Study & Master

Life Sciences

CAPS

Teacher's Guide

Grade 12

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SECTION A

INTRODUCTION

Introduction to Life Sciences

Life Sciences could be defined as the scientific study of living things from molecular level to their interactions with one another and their interactions with the environment.

Life Sciences is important for the following reasons:

- To provide useful knowledge and skills that are needed in everyday life.
- To expose learners to the range and scope of biological studies, to stimulate interest in and create awareness of possible specialisations, e.g. medicine, pharmacy, genetics, research, environmental occupations, botany, zoology, and so on.
- To provide sufficient background/foundation for further studies in one or more of the biological sub-disciplines, e.g. Botany, Zoology, Physiology, Genetics, Biochemistry, Biotechnology, and so on.

The organisation of the Life Sciences curriculum

Four "Knowledge Strands" are used as organisers of the Life Sciences content framework. These are developed progressively over the three years of FET.

In Grade 12, three of the four Knowledge Strands are addressed and serve to ensure progression. The content described in Environmental Studies: Human Impacts (Current Crises) is dealt with in Grade 11 in order to lessen the pressure in Grade 12 but this Knowledge Strand will be examined in the National Senior Certificate examination at the end of Grade 12.

The recommended Grade 12 teaching sequence for the four Knowledge Strands is:

1 Life at Molecular, Cellular and Tissue level (DNA and protein synthesis)
2 Life Processes in Plants and Animals (Processes that sustain life)
3 Diversity, Change and Continuity (Darwinsim and human evolution)
4 Environmental Studies (Human impact, taught and assessed in Grade 11)

This is the recommended teaching sequence in Grade 12. However, none of the Knowledge Strands, nor the topics within each Strand, should be studied separately or independently. Learners should be able to see the links with related topics so that they acquire a thorough understanding of the nature and inter-connectedness of life. These links must also be made across grades.

It is useful, therefore, to know the content and concept progression of Life Sciences over the three years of FET, as shown in Table 1.

Table 1 The concept and content progression of Life Sciences through Grades 10–12

Strands/grades	Life at the molecular, cellular and tissue level	Life processes in plants and animals	Environmental Studies	Diversity, change and continuity
Grade 10	**1** Chemistry of life – inorganic and organic compounds **2** Cell – unit of life **3** Cell division (mitosis) **4** Plant and animal tissues	**1** Support and transport systems in plants **2** Support systems in animals **3** Transport systems in mammals (humans)	**1** Biosphere to ecosystems	**1** Biodiversity and classification **2** History of life and Earth
Grade 11		**1** Energy transformations to support life: photosynthesis **2** Animal nutrition **3** Energy transformations: respiration **4** Gas exchange **5** Excretion	**1** Population ecology **2** Human impact on environment: current crises	**1** Biodiversity – classification of micro-organisms **2** Biodiversity – plants **3** Reproduction – plants **4** Biodiversity -– animals
Grade 12	**1** DNA code of life **2** RNA and protein synthesis **3** Meiosis **4** Genetics	**1** Reproduction in vertebrates **2** Human reproduction **3** Nervous system **4** Senses **5** Endocrine system **6** Homeostasis		**1** Darwinism and natural selection **2** Human evolution

The specific aims of Life Sciences

There are *three* broad subject-specific aims in Life Sciences, which relate to the purposes of learning science. These are:

Specific Aim 1: which relates to knowing the subject content

Specific Aim 2: which relates to doing science or practical work and investigations

Specific Aim 3: which relates to understanding the applications of Life Sciences in everyday life, as well as understanding the history of scientific discoveries and the relationship between indigenous knowledge and science.

The meaning of the specific aims and their relationship to assessment

Specific Aim 1: Knowing Life Sciences (Life Sciences concepts, processes, phenomena, mechanisms, principles, theories, laws, models, etc)

The following cognitive (thinking) skills comprise the range of skills that all learners should develop by working through the curriculum in a school year. These skills indicate what should be assessed at the appropriate grade level using a variety of assessments:

- Acquire knowledge – learners must: access information from a variety of sources (teachers, textbooks, internet, parents, etc); select key ideas; recall facts and describe concepts, processes, phenomena, mechanisms, principles, theories, laws and models in Life Sciences.
  Action verbs to be used in assessment include: *state, name, label, list, define, describe*.

- Understand and make connections between ideas and concepts to make meaning of Life Sciences – learners must: build a conceptual framework of science ideas; organise or reorganise knowledge to derive new meaning; write summaries; develop flow charts, diagrams and mind maps; and recognise patterns and trends.
  Action verbs to be used in assessment include: *explain, compare, rearrange, give an example of, illustrate, calculate, suggest a reason, make a generalisation, interpret information or data, predict, select, differentiate*.

- Apply knowledge of Life Sciences in new and unfamiliar contexts – learners must: use information in a new way; and apply knowledge to new and unfamiliar contexts.
  Action verbs to be used in assessment include: *demonstrate, interpret, predict, compare, differentiate, illustrate, solve, select*.

- Analyse, evaluate and synthesise scientific knowledge, concepts and ideas – learners must: analyse information/data; recognise relationships between existing knowledge and new ideas; critically evaluate scientific information; identify assumptions; and categorise information.
  Action verbs to be used in assessment include: *appraise, argue, judge, select, evaluate, defend* (a point of view), *compare, contrast, criticise* (an argument or assumption), *differentiate, distinguish, discuss*.

Specific Aim 2: Doing Life Sciences (doing practical work and investigations)

The following seven skills relate to doing practical work in Life Sciences. All seven skills will not apply equally to every activity:

a follow instructions
b handle equipment/apparatus
c make observations in the following ways: drawings; descriptions; group materials or examples based on observable similarities and/or differences; take measurements; compare materials before and after treatment; observe results of an experiment/investigation involving recording information in an appropriate way; and counting
d record information/data in the following ways: as drawings, descriptions, in tables, graphs, etc
e measure – measure length, volume, temperature, weight, mass, and count accurately
f interpret/translate – convert information from one form into another, e.g. converting a table into an appropriate graph
g design/plan investigations/experiments – Grade 11 learners must be able to plan and design a simple investigation/experiment.

The steps/skills required to design/plan investigations include:

1 identifying a problem
2 stating a hypothesis
3 select apparatus/equipment/materials
4 identify variables
5 suggest ways of controlling variables
6 plan – make all the logistical arrangements
7 suggest ways of recording results
8 understand the need for replication and verification.

Specific Aim 3: Appreciating and understanding the history, importance and applications of Life Sciences in society. The skills that can be developed in the process of achieving Specific Aim 3 are cognitive (same skills as for Specific Aim 1) rather than practical skills:

- understand the history and relevance of some scientific discoveries
- understand the relationship between indigenous knowledge and Life Sciences. All knowledge grows out of a view of how the world works. Science and indigenous knowledge have their origins in different world views.
- understand the value and application of Life Sciences knowledge in industry, in respect of career opportunities and in everyday life. Some careers that can be pursued after doing Life Sciences include: medical fields, research, genetics, environmental fields (game management, ecology, ecotourism, etc), agricultural fields, education fields.

How to use the Learner's Book and this Teacher's Guide

Study & Master Life Sciences is written in a way that should be easy for you and the learners to understand and help you and the learners to come to grips with the requirements of the curriculum.

The special features of this book include:

- The activities in this book are structured in a logical way, progressing from simple to new and complex learning.
- Each strand has strand openers, which clearly explain the key questions that will be addressed in that strand.
- Each unit has boxes listing the key questions to assist learners whose home language may not be English to deal with new terms.
- Each unit includes investigations in which learners solve problems, design solutions, set up experiments and controls, and record their results.
- Each unit includes assessment activities, ensuring continuous self-, peer and group assessment.
- Projects are provided that deal with issues related to the real world and move learners beyond the confines of the classroom.

Advise learners that the best way to use the Learner's Book is to:

- Carefully read each topic.
- Summarise the information in each topic in point form. Do flow diagrams to enhance their understanding of concepts. Infuse other material dealt with in class.
- Do the activities under each topic – these are meant to give the learners a better understanding of concepts and practical skills in the topic.
- Learners need to practise drawing diagrams and adding labels in the correct way – they can check the accuracy of their diagrams and labels by comparing them with the diagrams in this book.
- The more the learners practise the skills (cognitive and practical), the better they will understand them and the better you, the teacher, will be able to assess the learners.
- Learners must test their knowledge during and after each topic. Encourage them to find examination question papers and work out the answers first before looking up the answers in the textbook.

SECTION B

PLANNING

Weekly year planner

Year _____

Week	Planned date (week ending)	Completion date (week ending)	Topic for the week
TERM 1			
Week 1			DNA: Location in cell, discovery, structure, role of DNA, replication – cell cycle
Week 2			RNA: Types, location in cell, structure, transcription from DNA, translation of RNA into proteins, genetic code
Week 3			RNA: genetic code continued Meiosis: reduction division, diploid to haploid, production of gametes
Week 4			Meiosis (continued): genetic varitation, abnormal meiosis, similarities and differences between mitosis and meiosis
Week 5			Reproduction in vertebrates: diversity of reproductive strategies Human reproduction: structure of male and female reproductive systems
Week 6			Human reproduction (continued): Unique characteristics
Week 7			Human reproduction (continued): puberty, menstrual cycle, fertilisation
Week 8			Human reproduction (continued): gestation, implantation and development Formal assessment and practical task
TERM 2			
Week 1			Genes: dominant and recessive alleles, Mendel's experiments
Week 2			Inheritance and variation: phenotype and genotype, homozygous and heterozygous, complete, incomplete/ partial dominance and codominance
Week 3			Sex chromosomes: Sex linked alleles and disease Mutations: harmless, harmful, diseases associated with mutations, chromosome aberrations, useful mutations
Week 4			Genetic engineering and biotechnology: stem cell research, GMO, cloning, mitochondrial DNA, paternity testing, DNA fingerprinting
Week 5			Human nervous system: central nervous system – brain, meninges, functions of cerebrum, cerebellum, corpus callosum, medulla oblongata, spinal cord
Week 6			Peripheral and autonomic nervous systems Structure of nerves: Nerve tissue, sensory and motor neurons. Reflex arc: structure, function and significance of simple reflex arc, synapses
Week 7			Disorders and injuries to nervous system, effects of drugs. Receptors: light, sound, temperature, pain, pressure, pain and chemicals Human eye: structure and function
Week 8			Human eye (continued): disorders of sight Human ear: structure and function, hearing and balance, hearing defects

