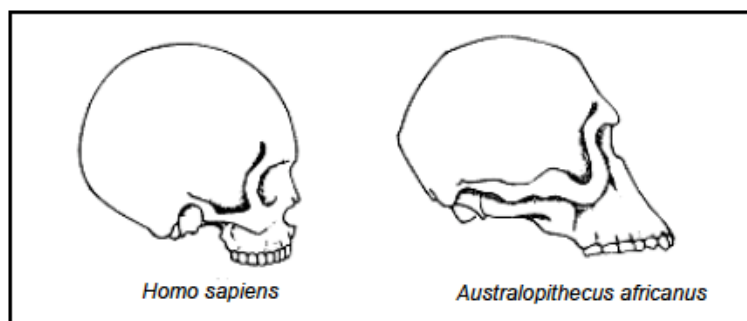


- 4.1. State ONE reason why apes and humans are referred to as 'hominids'. (2)
- 4.2. Name the term used to describe the locomotion of
 - a) humans (1)
 - b) chimpanzees (1)
- 4.3. Suggest TWO ways in which locomotion of modern humans will be disadvantaged if they had the skeletal structure of apes and 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]

Question 5

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]



DNA & RNA

DNA & RNA QUESTIONS

Question 1 (Adapted from Nov 2011, Feb 2012 & Exemplar 2011, P1, Question 1)

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

1.1 RNA differs from DNA in that it ...

- A has thymine and a phosphate group.
- B has a deoxyribose sugar and cytosine.
- C is a double stranded molecule.
- D has uracil and a ribose sugar.

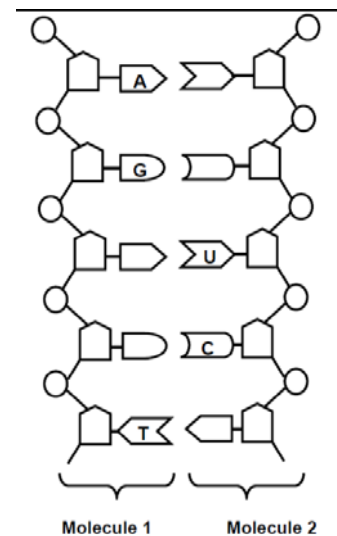
QUESTIONS 1.2 to 1.4 are based on the diagrammatic representation below of a part of two different nucleic acid molecules found in the cells of organisms during a stage in the process of protein synthesis.

1.2 The diagram above illustrates the process of ...

- A replication.
- B transcription.
- C translation.
- D mutation.

1.3 The process illustrated above occurs in the ...

- A cytoplasm.
- B centrosome.
- C ribosome.
- D nucleus.



1.4 An observable difference between molecule 1 and molecule 2 is that ...

- A molecule 1 is double stranded and molecule 2 is single stranded.
- B molecule 1 contains deoxyribose sugars and molecule 2 contains ribose sugars.
- C molecule 1 has thymine and molecule 2 has uracil.
- D molecule 1 is longer than molecule 2.



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1.5 The mRNA sequence from a portion of a DNA template GATCAA is ...

- A CTAGTT.
- B CUAGUU.
- C AGCTGG.
- D AGCUGG.

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

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

1.7 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 |

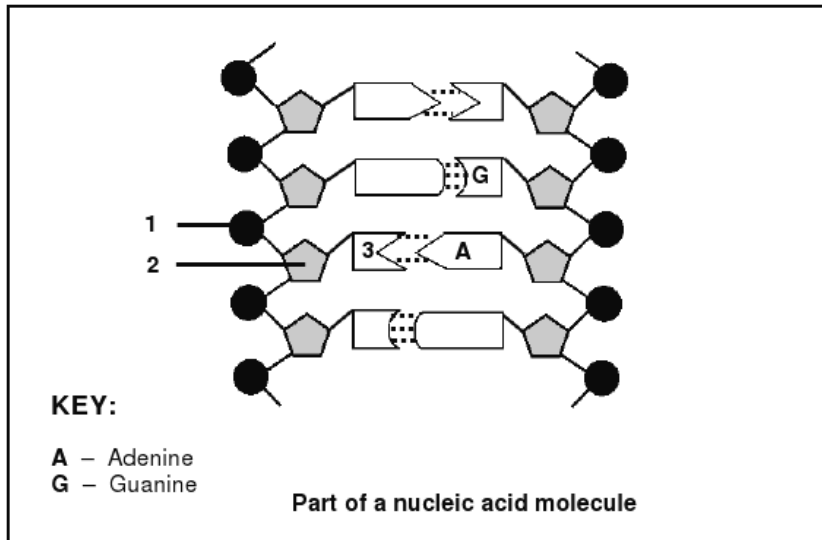
1.8 If all 18 nucleotides of a DNA strand code for amino acids, how many amino acids will be present in the polypeptide that is formed?

- A 9
- B 18
- C 7
- D 6



Question 2 (Adapted from Nov 2011, P1, Question 4.1)

Study the diagram below which represents a part of a nucleic acid molecule and answer the questions that follow.



- 2.1 Identify the nucleic acid shown in the diagram above. (1)
- 2.2 Label the following:
- (a) Part 1
 - (b) Part 2
 - (c) The nitrogenous base 3 (3)
- 2.3 What is the collective name for the parts numbered 1, 2 and 3? (1)



Question 3 (Adapted from Nov 2011, P1, Question 4.3)

The questions below are based on protein synthesis.

3.1 Describe the role of DNA during transcription in protein synthesis. (4)

3.2 The diagram below shows the sequence of nitrogenous bases of a small part of a strand of DNA which codes for part of a protein molecule.

CGG — TAT — CCT

Write down the mRNA codon sequence that reads from left to right from the DNA sequence above. (3)

3.3 The table below shows the tRNA anticodons and their corresponding amino acids.

ANTICODONS OF tRNA	AMINO ACIDS
CAA	Valine
CCC	Glycine
CGU	Alanine
AAA	Phenylalanine
UUA	Asparagine
UAC	Methionine
GGU	Proline
ACC	Tryptophan
UCA	Serine

Select and write down from the table above, the amino acids (in the correct sequence) that would be required for the base sequence of mRNA shown below.