Week 9			Revision and June exam
Week 10			June exam (continued)
TERM 3			
Week 1			Human endocrine system: location of glands, hormones secreted, role of hormones – see glands listed in CAPS document
Week 2			Human endocrine system (continued): negative feedback – TSH and thyroxine, insulin and glucagon Homeostasis in humans: definition, negative feedback – glucose, carbon dioxide, water and salts Thermoregulation: adaptations of human skin
Week 3			Thermoregulation (continued): vasodilatation, vasoconstriction Plant hormones: auxins, gibberellins, abscisic acid, weed contril Geotropism and phototropism Plant defence mechanisms
Week 4			Origins of ideas about origins: fossil record, comparative anatomy, biogeography, genetics Hypothesis and theory: difference between Darwin's theory of natural selection
Week 5			Evolution through natural selection, continuous and discontinuous variation Artificial selection: domesticated animal and domesticated crop Speciation: biological species concept, examples of speciation due to geographic isolation Mechanisms for reproductive isolation with examples Evolution in present times: insecticide resistant, bill and body size in Galápagos finches, resistance to antibiotics and antiretrovirals
Week 6			Human evolution: evidence of common ancestors for living hominids including humans – similarities and differences between great apes and humans Start practical activity, either three major phases in hominid evolution from six million years ago to present OR map out changes in evolution of genus *Homo*
Week 7			Human evolution (continued): genetic evidence (mtDNA), cultural evidence, tool making Out of Africa hypothesis: African origin of all modern humans, genetic links, mtDNA Rift Valley and southern African fossils and fossil sites
Week 8			Revision and formal assessment and practical task
Week 9			Trial exam
Week 10			Trial exam

TERM 4			
Week 1			Human evolution (continued): Main fossil sites in South Africa – Cradle of Humankind – location – fossil finds, significance of fossil finds, scientists involved
Week 2			Human evolution (continued): Evolutionary trends in fossils found at South African sites Alternatives to evolution
Week 3			Environmental Studies: Human influences on the environment (current crises), revision questions and answers, reference to Grade 11 text books
Week 4			Environmental Studies: revision continued
Week 5			Environmental Studies: revision continued
Week 6			Revision
Week 7			Revision
Week 8			NSC exams
Week 9			NSC exams
Week 10			NSC exams

SECTION C

TEACHING GUIDELINES

This section contains teaching notes for the strands in the Learner's Book, and answers to all the activities and informal assessment suggestions.

PRESCRIBED PRACTICAL ACTIVITIES IN THE LEARNER'S BOOK

This section contains Prescribed Practical Activities in the Learner's Book

Learner's Book pages 15–75
Duration: 4,5 weeks

STRAND 1 LIFE AT MOLECULAR, CELLULAR AND TISSUE LEVEL

Learner's Book pages 16–53
Duration: 10 hours

Unit 1 DNA: the code of life

TERM 1, Weeks 1–2, 5

Activity number	Title	Learner's Book Page	Teacher's Guide Page
3	Extracting DNA from bananas	20	C6
11	DNA fingerprint (profile) analysis	46	C12

Learner's Book pages 54–75
Duration: 8 hours

Unit 2 Meiosis

TERM 1, Weeks 2, 5–4, 5

Activity number	Title	Learner's Book Page	Teacher's Guide Page
5	Meiosis	62	C21

Learner's Book pages 77–117
Duration: 0 weeks

STRAND 2 LIFE PROCESSES IN PLANTS AND ANIMALS

Learner's Book pages 78–87
Duration: 2 hours

Unit 1 Reproduction in vertebrates

TERM 1, Weeks 4,5–5

No Prescribed Practical Activities.

Learner's Book pages 88–117
Duration: 12 hours

Unit 2 Human reproduction

TERM 1, Weeks 5–8

Activity number	Title	Learner's Book Page	Teacher's Guide Page
4	Observing reproductive structures	98	C32
8	Observing the stages of development of the embryo	107	C36
9	Observing embyonic development and the stages of pregnancy	109	C36
11	Observing contraceptive devices	113	C38

Learner's Book pages 119–155
Duration: 4 weeks

STRAND 1 LIFE AT MOLECULAR, CELLULAR AND TISSUE LEVEL (continued)

Learner's Book pages 120–155
Duration: 16 hours

Unit 3 Genetics and inheritance

TERM 3, Weeks 8–12

Activity number	Title	Learner's Book Page	Teacher's Guide Page
4	Genotypes and phenotypes	133	C44
5	Heterozygous and homozygous crosses	136	C45
6	Human sex chromosomes	136	C46
14	Mitochondrial DNA and genetic lineages	150	C50

Learner's Book pages 157–234
Duration: 11.5 weeks

STRAND 2 PROCESSES IN PLANTS AND ANIMALS (continued)

Learner's Book pages 158–197
Duration: 16 hours

Unit 3 Responding to the environment: humans

TERM 3, Weeks 12–16

Activity number	Title	Learner's Book Page	Teacher's Guide Page
2	Dissection of a sheep's brain	164	C53
5	Reaction times	174	C55
6	The mammalian eye	178	C56

Learner's Book pages 198–209
Duration: 6 hours

Unit 4 Human endocrine system

TERM 3, Weeks 16–17,5

Activity number	Title	Learner's Book Page	Teacher's Guide Page
3	Research on disorders of the endocrine system	206	C63

Learner's Book pages 210–223
Duration: 4 hours

Unit 5 Homeostasis in humans

TERM 3, Weeks 17,5–18,5

Activity number	Title	Learner's Book Page	Teacher's Guide Page
2	Investigating the structure of skin	218	C67

Learner's Book pages 224–234
Duration: 4 hours

Unit 6 Responding to the environment: plants

TERM 3, Weeks 18,5–19,5

Activity number	Title	Learner's Book Page	Teacher's Guide Page
1	The effect of unilateral light on the growth of stems (shoots)	227	C70
2	The effect of gravity on the growth of roots	228	C73

Learner's Book pages 235–311
Duration: 6 weeks

STRAND 4 DIVERSITY, CHANGE AND CONTINUITY

Learner's Book pages 236–278
Duration: 8 hours

Unit 1 Evolution by natural selection

TERM 3, Weeks 19,5–21,5

Activity number	Title	Learner's Book Page	Teacher's Guide Page
1	Class debate and discussion on the evidence for biological evolution	241	C77
4	A game to explore natural selection	253	C79
5	Research an example of artificial selection	258	C80

Learner's Book pages 278–311
Duration: 16 hours

Unit 2 Human evolution

TERM 3 and 4, Weeks 21,5–25,5

Activity number	Title	Learner's Book Page	Teacher's Guide Page
2	Poster presentation: Three major phases in hominid evolution from six million years ago to the present	299	C86
3	Poster presentation: The evolution of the genus *Homo*	301	C87
4	Evolutionary trends in hominins	307	C87
5	Different cultural and religious explanations for the origin and development of life on Earth	309	C88

STRAND 1

LIFE AT MOLECULAR, CELLULAR AND TISSUE LEVEL

Unit 1: DNA: the code of life
Unit 2: Meiosis

Learner's Book pages 16–53
Duration: 10 hours

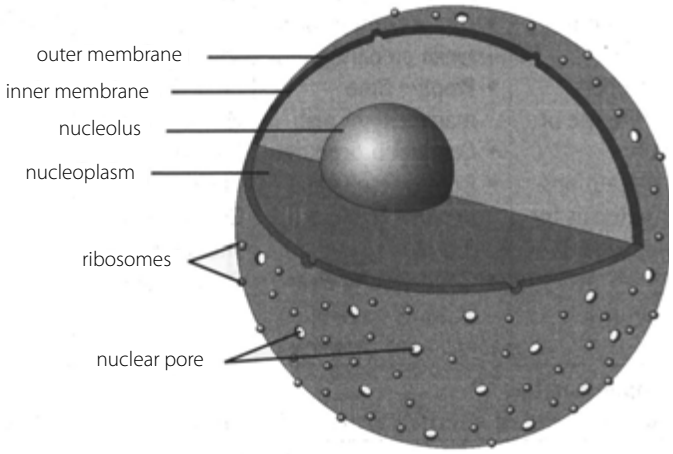
UNIT 1 DNA: the code of life

TERM 1

Activity 1 Review *(Specific Aims 1 and 2)*

Learner's Book page 18

1 A typical nucleus:



(8)

Diagram drawn from a micrograph showing the nucleus of a eukaryotic cell, magnified x 10 200

2 The molecule DNA is located within the nucleus. It is DNA that controls all the activities of the cell. How is this possible? All chemical reactions in the cells, and therefore all their activities, are controlled by special proteins, called enzymes. DNA determines which proteins are synthesised. The "instruction" (code) for the manufacture of enzymes and all other proteins is located in the DNA, which is found in the nucleus. (5)

Activity 2 The discovery of DNA *(Specific Aims 1 and 3)*

Learner's Book page 19

1 It was important to purify the DNA because it was only possible to see the double helix structure of DNA in the purified molecule. (2)

2 The technique used to gather data on the structure of DNA was X-ray crystallography. For this technique, molecules of DNA are bombarded by X-rays and this produces a photograph that can predict the three-dimensional structure of the molecule. (1)

3 **a** Each nucleotide making up the structure of DNA and RNA contains one of four different bases.
DNA contains:
- adenine and guanine (double-ring compounds called purines)
- cytosine and thymine (single-ring compounds called pyrimidines).

RNA contains:
- adenine and guanine (double-ring compounds called purines)
- cytosine and uracil (single-ring compounds called pyrimidines).

Note that RNA contains uracil instead of thymine. (4)

b DNA is a nucleic acid that carries the genetic information for a cell. A genome is the sum total of all the genetic material of a cell. A chromosome is a separate cellular structure composed of a long, neatly packaged piece of DNA.
A gene can be defined in a number of ways:
- In classical genetics, a gene is the fundamental unit of heredity that is responsible for a given trait in an organism.
- In molecular and biochemical genetics, it is a site on the chromosome that provides information for a certain function for the cell.
- More specifically, it is a certain segment of DNA that contains the necessary code to make a protein or a RNA molecule. (4)

PPA Activity 3 Extracting DNA from bananas *(Specific Aim 2)*

Learner's Book page 20

Learners observe that a white, stringy substance is formed, which is DNA.

1 Crushing the banana separates its cells and exposes them to the detergent and the salt. (2)

2 **a** Liquid detergent helps to breakdown the cell and nuclear membranes and release DNA. (2)

b Salt helps the strands of DNA to stick together. (1)

c Meat tenderiser/pineapple juice contains enzymes to break down the proteins that wrap around the DNA, thus exposing it. (2)

d The filter paper/strainer prevents larger particles in the broken down banana from being collected. (1)

3 The solution that collects in the cup during filtration is called filtrate. (1)

4 DNA normally stays dissolved in water, but when salty DNA comes into contact with alcohol it is precipitated out as a solid. The physical force of the DNA clumping together as it precipitates pulls more strands along with it as it precipitates out in the alcohol. Alcohol is less dense than water, so it floats on top of the water and this allows the DNA to be separated. (2)

5 Four precautions are:
- Stirring must be gentle to prevent foam from forming during the preparation.
- Ensure that the banana is completely crushed/pulped to separate and break down cells.
- Ensure that the alcohol is cold.
- The test tubes with alcohol and filtrate must stand undisturbed while the DNA precipitates.

Learners may also state other precautions, such as: alcohol must be cold, filter paper/strainer must not touch the bottom of the cup, pour the alcohol slowly along the side of the test tube containing the filtrate. (4)

6 These are clumps of tangled DNA molecules. (1)

7 No – the DNA is in the cells of all living organisms. It is possible that the amount of DNA extracted may be different. (2)

Activity 4 Designing DNA extraction *(Specific Aim 2)*

Learner's Book page 22

This is an enrichment activity. Give 20 marks for the design and five for question 2.

Provide these guidelines to learners before they design and conduct the investigation:
- Investigate the properties and/or characteristics of yeast cells.
- Review the procedure used to extract DNA from an onion.
- Design a procedure to extract DNA from yeast cells based on the characteristics of yeast cells.
- Carry out the procedure.
- Write up your investigation.

RPA

Activity 5 Looking at nitrogenous bases *(Specific Aims 1 and 2)*

Learner's Book page 24

1 In all the samples of DNA, the percentages of adenine and thymine guanine and cytosine are identical. (1)

2 One of the characteristics of DNA is that for a particular species, the relative amounts of nitrogenous bases is almost constant in all cells for that species. (2)

3 There is a difference in the percentage of the paired bases. (2)

4 For any given organism the percentage of nitrogenous bases is almost identical for adenine and thymine, and guanine and cytosine. In addition, these percentages may differ from one organism to another. (3)

5 The double-helix model of DNA is like a twisted ladder because the sugar-phosphate backbones make up the sides, and the hydrogen-bonded bases make up the rungs or steps of the ladder. (2)

6 The complementary strand will be CGCTACAGTACG. (2)

Activity 6 Nucleotide ratios *(Specific Aim 1)*

Learner's Book page 25

1 To increase the reliability of the results: (1)

2 1:1/(90:90) (1)

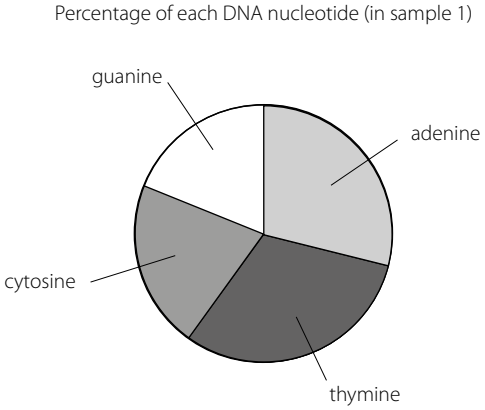
3 In a DNA molecule, thymine always pairs with adenine/thymine and adenine are complementary bases (1)

4 $\frac{29}{100} \times 360^{o} = 104{,}4^{o}/104^{o}$

$\frac{31}{100} \times 360^{o} = 111{,}6^{o}/112^{o}$

$\frac{21}{100} \times 360^{o} = 75{,}6^{o}/76^{o}$

$\frac{19}{100} \times 360^{o} = 68{,}4^{o}/68^{o}$



Mark allocation of the graph:

Calculations/working to determine the correct proportions	2 marks: All 4 calculations correct 1 mark: 1 to 3 calculations correct
Correct type of graph (pie chart)	1
Title of graph	1
Proportions accurate for each sector/slice labelled /key	4 marks: All four sectors correct (use transparency template) (1 × mark/ sector)

(8)

Note: If the wrong type of graph is drawn: marks will be lost for "correct type of graph" as well as for "drawing of sectors in correct proportion".

RPA » Activity 7 The order of bases *(Specific Aim 2)*

Learner's Book page 31

1 The mRNA resembles the DNA strand that was not involved with transcription. The DNA strand that was used in transcription acted as the template, allowing only the appropriate base pairs to join. (2)

2 **a** DNA is easy to transcribe because of its double-stranded structure and the bonds between the bases are relatively weak, allowing for a process similar to that of replication. (2)

b This feature is important for the transmission of genetic information from the nucleus to the cytoplasm, where protein synthesis occurs. In addition, it is important for the transmission of hereditary information from parent to offspring. (2)

» Activity 8 Differences between RNA and DNA *(Specific Aim 1)*

Learner's Book page 36

1 Differences between RNA and DNA

DNA	RNA
Double-stranded molecule	Single-stranded molecule
Contains deoxyribose sugars	Contains ribose sugars
Contains four nitrogenous bases: • Adenine • Guanine • Cytosine • Thymine	Contains four nitrogenous bases but thymine is replaced by uracil: • Adenine • Guanine • Cytosine • Uracil

(7)

2 **a** A sequence of three nitrogenous bases that represent an amino acid is referred to as a *codon*. The codon is usually found on mRNA. The *anticodon* is a sequence of bases that are complementary to the codon. The anticodons are located on the tRNA which carries the appropriate amino acid. (4)

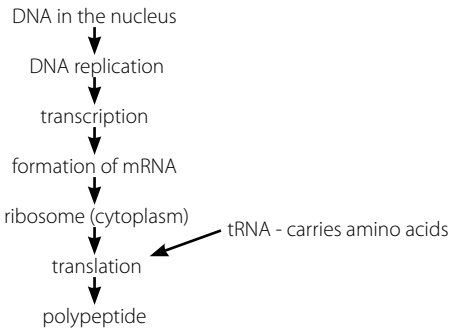
b The process of *transcription* involves the synthesis of RNA from DNA. It involves the movement of information from DNA that is found in the nucleus to the cytoplasm.

Translation is a process that converts the information from mRNA to a sequence of amino acids that make up proteins. (4)

3 Without a stop signal, the DNA strand and the polypeptide will continue to grow in size. This would waste materials and energy. (2)

4 The ribosomes hold the mRNA, tRNA and associated enzymes that control the process of translation in position until a peptide bond forms between adjacent amino acids.

4 Protein synthesis can be outlined as follows:



(9)

RPA

» Activity 9 The genetic alphabet *(Specific Aims 1 and 2)*

Learner's Book page 37

Before learners attempt this activity, discuss how information is communicated using the 26-letter alphabet. Highlight the fact that information is in the form of words and sentences.

Using examples, illustrate how words and sentences have different meanings in the same language as well as in different languages. For example, the word "minute" is pronounced and means different things in different contexts. It could refer to minute as in small or minute as in time.

The next step is to introduce learners to the genetic alphabet (A, G, C and T). A brief introduction to the genetic words (genetic code) should follow. At this point emphasise that the same genetic code is used by all organisms. That is, the genetic code is universal. Discuss the significance of this.

3 There are 20 naturally occurring amino acids — but DNA contains only four bases. If a single base represents an amino acid then a protein can consist of only four amino acids. (2)

4 A sequence of two bases, for example AT, GC, or AG will yield only 16 (2^4 or $2 \times 2 \times 2 \times 2$) possible combinations. (2)

5 Learners list as many three letter words as possible using the 26-letter alphabet, for example: and, the, but, car, cat, mat, tar, and so on. (6)

6 The number of permutations will be 64 (4^3 or $4 \times 4 \times 4$). (3)

7 Three bases. (2)

Extend the discussion further by indicating that all 64 words make sense to a cell. These words are lined up to form genetic sentences in the form of genes that then determine the components that make up our body.