GGG — CCA — AGU

(3)

Question 4 (Adapted from Exemplar 2011, P1, Question 4.3)

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)

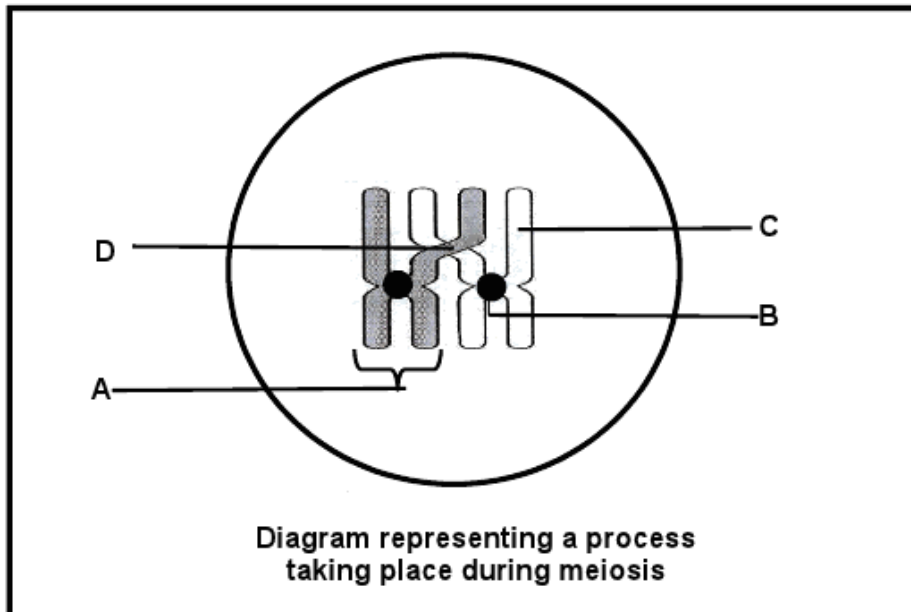


MEIOSIS

MEIOSIS QUESTIONS

Question 1 (Adapted from Exemplar 2011, P1, Question 2.3)

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

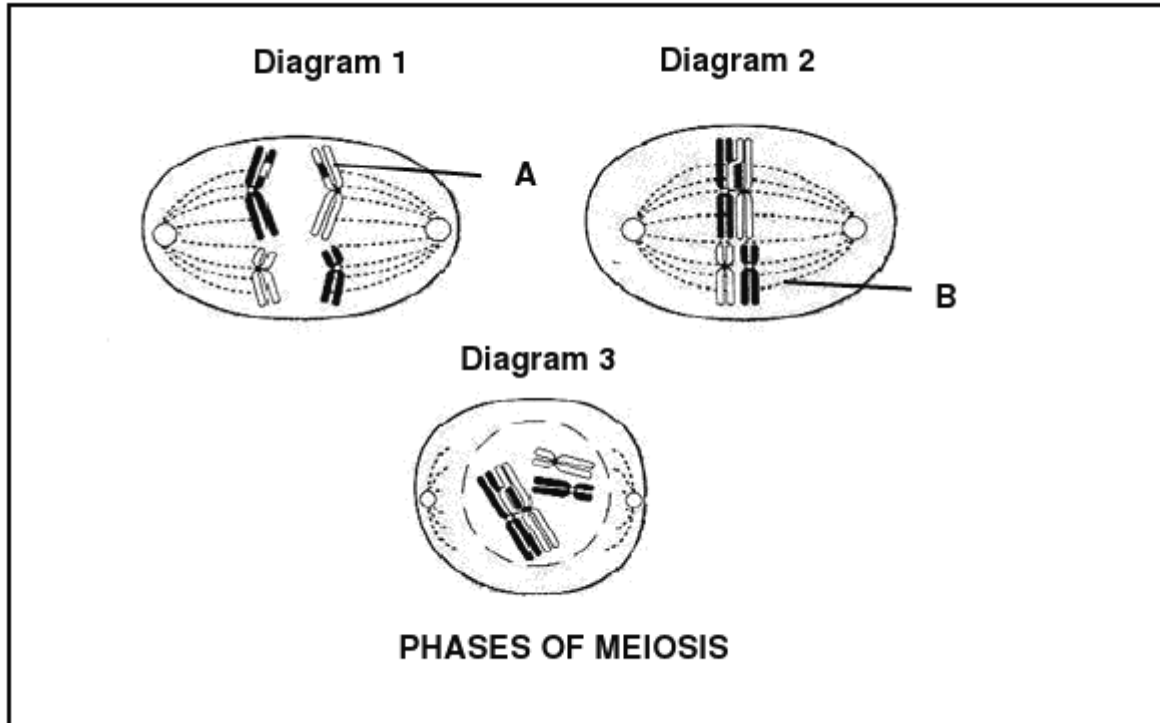


- 1.1 Give labels for parts B, C and D. (3)
- 1.2 Name the process in meiosis that is illustrated in the diagram above. (1)
- 1.3 State ONE importance of the process named in QUESTION 1.2. (1)
- 1.4 Draw a diagram of the structure labelled A to show its appearance immediately after the process named in QUESTION 1.2. (2)



Question 2 (Adapted from Feb/Mar 2012, P1, Question 2.1)

Study the diagrams below which illustrate some phases of meiosis I.



- 2.1 Label parts A and B respectively. (2)
- 2.2 The diagrams above are not placed in the correct sequence. Use the diagram numbers to write down the correct sequence in which part of the process of meiosis I takes place. (2)
- 2.3 Give TWO observable reasons why the phases in the diagram are part of meiosis I. (2)

Question 3 (Adapted from Nov 2011, P1, Question 4.4)

Describe the mechanisms by which meiosis contributes to genetic variation and describe how abnormal meiosis leads to Down's syndrome and polyploidy. Also describe the advantages of polyploidy in agriculture.

Content (17)

Synthesis (3)

Question 4 (Adapted from Feb/Mar 2012, P1, Question 4.3)

Describe how point mutations, frame-shift mutations and meiosis contribute to genetic variation.

Content (17)

Synthesis: (3)



GENETICS

GENETICS QUESTIONS

Question 1 (*Adapted from Feb 2012 & Nov 2011, P1, Question 1.2.*)

Give the correct biological term for each of the following descriptions:

- 1.1 Chromosomes other than the sex chromosomes.
- 1.2 The transfer of a selected gene from one organism to another.
- 1.3 All the genes of a particular species.
- 1.4 The position of a gene on a chromosome.
- 1.5 Different forms of a gene which occur at the same locus.
- 1.6 A cell condition in which the nucleus contains a single set of chromosomes.

Question 2 (*Adapted from Nov 2011, P1, Question 1.3*)

Indicate whether each of the statements in COLUMN I applies to **A ONLY**, **B ONLY**, **BOTH A AND B** or **NONE** of the items in COLUMN II.

COLUMN I	COLUMN II
2.1 The type of gene mutation where only one nitrogenous base is replaced with another in the mRNA template	A: Frame-shift mutation B: Point mutation
2.2 The physical and functional expression of a gene	A: Genotype B: Phenotype

Question 3 (*Adapted from Nov 2011, P1, Question 1.1.7 & 1.1.10*)

Various options are provided as possible answers to the following questions. Choose the correct answer.

- 3.1 Blood group AB is a result of ...
- A complete dominance.
 - B polygenic inheritance.
 - C incomplete dominance.
 - D co-dominance.



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3.2 The probability that two heterozygous parents will have a homozygous dominant offspring, is ...

- A 75%.
- B 50%.
- C 25%.
- D 100%.

Question 4 (Adapted from Feb 2012, P1, Question 2.3)

A boy's mother had a patch of white hair called a 'white forelock' which is caused by a dominant allele **H**. The mother is heterozygous for this trait. His father does not have a 'white forelock'. The symbol for the recessive allele is **h**.