RPA

» Activity 10 Protein coding simulation *(Specific Aim 2)*

Learner's Book page 40

Part 1

1 The coding strand is:
TAC CGA CCA ACA TTC TTG AAG AAA ACC TTC TGA AAG TGA AGC ACA ACT ATC
This strand is the template for transcription, that is, for the formation of mRNA. This means that it will be used as the "code" (instructions) for the synthesis of proteins. (4)

2 The mRNA sequence is:
AUG GCU GGU UGU AAG AAC UUC UUU UGG AAG ACU UUC ACU UCG UCU UGA UAG

a Transcription (1)

b The mRNA is complementary (opposite) to the DNA strand. It is identical to the original strand except that U (uracil) has been substituted for T (thymine). (2)

3 Remember to convert this mRNA strand to the coding DNA strand, but replace U with T and then check it against Table 1.1.4 in the Learner's Book.

a mRNA:
AUG GCU GGU UGU AAC UUC UUU UGG AAG ACU UUC ACU
met ala gly cys asp phe phe trp lys thr phe thr
UCG UGU UGA UAG
ser cys stop stop (4)

b Translation, the protein was successfully synthesised as indicated in 3 above. (2)

Part 2

1 **a** The normal red blood corpuscles are spherical in shape with a depression in the middle. The abnormal red blood corpuscles are somewhat elongated and curved or sickle-shaped. (2)

b The normal shaped cells present a larger surface area for the absorption and transport of oxygen and carbon dioxide. (2)

c Sickle cell disease. (1)

2 It is possible for more than one form of a protein to form because of mutations. When there is a shift in the nitrogenous bases, the DNA code is affected so that there is a change in one amino acid in the sequence of the protein. (2)

3 **a** Mutations are changes or mistakes (errors) that can occur in the DNA. These changes in DNA can come from errors that occurred during the process of replication and the changes were not corrected. Mutations or changes in DNA can also be due to the spontaneous rearrangement of segments of DNA. (2)

b There is a difference at amino acid number 6. In the normal form of the protein, the amino acid at this position is glutamate or glutamic acid while in the mutated form the amino acid is valine. (2)

c When the mRNA codon for glutamic acid and for valine is observed, there is only one base difference between them. That is, the codon for glutamic acid is GAA and for valine it is GUA. The DNA template for glutamic acid is CTT and for valine it is CAT. (2)

d The slightest deviation could result in a code for a different amino acid — thus resulting in a mutation or the formation of a different protein. (2)

Part 3

Teacher assessment: Oral presentation				
Assessment criteria	**4**	**3**	**2**	**1**
Could the speaker be heard?				
Did the speaker make eye contact with the audience?				
Did the speaker make use of a variety of relevant presentation aids?				
Did these aids assist the audience in understanding the topic?				
Did the speaker capture the audience's interest?				
Did the introduction get the audience wanting to know more?				
Was the presentation logical and easy to follow?				
Did the speaker use body language to support the presentation?				
Did the speaker refer to notes?				
Was the speaker enthusiastic about the topic?				
Did the speaker make effective use of time?				
Did the speaker allow the audience to participate, i.e. was the presentation interactive?				
Was the response to questions satisfactory?				
Key: 4: Always 2: Most of the time 3: Sometimes 1: Not at all Total: 52 marks				

PPA » Activity 11 DNA fingerprint (profile) analysis *(Specific Aim 2)*

Learner's Book page 46

Because human genomes reflect the variation that exists within the human species, any material containing DNA that is found at a crime scene can be used to determine whether blood, semen or hair came from the victim, suspect or an unknown person. A sample of restriction fragments of an individual will show differences in the length of one or more of the fragments when compared with the same restriction fragments of another individual. This difference will reflect slight variations within their genetic make-up.

1 Individual number 1 (2)

2 No, because this individual's DNA pattern does not match the pattern of the DNA fragments that were found at the crime scene. (2)

3 X — because all the other patterns are compared with it. (2)

» Activity Self assessment

Learner's Book page 49

1 b

2 a

3 b

4 c

5 d

6 a

7 c (7 × 2) (14)

8 a replication

b amino acids

c peptide bond

d hydrogen

e tRNA

f uracil

g transcription/mRNA (7 × 1) (7)

9 a

DNA	RNA
Double-stranded molecule	Single-stranded molecule
Contains deoxyribose sugars	Contains ribose sugars
Contains four nitrogenous bases: • Adenine • Guanine • Cytosine • Thymine	Contains four nitrogenous bases but thymine is replaced by uracil: • Adenine • Guanine • Cytosine • Uracil

(7)

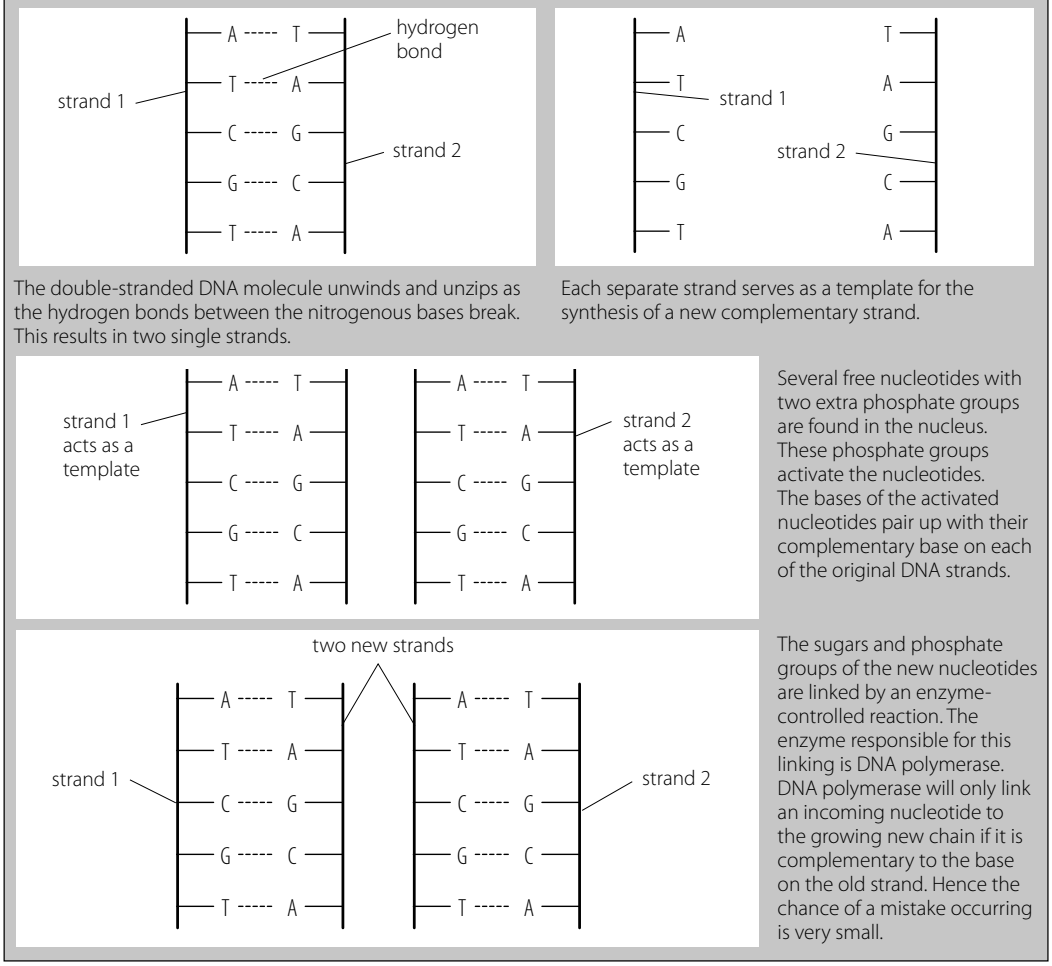
b i A codon is a sequence of three nitrogenous bases that represent an amino acid and is usually found on mRNA. An anticodon is a sequence of bases that are complementary to the codon. The anticodons are located on the tRNA, which carries the appropriate amino acid. (4)

ii Transciption involves the synthesis of RNA from DNA. It involves the movement of information from RNA to DNA. It involves the movement of information from DNA that is found in the nucleus to the cytoplasm. Translation is a process that converts the information from mRNA to a sequence of amino acids that make up proteins. (4)

c mRNA is messenger RNA and is involved in the transfer of genetic information from DNA to ribosomes. rRNA is ribosomal RNA which forms a major structural component of the ribosomes. tRNA is transfer RNA, which carries amino acids to the ribosomes to be inserted into the correct sequence during translation. (3)

d Protein synthesis can be outlined as follows:

10



(6)

11 a 1 – DNA
2 – mRNA (2)

b DNA contains the nitrogenous base thymine, RNA contains the nitrogenous base uracil. (2)

12 a A nuclear membrane
B mRNA
C DNA (3)

b Carries hereditary characteristics from parents to offspring, controls the synthesis of proteins. (1)

c Transcription (1)

d Ribosome (1)

e Translation: The mRNA strand from the nucleus becomes attached to a ribosome with its codons exposed. Each tRNA molecule carries a specific amino acid according to its anticodon and matches up with/complements the codon of the mRNA so that the amino acids are placed in the correct sequence. Amino acids next to each other are linked to form a protein. (6)

f CAC (the anticodon is GUC so the complementary codon is CAC) (2)

13 a Transcription (1)

b 5 (1)

c GCU– CAU–UGG (3)

Extraction of DNA from banana

Learner's Book page 20

Introduction

DNA is a long molecule that holds the genetic information for all organisms – plants, animals or micro-organisms. DNA can copy itself and make RNA. In more complex organisms, DNA is found in the nucleus of the cells. All cells, except for the red blood corpuscles of mammals (which do not contain a nucleus), have their own DNA. The cells of an organism use certain parts of the DNA molecule, or genes, to produce the proteins that they require for the functions of life.

Something is only thought of as living if it can reproduce. Part of this process of reproduction is that cells pass DNA from parent cells to offspring cells. DNA provides a blueprint for an organism's growth and development. Studying DNA is one way that scientists learn about what is necessary for life. In this activity, you will extract and observe DNA from bananas. Other DNA sources could also be used, for example, chicken liver, strawberries, spinach, onion, etc.

You will need:

- 1 × banana
- distilled water
- liquid dishwashing detergent
- table salt
- alcohol (chilled by placing in a test tube in a beaker containing ice cubes)
- blender or plastic bowl
- 3 × plastic/polystyrene cups
- tape
- metal spoon
- 2 × plastic spoons measuring cup
- filter paper/strainer
- 250 ml beaker
- medicine dropper
- source of enzyme – such as meat tenderiser or pineapple juice
- glass rod/straw

Procedure

1 Preparation of the solution used to extract the DNA.
Mix 1 teaspoon of detergent with $^1/_4$ teaspoon of salt in a plastic cup. Add two tablespoons of distilled water. Stir gently to avoid forming foam. Continue for a few minutes until the salt is dissolved in the detergent.

Preparing the extract solution

2 Preparation of the banana pulp.
Pour $^1/_2$ cup of distilled water and place one banana into the blender or plastic bowl. Use the metal spoon to crush the banana in the bowl or blend for 25 seconds, making sure the banana is completely crushed/pulverised.