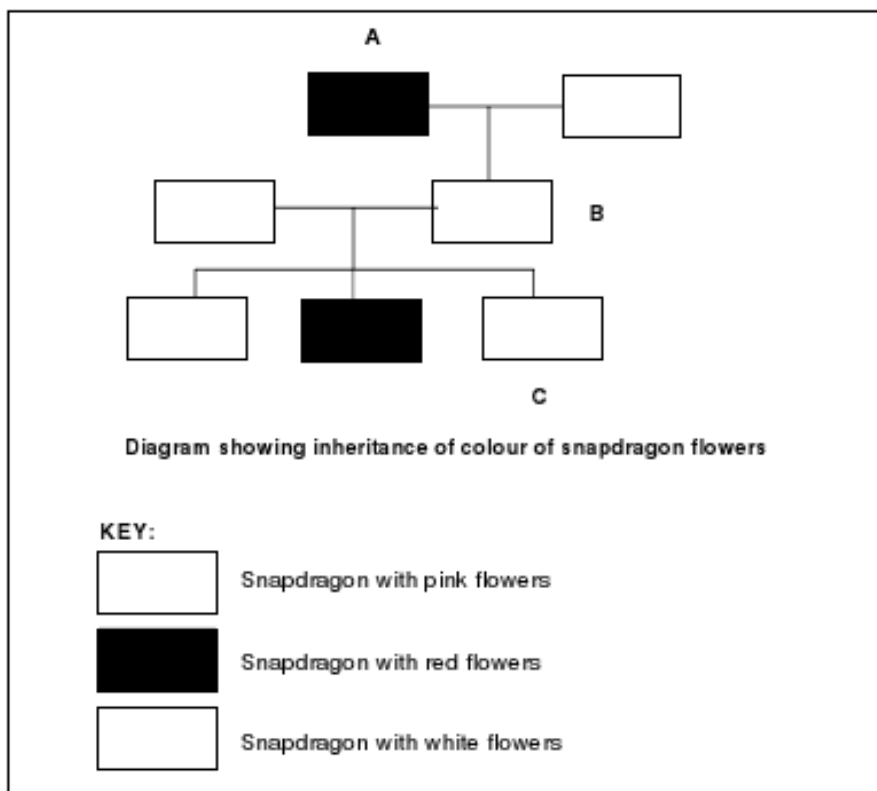
Represent a genetic cross to determine the possible genotypes and phenotypes of the children. (6)

Question 5 (Adapted from Nov 2011, P1, Question 1.4)

Study the diagram below which shows three generations of snapdragon plants and answer the questions which follow. Use the following symbols for the contrasting alleles:

W – for white flowers

R – for red flowers



5.1 State the kind of dominance shown in the diagram above.

(1)



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5.2 Use the symbols **R** and **W** and write down the genotypes of each of the following snapdragon plants:

- (a) A (2)
- (b) B (2)
- (c) C (2)

Question 6 (Adapted from Nov 2011, P1, Question 2.1)

Haemophilia is a sex-linked disease caused by the presence of a recessive allele (X^h). A normal father and heterozygous mother have children.

6.1 Represent a genetic cross to determine the possible genotypes and phenotypes of the children of the parents mentioned in above.

(6)

6.2 What are the chances of the parents having a child that will be a haemophiliac male?

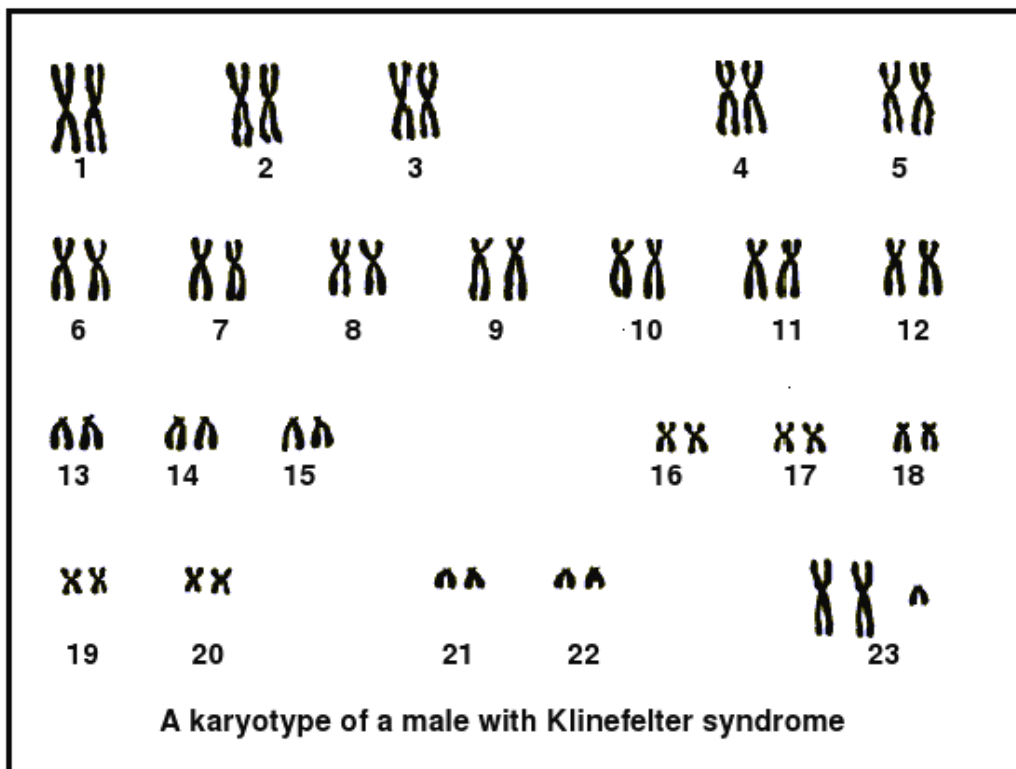
(2)

6.3 Explain why the father is not a carrier for haemophilia.

(2)

Question 7 (Adapted from Feb 2012, P1, Question 2.2)

The karyotype below is that of a male person with a genetic disorder called Klinefelter syndrome.





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- 7.1 State ONE visible difference between the karyotype above and the karyotype of a normal male. (2)
- 7.2 Use your knowledge of meiosis to explain how Klinefelter syndrome could have resulted. (6)

Question 8 (*Adapted from Nov 2011, P1, Question 2.3*)

Height of humans is a trait that is controlled by more than one gene. The Grade 12 learners at a girl's school did an investigation to determine the height of the Grade 12 learners.

The results of the investigation are shown in the table below.

Height (cm)	150–151	152–153	154–155	156–157	158–159	160+
Number of girls	5	18	30	24	14	2

- 8.1 Plot a histogram using the information in the table above. (9)
- 8.2 Name this type of inheritance that is controlled by more than one gene. (1)
- 8.3 How is the type of inheritance, named in QUESTION 8.2, different from that of inheritance due to one gene? (2)
- 8.4 State TWO other possible variables/factors that might have an influence on the height of a person. (2)

Question 9 (*Adapted from Feb 2012, P1, Question 4.1*)

The table below shows the percentage distribution of blood groups in a province in South Africa.

BLOOD GROUPS			
A	B	AB	O
35	15	10	40

- 9.1 How many genes control the blood groups shown above? (1)
- 9.2 Explain how it is genetically possible to have four blood groups in a population. (2)
- 9.3 Draw a pie chart using the information in the table above. Show ALL calculations. (8)



BIOTECHNOLOGY

BIOTECHNOLOGY QUESTIONS

Question 1 (*Adapted from Feb 2012, P1, Question 4.1*)

The table below shows the percentage distribution of blood groups in a province in South Africa.

BLOOD GROUPS			
A	B	AB	O
35	15	10	40

1.1 How many genes control the blood groups shown above? (1)

1.2 Explain how it is genetically possible to have four blood groups in a population. (2)

1.3 Draw a pie chart using the information in the table above. Show ALL calculations. (8)

Question 2 (*Adapted from Nov 2011, P1, Question 2.2*)

The risks and benefits of using biotechnology have been the subject of considerable debate in recent times. State the following:

2.1 THREE disadvantages of genetic engineering. (3)

2.2 THREE advantages of genetic engineering (3)

Question 3 (*Adapted from Nov 2011, P1, Question 2.3*)

Height of humans is a trait that is controlled by more than one gene. The Grade 12 learners at a girl's school did an investigation to determine the height of the Grade 12 learners.

The results of the investigation are shown in the table below.

Height (cm)	150–151	152–153	154–155	156–157	158–159	160+
Number of girls	5	18	30	24	14	2

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3.2 Name this type of inheritance that is controlled by more than one gene. (1)

3.3 How is the type of inheritance, named in QUESTION 8.2, different from that of inheritance due to one gene? (2)

3.4 State TWO other possible variables/factors that might have an influence on the height of a person. (2)



Question 4 (*Adapted from Feb/Mar 2012, P1, Question 3.1 & 3.2*)

4.1 A young couple wants to have a child, but they are aware of a serious genetic disorder in one of their families that could be carried through to their offspring.

In this case state:

4.1.1 ONE advantage of DNA testing. (1)

4.1.2 THREE benefits of genetic counselling. (3)

4.2 State TWO ways in which DNA profiling can be used to our advantage. (2)

Question 5 (*Adapted from Exemplar 2011, P1, Question 4.2*)

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

5.1 Plot line graphs, on the same set of axes, using the information in the table above.

(12)

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



SOLUTIONS TO THEORIES OF EVOLUTION

Question 1 (Nov 2011 Question 1.1.1 – 1.1.6)

- 1.1 B✓✓
1.2 C✓✓
1.3 D✓✓
1.4 C✓✓
1.5 A✓✓
1.6 A✓✓ (10 x 2) (20)

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 (Nov 2011 Question 3.3 & 3.4)

5.1.1 More/fewer✓ dark peppered moths✓/ pale peppered moths survive in the polluted /unpolluted environment✓ than in the unpolluted / polluted environment

OR

No difference✓ in the number of dark/ pale peppered✓ moths that survive in both environments✓. Max (3)

5.1.2 - Was not a closed system so moths could fly in and out of the environment✓ / migration may have taken place

- The number of predators might have been different in both polluted and unpolluted environment✓

- Both environments could have been different with regard to vegetation found in them✓

- Both environments could have been different with regard to climatic conditions ✓

- Human error in sampling✓/counting/recording/no repeats

(Mark first THREE only) Any 3 (3)

5.1.3 - Variation in the moth population produces dark and pale forms✓

- The dark moths were camouflaged by black tree trunks✓/not easily detected by birds/predators

- More dark moths survived✓ / able to reproduce /fewer eaten by birds

- Pale moths were NOT camouflaged by the black tree trunks✓/ easily detected by birds

- Fewer pale moths survived✓/fewer able to reproduce/more eaten by birds

(Max 4) (4)

5.2 - There is variation in a population✓

- *Population occupies the same area✓ / No geographical barrier

- *They may separate into different groups/ different niches due to differences in behavioural patterns✓ / feeding habits / due to polyploidy

- Each group undergoes natural selection independently✓ and develops differently✓

- Genotypically✓ and phenotypically✓

- Gene flow✓ /reproduction between the different populations does not occur

- The differences that develop between the different populations prevent them from inter-breeding✓ even if they were to mix

- Such that each group becomes a new species✓

(Max 4 + 2* compulsory marks) (6)

Question 6

6.1 Natural selection– those organisms with the most beneficial ✓ traits are more likely to survive and reproduce✓. (2)

6.2 Organisms produce more offspring ✓ than can survive. These organisms compete for limited resources✓

There is variation ✓ in populations. Organisms change over time, those living today are different to those who lived in the past✓, i.e.

Change is gradual and slow, taking place over a long time✓



The mechanism of evolutionary change was natural selection ✓
All organisms are derived from common ancestors ✓ by a process of
branching, i.e. organisms pass genetic traits to the next generation ✓

Any 6 (6)
[8]

SOLUTIONS TO HUMAN EVOLUTION

Question 1

- 1.1 5P mya ✓✓ (2)
1.2 Chimpanzee ✓✓✓ (1)
1.3 98,6 ✓% ✓ (2)
[5]

Question 2 (Nov 2011 P1 Question 3.1)

- 2.1 (a) Pan troglodytes ✓/chimpanzee/C
(b) Homo erectus ✓/A
(c) Homo sapiens ✓/B
OR
(a) Homo erectus ✓/A
(b) Pan troglodytes ✓/chimpanzee/C
(c) Homo sapiens ✓/B

2.2

DIAGRAM A/Homo erectus	DIAGRAM B/Homo sapiens
1 Small cranium/brain ✓	1 Large cranium/brain ✓
2 Less rounded cranium/skull/flatter forehead ✓	2 More rounded cranium/ skull/ forehead ✓
3 Prognathus ✓/ protruding jaws	3 Not prognathus ✓
4 No obvious chin ✓	4 Pronounced chin ✓
5 Eyebrow ridges visible ✓	5 Eyebrow ridges less visible ✓
6 Eyes face forward ✓	6 Eyes to the side ✓
7 More developed cheekbone/zygomatic arch ✓	7 Less developed cheek bone/ zygomatic arch ✓
8 Bigger lower jaw ✓	8 Slightly smaller lower jaw ✓

Mark first 3 only

1 mark for table + (3x2)

(7)



Question 3

1.1

HUMAN	CHIMPANZEE
Foramen magnum more central / in the middle/ Spinal cord exits underneath skull ✓	Foramen magnum at back of skull /Spinal cord exits at the back of skull ✓
Rounded / bigger skull ✓	Narrower / smaller skull ✓
Small canines ✓	Large canines ✓
No gap between teeth ✓	Gaps between teeth ✓
Dental arch /teeth arrangement more rounded ✓	Dental arch / teeth arrangement more rectangular ✓
Pelvis wide/ bowl shaped ✓	Pelvis tall / narrow ✓
Sacrum bigger / shorter ✓	Sacrum longer / narrow ✓

(Any 4 x 2) Tabulate ✓ +1 (9)

1.2 Human ✓ and Australopithecus ✓ (2)

1.3 The foramen magnum of both Human and Australopithecus is placed in the middle of the skull ✓ adaptation for upright walking/bipedalism ✓ (2)

1.1 Human has larger skull ✓/brain than Australopithecus / rounder skulls (Any 1 x 2) (2)

Question 4

4.1 No ✓ tails present ✓/tails ✓ are absent ✓ (2)

4.2 (a) Bipedal ✓ (1)