Give a reason why the banana must be crushed.

Pour the mixture into a beaker.

Crushing the banana with a spoon and then blending it in an electric blender

3 Extracting the DNA.
Add two tablespoons of the banana mixture to the cup containing the detergent solution. Use a spoon to stir the mixture for at least 10 minutes.

What do you think is the purpose of the detergent and salt solution?

Mix the banana with the detergent solution

4 Filtration.
Insert a filter/strainer into a clean plastic cup so that it does not touch the bottom of the cup. If necessary, tape the sides of the filter to the cup.
Pour the mixture from Step 3 into the filter/strainer. After 10 minutes, some liquid should have collected at the bottom of the cup. Gently stir the mixture in the filter/strainer and let it stand for another minute. Remove the filter/strainer and place it to one side of the rest of your apparatus.

Filtering the mixture of banana and detergent

Suggest a reason for the use of the filter/strainer.

5 Removing the proteins.
With this step it is possible to obtain a purer DNA extract.
For this you will need an enzyme.
What do you think is the purpose of the enzyme?
A source of such enzymes is meat tenderiser or pineapple juice.

Pour about 2 ml of meat tenderiser/pineapple juice into the liquid that collected in the cup and stir gently.

Pineapple juice can be used as a meat tenderiser

6 Precipitating the DNA.

6.1 Pour the solution into test tubes until the test tube is about $^1/_3$ full.

6.2 Get a test tube of cold alcohol.

6.3 Tilt the test tube that contains the filtrate and pour the cold alcohol gently down the side of this test tube so that the alcohol forms a layer on top of the banana mixture. Pour until the amount of alcohol is the same as that of the banana mixture.
Explain the role of the cold alcohol.

Placing the DNA with the alcohol and filtrate into a beaker or test tube

6.4 Place the test tube with the alcohol and filtrate into a beaker or test tube holder. Let it stand undisturbed for about four minutes. Do not shake.

Why must the test tube be undisturbed?

6.5 Dip the glass rod/straw into the tube, slowly rotating it to spool out the DNA.

Describe what you observe.

Twisting the DNA out of the test tube using a glass rod

Questions

1 State FOUR precautions that must be taken during this experiment.
2 What is the stringy substance that is formed at the end of the experiment?
3 Do you think your results would be different if you were to use a different fruit from a banana? Explain.

Memo: Extraction of DNA from banana

The learners describe the stringy white substance that they collect in the test tubes as DNA.

Questions

1 Any four of:
- Stirring must be gentle to prevent foam formation during preparation of the extraction solution.
- Make sure that the banana is completely crushed/pulped to separate and breakdown cells.
- The filter paper/strainer must not touch the bottom of the cup.
- Make sure that the alcohol is cold.
- The alcohol must be poured slowly along the side of the test tube containing the filtrate.
- The test tubes with the alcohol and filtrate must stand undisturbed while the DNA precipitates.

2 These are clumps of tangled DNA molecules.

3 The results would not be different if another fruit were used because DNA is in the cells of all living organisms. However, it is possible that the amount/yield of DNA would be different.

Activity 1 DNA division *(Specific Aim 1)*

Learner's Book page 57

1 DNA divides by a process called replication. (1)

2 Replication is important for:
- cell division
- maintaining a constant number of chromosomes
- the transmission of genes. (3)

3 When DNA is coiled, it occupies less space in the nucleus. When DNA is uncoiled, it can actively be involved in the making of RNA and in replicating itself. (2)

4 When DNA is attached to proteins such as histones, it is referred to as chromatin. This portion of the cell nucleus also stains (colours) more easily. (1)

5 DNA is a large double-helical molecule that is found in the nucleus. It determines how an organism will look and behave, that is, it forms the genetic code.
A chromosome is a discrete cellular structure composed of a long, neatly packaged piece of DNA.
A gene can be defined in a number of ways:
- In classical genetics, it refers to the fundamental unit of heredity that is responsible for a given trait in an organism.
- In molecular and biochemical genetics, it is a site on the chromosome that provides information for a certain function for a cell.
- It is a segment of DNA that contains the necessary code to make a protein or RNA molecule. (3)

RPA

Activity 2 Using a karyogram *(Specific Aim 2)*

Learner's Book page 57

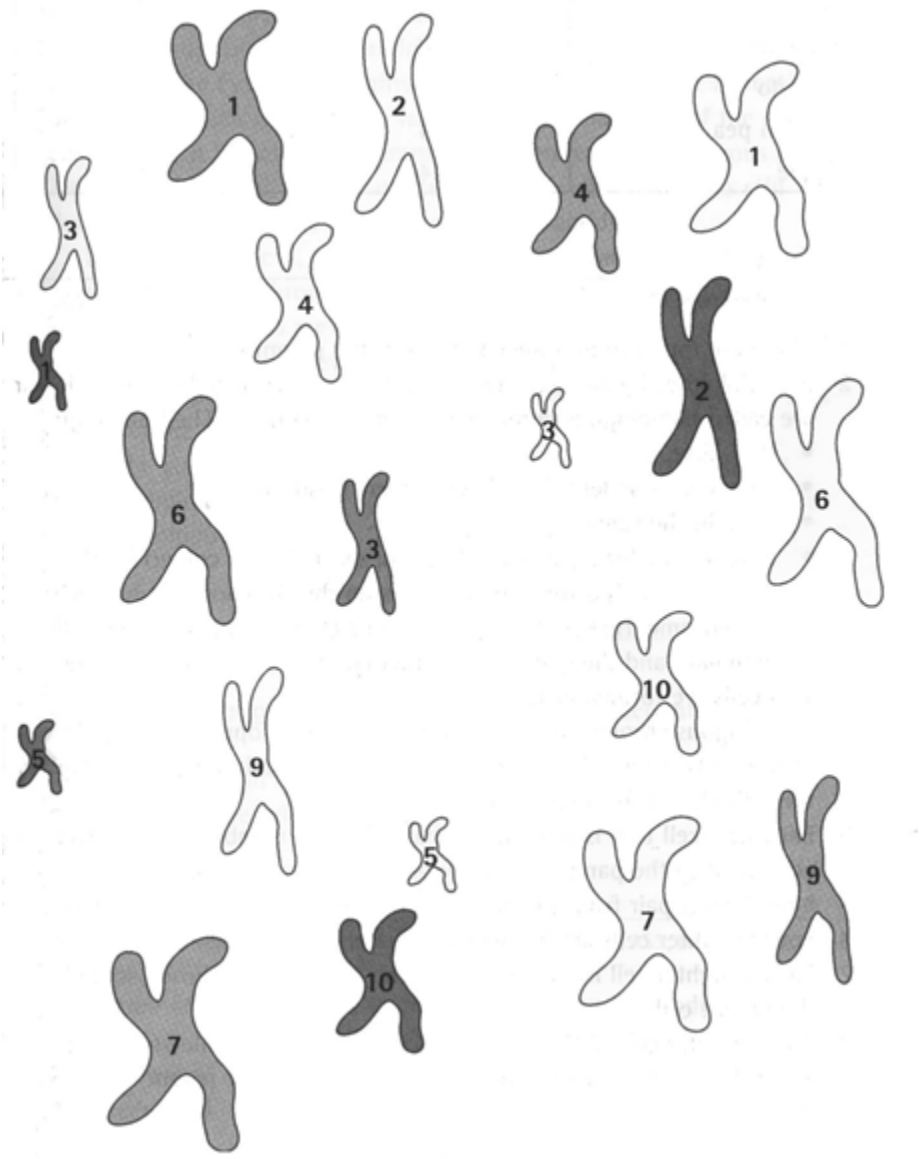
Prepare photocopies of the chromosomes on the next page for each learner. Learners then cut the chromosomes out, pair them and arrange them in order before attempting the questions for this activity.

1 The chromosomes are arranged according to size. (1)

2 Humans have 46 chromosomes altogether. In this set of chromosomes there are only 20. (1)

3 We have 23 pairs of chromosomes. In this set of chromosomes, there are only 10 pairs. (1)

4 Each pair of chromosomes is called a homologous pair. (1)



Activity 3 The number of chromosomes in different organisms

(Specific Aim 1)

Learner's Book page 58

Organism	Somatic cell or body cell (diploid number) 2n	Sex cell or gamete (haploid) n
Human	46	23
Fruit fly	8	4
Cat	38	19
Dog	78	39
Chimpanzee	48	24
Tomato	24	12
Garden pea	14	7
Apple	34	17

(8)

Activity 4 The process of meiosis *(Specific Aim 1)*

Learner's Book page 60

1 There are four chromosomes present in the parent cell. (1)

2 In a diploid cell, chromosomes occur in pairs. The members of each pair are called homologous chromosomes or homologues. The homologues:
- look alike
- have the same length and centromere position
- contain the same types of genes
- have a gene for a particular trait (for example hair colour) located at similar loci (positions or locations on the chromosome) for each chomosome. However, the gene on one chromosome could be dominant and the gene on the other chromosome could be recessive. (4)

3 Two cells are formed at the end of meiosis I. (1)

4 Homologous chromosomes separate and move to opposite poles. This results in two sets of chromosomes, one set at each pole. The cytoplasm then divides to form two cells. (2)

5 Each new cell that is formed will have half the number of chromosomes compared to the parent cell. Only one chromosome from each homologous pair from the parent cell is found in the daughter cells. (2)

6 Four daughter cells are produced at the end of meiosis II. (1)

7 Each daughter cell has a member of the homologous chromosome from the parent cell. (2)

8 The daughter cells differ from the parent cell because each cell has half the chromosome number of the parent cell. (2)

PPA

Activity 5 Meiosis *(Specific Aim 2)*

Learner's Book page 62

This activity serves to develop learners' ability to observe. It is therefore important to assess their drawings for accurate representation. Check that learners draw and label only what they see. Take into account aspects such as size, shape and proportion.