(b) Quadrupedal ✓ (1)

4.3 Their view of surroundings would have been limited. ✓
They would have been slow in ✓ moving (in their current environment) (Any reasonable answer) (2)

4.4

MAN	CHIMPANZEES
Straight finger bones	Curved finger bones
Fully opposable thumbs	Longer thumbs
Legs longer than arms	Arms longer than legs
Legs and spine almost straight	Spine rectangular to legs
Reduced snout (nose) - s-shaped	Noticeable snout – c shaped
Smaller teeth	Bigger teeth

(Any) (5x2) (10)

4.5 Makes brachiation (swinging from branches) ✓ more difficult ✓ (2)

(Any reasonable and logical answer)

[18]



Question 5

5.1

	<i>Homo sapiens</i>	<i>A. africanus</i>
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]

SOLUTIONS TO DNA & RNA

Question 1

1.1 D

1.2 B

1.3 D

1.4 C

1.5 B

1.6 B

1.7 A

1.8 D

Question 2 (Adapted from Nov 2011, P1, Question 4.1)

2.1 DNA

2.2 (a) Phosphate

(b) Deoxyribose sugar

(c) Thymine

2.3 Nucleotide

Question 3 (Adapted from Nov 2011, P1, Question 4.3)

3.1 DNA codes for a particular protein /polypeptide/amino acid sequence

One strand is used as a template to form mRNA

DNA cannot leave nucleus

3.2 GCC AUA GGA (in sequence)

3.3 Glycine Proline Serine (in sequence)



Question 4

The process of protein synthesis occurs in two steps, namely transcription and translation

Transcription

- Double stranded DNA unzips
- When the hydrogen bonds break
- One strand is used as a template
- To form mRNA
- Using free RNA nucleotides from the nucleoplasm
- The coded message for protein synthesis is thus copied onto mRNA
- mRNA moves from the nucleus to the cytoplasm and attaches to the ribosome

Max (6)

Translation

- tRNA collects amino acids
- tRNAs, with amino acids attached, become arranged on the mRNA
- The anticodons on the tRNAs match complementary bases on the codons of mRNA
- Amino acids become attached by peptide bonds to form the required protein
- Each tRNA is released to pick up more amino acids

Max (6)

Impact of gene mutations on protein synthesis

- Errors/mistakes/changes may occur during DNA replication
- Point mutation: replacing one base of a codon with another
- Small change that may possibly result in one amino acid changing in a protein
- Frameshift mutation: addition/deletion of one or more bases of a codon
- Resulting in changing the order/sequence of all the bases of the codons
- Resulting in forming a different protein with different functions

Max (5)

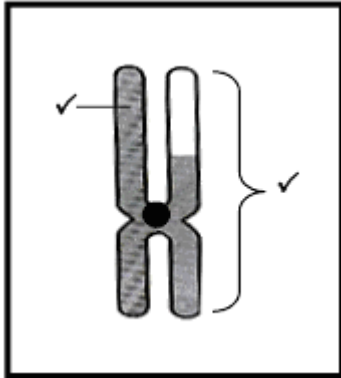
SOLUTIONS TO MEIOSIS

Question 1 (Adapted from Exemplar 2011, P1, Question 2.3)

- 1.1 B - Centromere
C - Chromatid
D – Chiasma
- 1.2 Crossing over
- 1.3 Mixing of genetic material introduces variation/gametes are different from each other



1.4



Question 2 (Adapted from Feb/Mar 2012, P1, Question 2.1)

- 2.1 A – chromatid /chromosome
B – Spindle fibre
- 2.2 Diagram 3, Diagram 2, Diagram 1 (in correct sequence)
- 2.3 Crossing over in diagram 3
Chromosomes moving to poles in diagram 1
Bivalents (homologous pair of chromosomes) lie in the equator in diagram 2

Question 3 (Adapted from Nov 2011, P1, Question 4.4)

Crossing – over

- Homologous chromosomes /bivalents pair up
- Each chromosome has 2 chromatids
- Chromatids overlap/cross over
- Points at which crossing-over takes place are referred to as chiasmata
- Genetic material is exchanged between non-sister chromatids
- After the process of crossing-over chromosomes have genes from its homologous partner
- This means that each gamete formed will have a mix of genes from maternal and paternal parents
- Brings about variation in the gametes formed and also the offspring **Max (5)**

Random arrangement of chromosomes at the equator

- Each pair of homologous chromosomes may line up either way on the equator of the spindle
- Independently of what the other pairs are doing / independent assortment
- This means that gametes will have differing number/mix of maternal and paternal chromosomes **Max (3)**

Down's syndrome

- In meiosis I the chromosome pair 21 does not separate or
- In meiosis II the chromatids of chromosome 21 do not separate / centromere



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does not divide

- Referred to as non-disjunction
- One gamete will have an extra copy of chromosome number 21 / two copies of chromosome number 21
- If this gamete fuses with a normal gamete /gamete with 23 chromosomes
- The resulting zygote will have 3 copies of chromosome number 21 instead of 2 / zygote has 47 chromosomes leading to Down's syndrome

Max (4)

Polyploidy

- During meiosis I
- There is a lack of separation of ALL homologous chromosomes /non-disjunction
- One gamete will inherit the diploid set of chromosomes
- When a diploid gamete is fertilized by a normal haploid gamete
- The zygote/offspring will have 3 sets of chromosomes /triploid
- In the similar way, tetraploid and other polyploid offspring could be formed

Max (3)

Advantages of polyploidy in agriculture

- Forms seedless varieties of fruit such as watermelons/bananas/some apples
- Polyploidy cells are bigger / produce larger flowers/fruits/storage organs
- Infertile plants become fertile e.g. wheat
- Plants may be more healthy /resistant to diseases

Max (2)

Content (17)

Synthesis (3)

Question 4 (*Adapted from Feb/Mar 2012, P1, Question 4.3*)

GENE MUTATIONS

- Errors /mistakes/changes may occur during transcription / DNA replication
- Point mutations: replacing/substituting one base of a codon with another
- Small change that may possibly result in one amino acid changing in a protein
- Frame-shift mutations: addition/deletion of one or more bases of a codon
- Resulting in changing the order/sequence of all the bases of the codons
- Resulting in forming a different protein with different functions
- Lead to different phenotypes

Max (6)

MEIOSIS

Crossing-over

- Homologous chromosomes / bivalents pair up
- Each chromosome has 2 chromatids
- Non-sister chromatids overlap/cross over
- Points at which crossing-over takes place are referred to as chiasmata
- Genetic material is exchanged between non- sister chromatids



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- After the process of crossing-over chromosomes have alleles from its homologous partner
- This means that each gamete formed will have a mix of alleles from both parents
- Brings about variation in the gametes formed and also the offspring

Max (7)

Random arrangement of chromosomes at the equator

- Each pair of homologous chromosomes may line up either way up on the equator of the spindle
- Independently of what the other pairs are doing
- This means that gametes will have differing number/mix of both parental chromosomes

Max (4)

SOLUTIONS TO GENETICS

Question 1 (Adapted from Feb 2012 & Nov 2011, P1, Question 1.2.)

- 1.1 Autosomes
- 1.2 Genetic engineering /Genetic modification/Biotechnology
- 1.3 Genome
- 1.4 Locus
- 1.5 Alleles
- 1.6 Haploid

Question 2 (Adapted from Nov 2011, P1, Question 1.3)

- 2.1 B
- 2.2 B

Question 3 (Adapted from Nov 2011, P1, Question 1.1.7 & 1.1.10)

- 3.1 D
- 3.2 C

Question 4 (Adapted from Feb 2012, P1, Question 2.3)

	Father	x	Mother	
P ₁ /parent phenotype	No white forelock		White forelock ✓	
genotype	hh	x	Hh ✓	
<i>Meiosis</i>				
G/gametes	h, h	x	H, h ✓	
<i>Fertilisation</i>				
F ₁ genotype	Hh, hh, Hh, hh ✓			
Phenotype	2 x without 'white forelock' & 2 x with 'white forelock' ✓			

OR

Gametes	H	h
h	Hh	hh
h	Hh	hh

1 mark for correct gametes
1 mark for correct genotypes

Parents and offspring ✓/P₁ and F₁
Meiosis and fertilisation ✓

Max (6)



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Question 5 (Adapted from Nov 2011, P1, Question 1.4)

- 5.1 Incomplete dominance
5.2 (a) RR
(b) RW
(c) WW

Question 6 (Adapted from Nov 2011, P1, Question 2.1)

6.1

	P₁/parent	<i>phenotype</i>	Father	x	Mother	
			Normal		Normal	✓
		<i>genotype</i>	X ^H Y	x	X ^H X ^h	✓
Meiosis	G/gametes		X ^H , Y	x	X ^H , X ^h	✓
Fertilisation						
	F₁/offspring	<i>genotype</i>	X ^H X ^H , X ^H X ^h , X ^H Y , X ^h Y ✓			
		<i>phenotype</i>	2 normal daughters, 1 normal son, 1 son with haemophilia ✓			

Gametes	X ^H	X ^h
X ^H	X ^H X ^H	X ^H X ^h
Y	X ^H Y	X ^h Y

OR

1 mark for correct gametes
1 mark for correct genotypes

Max (6)

- 6.2 25 %
6.3 The male has only one X chromosome Y chromosome does not have the allele for this trait

Question 7 (Adapted from Feb 2012, P1, Question 2.2)

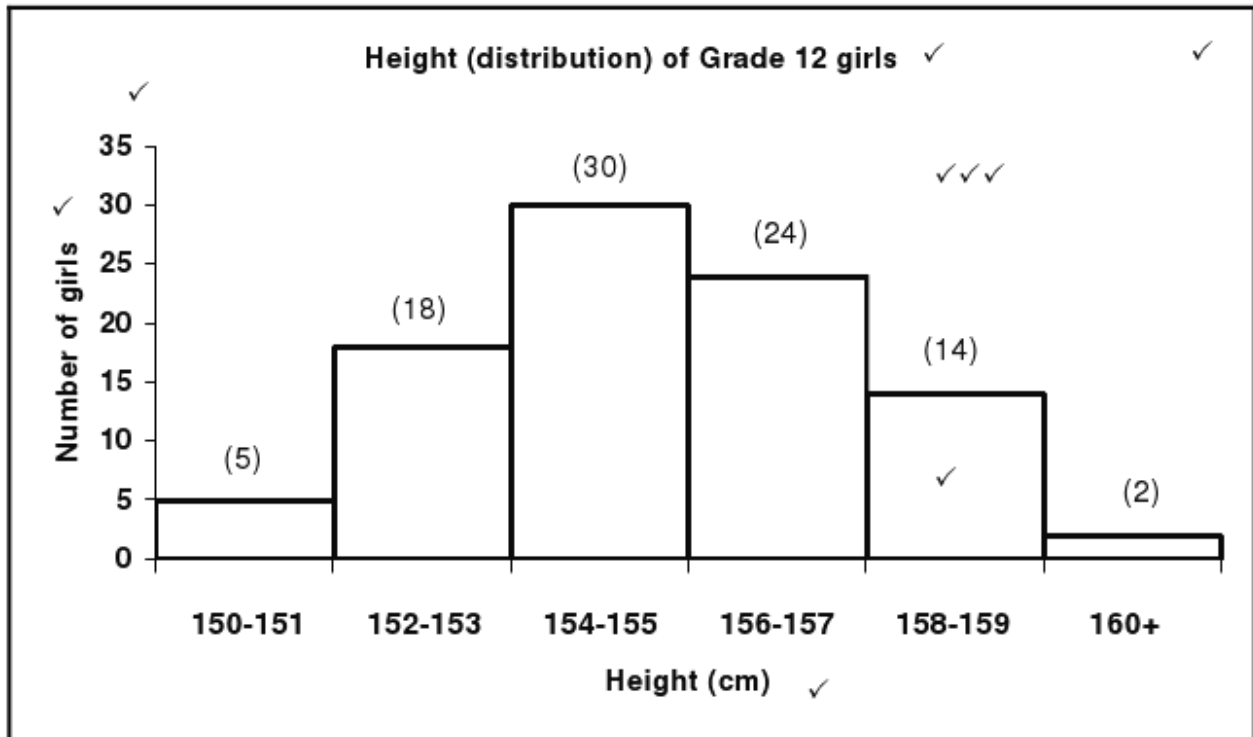
- 7.1 Normal male karyotype has an X and Y chromosome at 23
Klinefelter syndrome karyotype has an extra X chromosome /
3 chromosomes at number 23/two X and one Y chromosomes
- 7.2 During meiosis 1 the homologous chromosome pair 23 of the female parent does not separate /there is non-disjunction



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Question 8 (Adapted from Nov 2011, P1, Question 2.3)