1 and **2** Check each learner's drawings and labels. $(9 \times 3 = 27)$ and (18)

3 During prophase I the chromosomes coil up and spindle fibres form. The homologous chromosomes come together to form bivalents or tetrads. Crossing over takes place with the exchange of genetic material. During this stage the nuclear membrane also disintegrates. The spindle fibre is broken down in telophase I. The chromosomes uncoil and the cytoplasm begins to divide, resulting in the formation of two cells. Each cell has only half the genetic make-up of the original cell because it has only one chromosome from each homologous pair. Therefore another division is needed since the chromosome is still doubled, containing two identical sister chromatids. During anaphase II, the centromere of each chromosome splits, allowing the sister chromatids to separate and move to opposite poles. The sister chromatids are now called chromosomes.

The chromosomes move to each pole during telophase II. The nuclei re-form, the spindle fibres break down and the cytoplasm divides. This results in the formation of two cells.

At the end of meiosis II, four haploid cells are formed from the original diploid cell. Each haploid cell contains one chromosome from each homologous pair. (15)

Activity 6 The cells formed at the end of meiosis *(Specific Aim 1)*

Learner's Book page 65

1 No – exchange of genetic material between non-sister chromatids took place. (3)

2 No – they have half the number of chromosomes, which are also different from the original cell. (3)

RPA

Activity 7 Understanding the meiotic cell cycle *(Specific Aims 1 and 2)*

Learner's Book page 65

The intention of this activity is to consolidate the understanding of cell division.

Prepare sets of cards with copies of Figure 1.2.9 and Figure 1.2.10 from the Learner's Book. Each card is to contain only one picture depicting the relevant stage of cell division, for example one card for prophase I, another card for metaphase I and so on. Include also in each set or pack of cards, pictures of the stages of mitosis.

5 **a** Yes. The cells have twice the number of chromosomes in the first card compared to the cells in the last card. The type of chromosomes are also different in both cards. This is due to crossing over. (3)

b Two cells are formed at the end of meiosis I. (1)

c The cells are haploid (n). (1)

d There will be 39 chromosomes in the egg. (1)

e A pair of homologous chromosomes:

- look alike
- have the same length and centromere position
- contain the same types of genes
- have a gene for a particular trait (for example hair colour) located at similar loci (positions or locations on the chromosome) for each chomosome. However, the gene on one chromosome could be dominant and the gene on the other chromosome could be recessive. (4)

f Crossing over results in the exchange of genetic materials between non-sister chromatids of bivalents. It is responsible for the variation in future generations of a species. (2)

Activity 8 Changes in the number of chromosomes *(Specific Aim 1)*

Learner's Book page 71

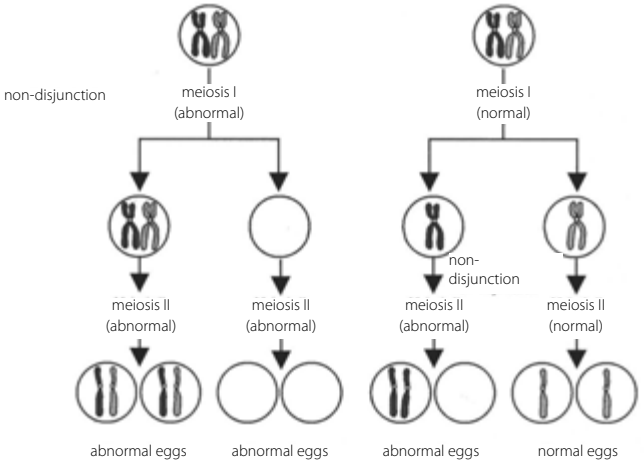
1 Mutations can sometimes be favourable, so a low level of mutation could sometimes result in mutations that are favourable and which will benefit the organism and be passed on to future generations. A high rate of mutation is more likely to result in large numbers of harmful mutations that could cause the organism to die out completely. (2)

2 Triploidy serves to increase variation and is therefore an evolutionary mechanism in plants. It allows fruits and flowers to be larger and so triploid plants are cultivated as a source of food. (2)

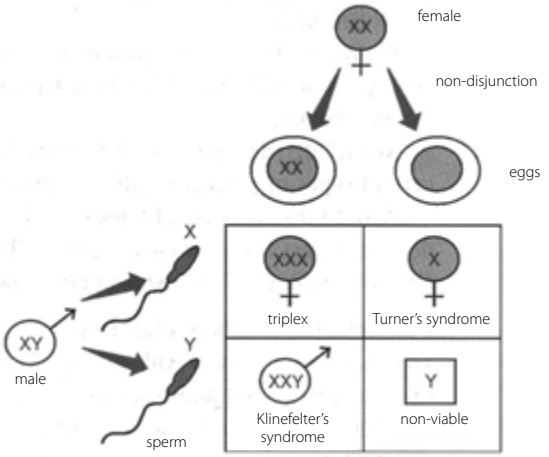
3

Non-disjunction results from an error in meiosis in which homologous chromosomes fail (abnormal) (normal) to separate during meiosis I.

Non-disjunction can also occur during meiosis II when two sister chromatids fail to separate.



This diagram shows how non-disjunction can result in abnormalities in the number of sex chromosomes. Both Turner's syndrome and Klinefelter's syndrome result from non-disjunction of eggs in either the male or female gamete. This diagram shows how these genetic disorders occur when non-disjunction takes place in female gametes. It also shows how non-disjunction can result in male a triple X female.



(8)

4 The following information will be useful: (15)

Turner's syndrome

Causes

This is a sex chromosome abnormality in which there is partial or complete absence of one of the two sex chromosomes, producing a phenotypic female. The chromosomal abnormalities vary. About 50% have a 45, X karyotype. Many patients are mosaics (e.g 45, X/46, XX or 45, X/47, XXX). The phenotype varies from a typical Turner's syndrome appearance to normal. Turner's syndrome occurs in about 1/4 000 live female births.

Historical perspective

This information may be difficult for all learners to access because many of the web sites that deal with medicine are closed except to subscribers. However, a good library search may allow some learners to find information similar to the following:

Before chromosomal analysis was available, Turner's syndrome was diagnosed based on the physical characteristics independently described by Otto Ullrich and Henry Turner, such as short stature, gonadal dysgenesis (poor development), typical specific variations in facial appearance, and abnormalities in organs, which present in individuals with a female phenotype.

Symptoms
Newborns may have swollen hands and feet and loose folds of skin at the back of the neck. But many females with Turner's syndrome are very mildly affected.

A typical female with Turner's syndrome will be short, with a webbed neck, a low hairline on the back of the neck, a broad chest with widely spaced nipples, broad hands with short fingers and poorly developed nails.

Many people with this syndrome also have heart abnormalities, kidney abnormalities and large red patches on the skin called haemangiomas. Mental deficiency is rare, but many have slight problems with certain types of perceptual abilities and so are poor at maths.

About 90% of affected females will not go through puberty, develop breast tissue or have menses. This can be corrected with female hormones. These women are usually infertile.

Societal views on these disorders
This part of the answer will vary widely, depending on the depth of research carried out and of the amount of thinking that each learner has done. Look for evidence of thought about the place of those with different mental and physical challenges in our society, the historical treatment of these people and how they are treated in our constitution.

Medical and/or biotechnological breakthroughs
There have been no breakthroughs in treatment or prevention of the syndrome itself.

New fertility treatment may help infertile women with Turner's syndrome, but only if their uterus is fully developed.

Klinefelter's syndrome

Causes
This is a sex chromosome abnormality in which there are two or more X chromosomes and one Y, resulting in a phenotypic male. This syndome occurs in about 1/800 live male births. The extra X chromosome is derived from the mother in 60% of cases. It is the most common cause of male infertility but is often not diagnosed because the way that the syndrome appears is very variable.

Historical perspective
Again, this may be difficult information for learners to find. But some may have something similar to the following: Klinefelter's syndrome was first described in 1942 and was thought of as a disorder of the endocrine system. Men with the syndrome were described as having small, firm testes, abnormally large amounts of breast tissue (gynaecomastia), small gonads and abnormally high levels of follicle stimulating hormone (FSH).

Symptoms
Affected men tend to be tall, with disproportionately long arms and legs. They often have small, firm testes and about one third develop gynaecomastia. Puberty often occurs at a normal age, but growth of facial hair is light.

They tend to have learning difficulties and many have problems with language and reading.

However, the way that the syndrome presents is very variable and many men with chromosome abnormalities appear to be normal and are only diagnosed as part of an investigation into infertility.

Societal views

Again, a variable answer. Since so many of these men appear normal the main discussion may be about their problems with infertility.

Medical and/or biotechnological breakthroughs

There have been no breakthroughs in treatment or prevention of the syndrome itself.

Treatment with testosterone can correct some of the symptoms but will have no effect on infertility. Infertility may be corrected using the technique of intracytoplasmic sperm injection in which a single sperm is injected into a single egg.

Activity Self assessment

Learner's Book page 74

1 **a** Meiosis II (1)

b Daughter chromosomes are being pulled to the poles (1)

c A – spindle fibre; B – cell membrane (2)

d **i** 8 (1) **ii** 4 (1) (2)

e ovaries (1)

f No (1)

g are only 4 chromosomes present instead of 23. (2)

h 1 – it introduces genetic variation
2 – it balances the doubling effect of fertilisation because it halves the number of chromosomes in the sex cells (2)

i Non-disjunction (1)

2 Any three of:

Meiosis I	Meiosis II
The chromosomes arrange at the equator of the cell in homologous pairs	Chromosomes line up at the equator of the cell individually
Whole chromosomes move to opposite poles of the cell	Daughter chromosomes move to opposite poles of the cell
Two cells form at the end of this division	Four cells are formed at the end of this division
The chromosome number is halved during meiosis I	The chromosome number remains the same during meiosis II
Crossing over takes place	Crossing over does not take place

(7)

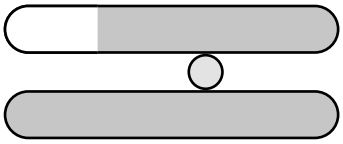
3 It reduces the number of chromosomes by half, ie. from diploid to haploid. This ensures that sex cells have half the number of chromosomes of other somatic cells so that when fertilisation occurs the zygote formed has the correct number of chromosomes. It balances the doubling effect of fertilisation.