8.1



8.2 Polygenic inheritance /polygeny

8.3 Polygenic: Genes at different/multiple loci

One gene: Gene at one locus

8.4 -Environmental factors /Nutrition

-Sex /Gender

-Age

-Medical conditions

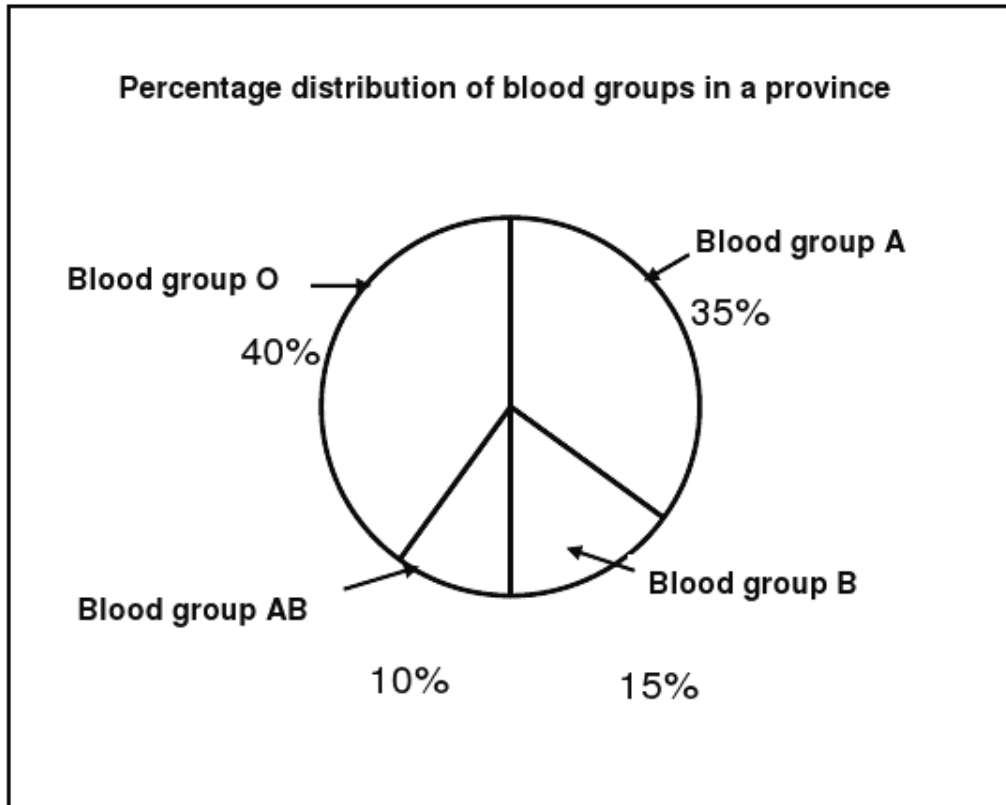
Question 9 (Adapted from Feb 2012, P1, Question 4.1)

9.1 One

9.2 Blood groups are controlled by three alleles / I^A , I^B , I which when in combination provide four phenotypes /A, AB, B, O.



9.3



Calculations

$$\begin{aligned} \text{Blood group A: } & \frac{35}{100} \times \frac{360}{1} \\ & = 126^\circ \end{aligned}$$

$$\begin{aligned} \text{Blood group B: } & \frac{15}{100} \times \frac{360}{1} \\ & = 54^\circ \end{aligned}$$

$$\begin{aligned} \text{Blood group AB: } & \frac{10}{100} \times \frac{360}{1} \\ & = 36^\circ \end{aligned}$$

$$\begin{aligned} \text{Blood group O: } & \frac{40}{100} \times \frac{360}{1} \\ & = 144^\circ \end{aligned}$$



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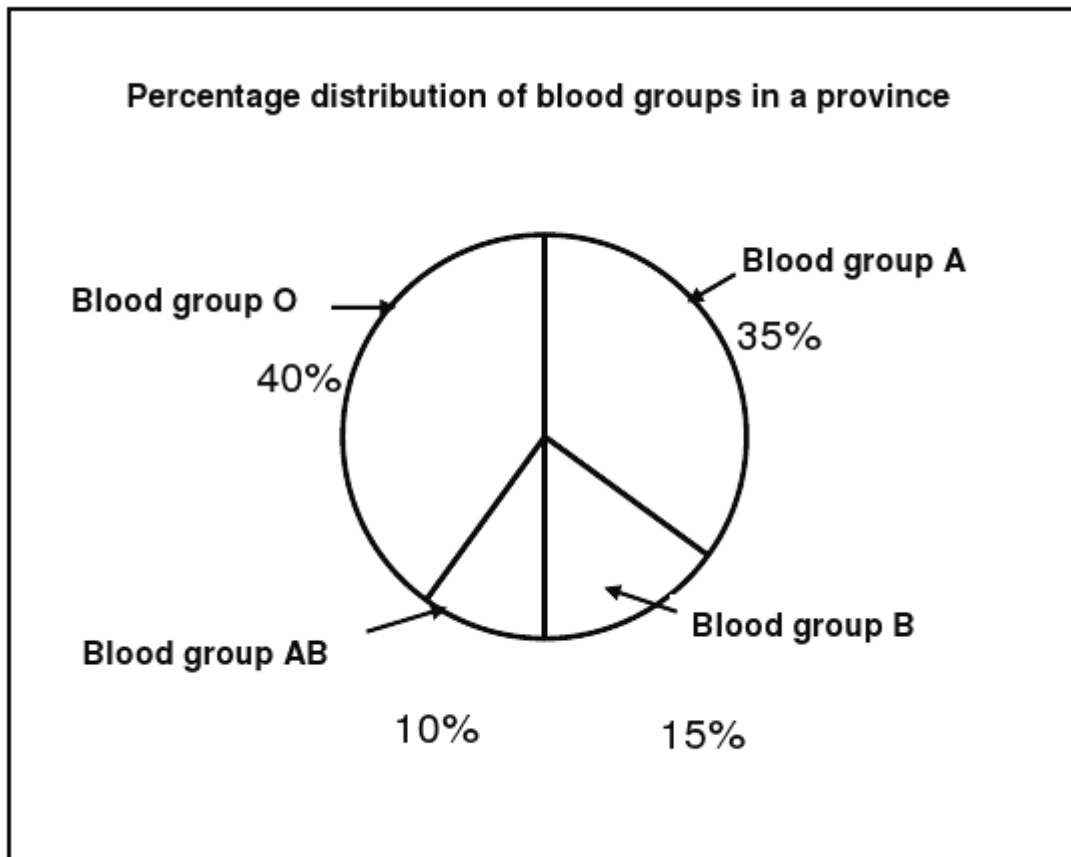
SOLUTIONS TO BIOTECHNOLOGY

Question 1 (Adapted from Feb 2012, P1, Question 4.1)

1.1 One

1.2 Blood groups are controlled by three alleles / I^A , I^B , I which when in combination provide four phenotypes / A, AB, B, O.

1.3





Calculations

$$\begin{aligned} \text{Blood group A: } & \frac{35}{100} \times \frac{360}{1} \\ & = 126^\circ \end{aligned}$$

$$\begin{aligned} \text{Blood group B: } & \frac{15}{100} \times \frac{360}{1} \\ & = 54^\circ \end{aligned}$$

$$\begin{aligned} \text{Blood group AB: } & \frac{10}{100} \times \frac{360}{1} \\ & = 36^\circ \end{aligned}$$

$$\begin{aligned} \text{Blood group O: } & \frac{40}{100} \times \frac{360}{1} \\ & = 144^\circ \end{aligned}$$

Question 2 (Adapted from Nov 2011, P1, Question 2.2)

2.1 Disadvantages of genetic engineering

Expensive

May be difficult for poor people to access

Interfere with nature

Immoral / we cannot play God

Domination of the world food products by only a few companies

- Loss of biodiversity
- Potential health impacts
- Violation of natural organism's intrinsic value (right to independent existence)
- Unsure of long term effects
- Genes from transgenic organisms could escape and be transferred to wild organisms

2.2 Advantages of genetic engineering

Production of medication

Production of resources cheaply

Control pests with specific genes inserted into the crop

Selecting the best genes to produce better resistant crops

Using specific genes to increase crop yields / food security

Selecting genes to increase shelf life of plant products

Selecting genes that may increase maturation times to meet the demand

Selecting genes that may decrease maturation times to meet the demand

Using specific genes to improve nutritional value of food for better health

Improve the taste of food

DNA and proteins of transgenic organisms unlikely to cause problems / transgenic organisms do not survive easily in wild