Crossing over introduces genetic variation. Genetic variation results in offspring that are better adapted to a particular environment and ensures that they will have a better chance of survival. (4)

4 **a** A – chromosome; B – centromere; C – chromatid;
D – chiasma / chiasmata (4)

b crossing over (1)

c It introduces genetic variation

d  (1)

- A double stranded chromosome with the strands joined by a centromere.
- There is evidence of crossing over. (3)

Practical worksheet

Observation of the different stages of meiosis

Learner's Book page 62

Introduction

It is important to understand that meiosis and mitosis are continuous processes. However, it is convenient to describe these processes as different stages, which makes it easier to understand the process.

In Grade 12 you studied meiosis. Meiosis consists of two sets of cell division, namely, meiosis I, and meiosis II. Each of these two sets of cell division is further divided into different stages.

Study the micrographs and/or the prepared microscope slides showing the process of meiosis at different stages.

Observe the behaviour of the chromosomes and then determine the sequence of the process. Use the prepared table on the next page to record your observations. Draw and label the different stages. Do not forget to show the magnification of the micrograph/slide as part of your caption for each drawing. Next to each drawing provide a brief description of what is happening at each stage.

First meiotic division

	Drawing	Description
A: Prophase I		
B: Metaphase I		
C : Anaphase I		
D: Telophase I		

Second meiotic division

	Drawing	Description
A: Prophase I		
B: Metaphase I		
C : Anaphase I		
D: Telophase I		

STRAND 2

LIFE PROCESSES IN PLANTS AND ANIMALS

Unit 1: Reproduction in vertebrates
Unit 2: Human reproduction

Learner's Book pages 78–87
Duration: 2 hours

UNIT 1 Reproduction in vertebrates

TERM 1

Activity 1 Self assessment

Learner's Book page 87

1 **a** Precocial (1)
b Altricial (1)
c External fertilisation (1)
d Internal fertilisation (1)
e Vivipary (1)

2 **a** A only (2)
b none (2)
c A only (2)
d B only (2)
e B only (2)

UNIT 2 Human reproduction

Activity 1 The male reproductive system *(Specific Aim 1)*

Learner's Book page 91

1 a A testis is the singular of testes; sperm are made in the testes. (2)

b The scrotum is the sac in which the testes are carried "outside" the body so that sperm can be produced at a lower temperature than body temperature. Sperm do not mature at body temperature. (2)

c The penis is the organ that is inserted into the vagina to transfer sperm during an ejaculation. (2)

d The vas deferens is a tube through which sperm travel from the testes to the urethra. (2)

e The urethra in males is a tube through which semen and urine pass through the penis to the outside of the body and in females the urethra is a tube through which urine (only) passes from the bladder to the outside of the body. (2)

f The prostate gland makes a fluid that contains citric acid, which provides energy for the sperm to swim. It also secretes an alkaline fluid that protects the sperm against acidic secretions in the female vagina. (2)

2 a Circumcision is a surgical procedure in which the foreskin of the penis is removed. (2)

b Testes hang outside the body because sperm do not develop well at body temperature. (2)

c Frutose is needed in semen to provide the fuel that the sperm need for movement. (2)

d Smegma forms on the inner surface of the foreskin from sebaceous glands, which produce a secretion that decomposes to form a whitish substance. (2)

Activity 2 The female reproductive system *(Specific Aim 1)*

Learner's Book page 94

1 a Eggs/ova are made in the ovary. (2)

b The oviduct is the tube through which eggs/ova travel from the ovary to the uterus. In humans it is usually called the Fallopian tube. (2)

c The vagina is a muscular tube that accommodates the penis during sexual intercourse. (2)

d The clitoris contains erectile tissue that becomes engorged with blood during sexual excitement. The clitoris is also rich in nerve endings and functions as a centre of sexual sensation in females. (2)

e The urethra in females is the tube through which urine passes from the bladder to the outside. (2)

2 a The uterus has very thick muscular walls so that it can stretch as the foetus grows inside it. During labour these muscles contract and so help to push the foetus out during childbirth. (2)

b The ciliated epithelial cells that line the Fallopian tube help to move the ovum along the Fallopian tube to the uterus. (2)

c The vestibular glands secrete mucus to lubricate the vagina during sexual intercourse. (2)

RPA

Activity 3 The age at which puberty takes place *(Specific Aims 2 and 3)*

Learner's Book page 95

1 Accept any one value from 13,5 to14 years. (2)

2 Most girls reach puberty before boys OR most girls reach puberty at age 12–13 years and boys at age 14–15 years (2)

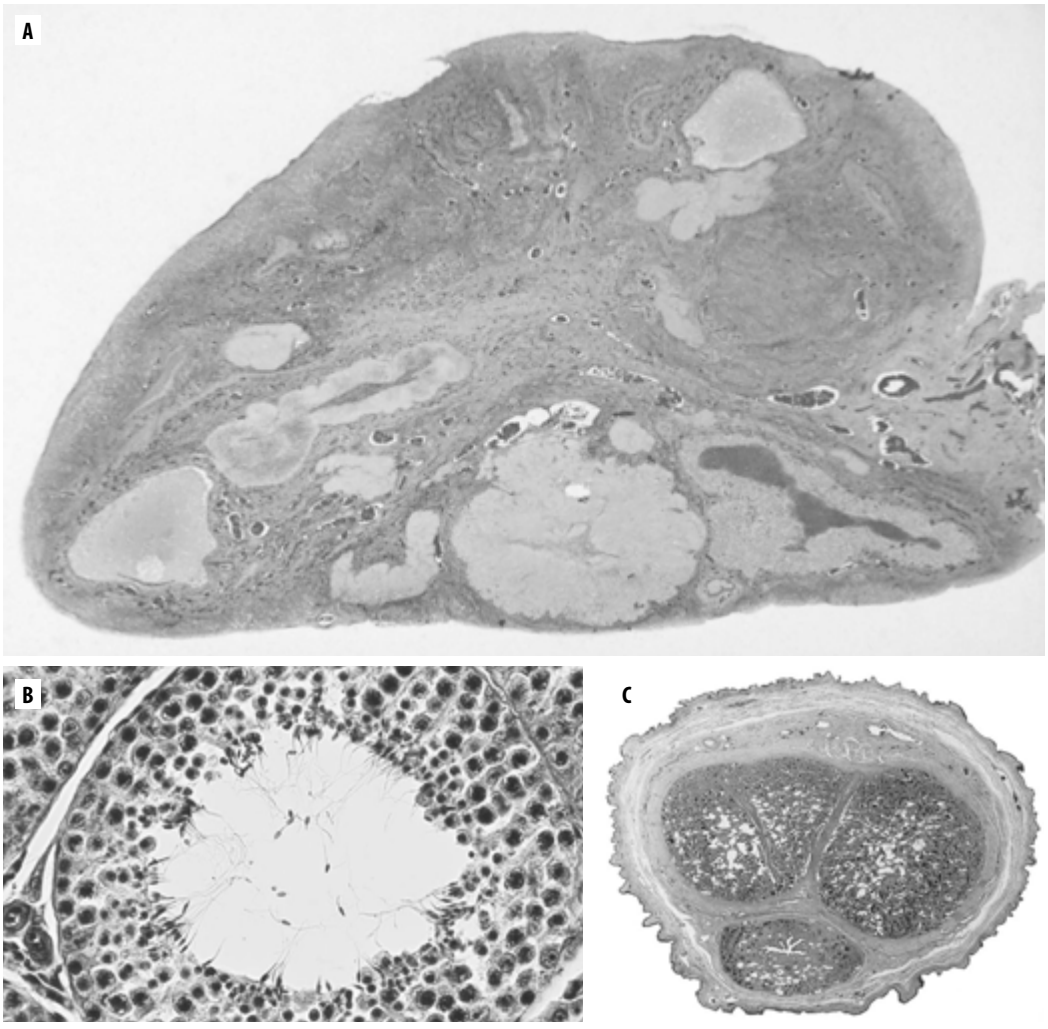
3 Some girls reach puberty at a later stage OR not all girls of 16 have reached puberty (2)

4 Any two of: Emotionally immature so not easy to change from being a teenager to a parent/not responsible yet, not yet financially independent and the costs/medical/clothes/food of raising a baby is high, need education/qualifications to get a good job, to raise a baby needs time/effort and no freedom for the teenager/cannot keep baby, teenager's body not physically ready and pregnancy may lead to complications, girls will be stigmatised and chances of finding a partner are reduced. (4)