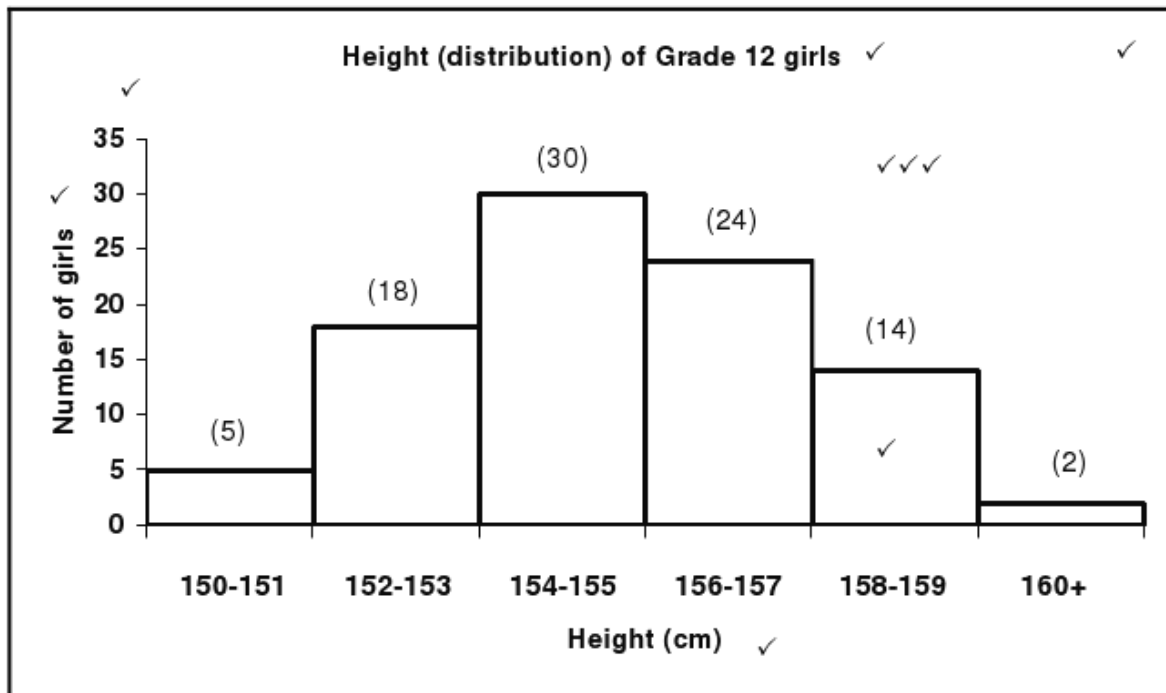


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Produce organisms that can clean up pollution
Endangered species can be saved
Increases genetic variation

Question 3 (Adapted from Nov 2011, P1, Question 2.3)

3.1



- 3.2 Polygenic inheritance /polygeny
- 3.3 Polygenic: Genes at different/multiple loci
One gene: Gene at one locus
- 3.4 -Environmental factors /Nutrition
-Sex /Gender
-Age
-Medical conditions

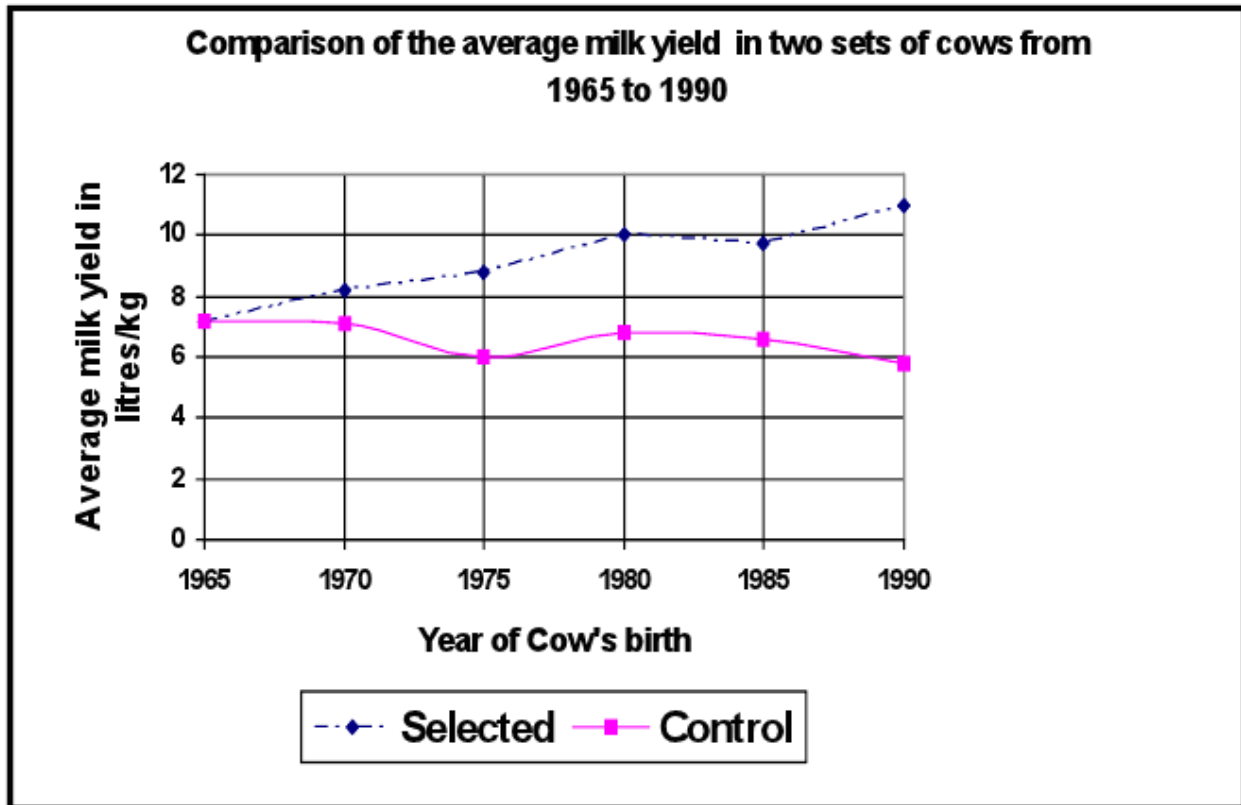
Question 4 (Adapted from Feb/Mar 2012, P1, Question 3.1 & 3.2)

- 4.1.1 To identify specific defective genes /to find out if they are possible carriers
- 4.1.2 To be given advice on the risk of transferring the defective gene / to find the probability of passing on the defective gene to offspring
-To be able to make decisions on whether they want to have children
-To be given explanation of the results of DNA
- To be given explanation of procedure to be involved in DNA testing
- 4.2 Identify criminals /biological evidence
Identify deceased bodies
Identify relatives / missing person/paternity



Question 5 (Adapted from Exemplar 2011, P1, Question 4.2)

5.1



5.2 $11,0 - 7,2 = 3,8$ litres/kg