PPA

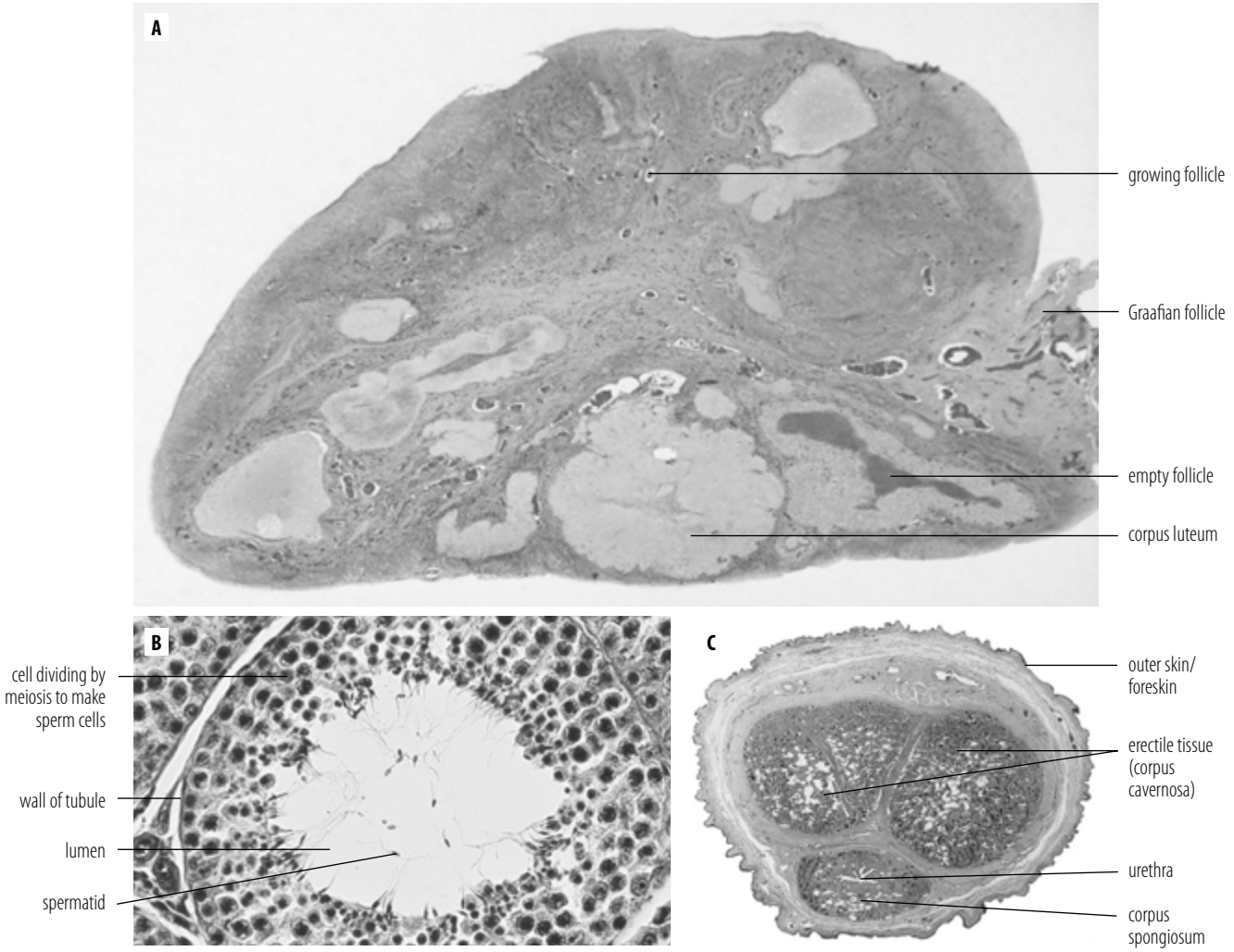
Activity 4 Observing reproductive structures *(Specific Aim 2)*

Learner's Book page 98



Sections through an ovary (**A**), testis (**B**) and penis (**C**)

Learners draw from the micrographs. If you cannot source micrographs you can photocopy these. Check their drawings and their labels.



3 Use the following checklists to mark the drawings

A

Criteria	Marks
Caption (T/S of human ovary)	1
Correct proportion	2
Any 3 correct labels (corpus luteum, epithelium of ovary, Graafian follicle)	3
TOTAL	**(6)**

B

Criteria	Marks
Caption (T/S of testis)	1
Correct proportion	2
Any 3 correct labels (wall of tubule, lumen, spermatids, cells dividing by meiosis)	3
TOTAL	**(6)**

C

Criteria	Marks
Caption (T/S of penis)	1
Correct proportion	2
Any 3 correct labels (erectile tissue, urethra, outer skin/foreskin)	3
TOTAL	**(6)**

Activity 5 Anatomy and function of the reproductive system
(Specific Aim 1)

Learner's Book page 99

1 a 1 acrosome – the cap-like structure on the sperm head
2 nucleus
3 neck
4 tail
5 head. (5)

b The enzymes in the acrosome digest the plasmalemma of the ovum, so that the nucleus of the sperm can penetrate it, so it can fuse with the nucleus of the ovum during fertilisation. (3)

c The sperm has to swim from the vagina through the uterus and through the Fallopian tube. This requires a lot of energy, which is supplied by ATP produced in the mitochondria. (3)

d The egg cell contains a small amount of yolk for the early development of the zygote and the embryo until it becomes implanted in the uterus wall. Also egg cells do not need to move actively, but sperm need to be small and mobile. (4)

e Pigeons are oviparous and the eggs hatch outside the body of the mother and are covered with a shell. The embryo has to be supplied with food in the form of large amounts of yolk and albumen inside the shell of the egg. (3)

2 a 1 Fallopian tube (oviduct)
2 funnel with fimbriae
3 ovary
4 uterus
5 vagina
6 opening of vagina (vulva). (6)

b i The sperm cannot reach the ovum. (2)

ii The egg produced in the other ovary can still be fertilised. (2)

c **i** one (1)

ii four. (1)

RPA

Activity 6 The menstrual cycle *(Specific Aims 1 and 2)*

Learner's Book page 103

1 a Days 1 to 5 should be shaded. (2)

b O should be on day 14 (a range of 12 to 14 is acceptable). (2)

c P should be on days 19 to 24. (2)

d X should be on days 13–14 and also on days 24–25. (2)

2 a A sudden decrease of the progesterone and oestrogen levels in the blood causes menstruation. (2)

b FSH, which is secreted by the pituitary gland (hypophysis). (2)

c The endometrium starts to disintegrate, which causes this hormone to start working. (2)

d Ovulation takes place as the progesterone levels drop. (2)

e The Graafian follicle, after ovulation, changes into a corpus luteum, which produces progesterone. (2)

f Fertilisation could occur between days 12 to 15. (2)

g LH induces ovulation and also controls the formation of a corpus luteum from the Graafian follicle. The corpus luteum produces progesterone. (2)

h Progesterone produced by the corpus luteum inhibits the formation of FSH, which controls the development of the Graafian follicle and eventually ovulation. (3)

Activity 7 Essay on the control of menstruation *(Specific Aim 1)*

Learner's Book page 104

Learner's essays should contain the following information:

- The pituitary gland secretes FSH which stimulates the development of a primary follicle in the ovary.
- The developing Graafian follicle secretes oestrogen with causes the lining of the uterus to start to thicken.
- At around day 13 the pituitary gland starts to secrete luteinising hormone (LH).
- The sharp rise in LH causes ovulation to occur on day 14.
- The remains of the Graafian follicle develops into the corpus luteum which starts to produce progesterone.
- Progesterone inhibits the production of FSH so that the ovaries are no longer stimulated to produce another follicle therefore no more ova are released while there is an ovum in the fallopian that may be fertilised.
- When fertilisation does not occur the corpus luteum degenerates and stops producing progesterone.
- The pituitary gland is no longer inhibited in its production of FSH and a new Graafian follicle can start to develop.
- Oestrogen that is produced by the developing follicle stimulates the initial thickening of the endometrium.
- Later, progesterone, produced by the corpus luteum, continues to thicken and maintain the lining of the uterus in preparation for a pregnancy.
- When fertilisation does not occur the corpus luteum degenerates and stops producing progesterone and the thick endometrium is no longer maintained.
- Menstruation occurs.

MARKS: Content 17
Synthesis 3

Assesses the presentation of the essay using the following checklist:

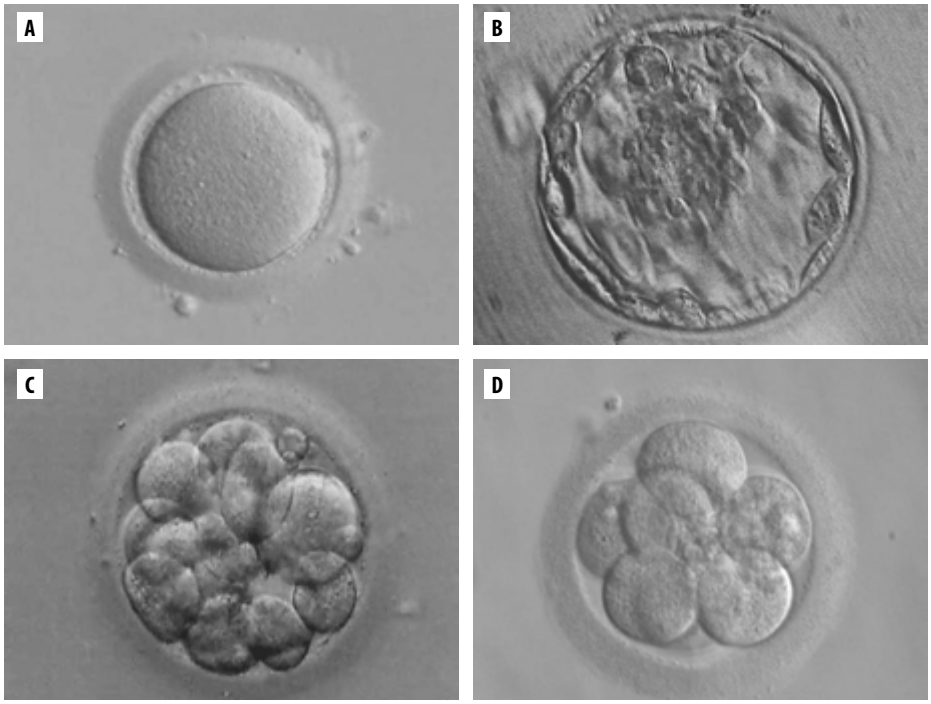
Marks	Description
3	Well structured – demonstrates insight and understanding of question
2	Minor gaps or irrelevant information in the logic and flow of the answers
1	Attempted but with significant gaps and irrelevant information in the logic and flow of the answers
0	Not attempted/nothing written other than question number/no correct information

Total: [20]

PPA

Activity 8 Observing the stages of development of the embryo *(Specific Aim 2)*

Learner's Book page 107



A oocyte **B** blastocyst **C** morula **D** embryo (8-cell stage)

If you do not have access to any micrographs of these stages of development you can use the photographs provided here. Make sure that learners know which stage of development is represented by each micrograph. Check their drawings and labels.

2 Use the following checklist to mark each of the drawings

Criteria	Marks
Caption (A – oocyte, B – blastocyst, C – morula, D – embryo)	1
Correct proportion	2
TOTAL	**(3)**

PPA

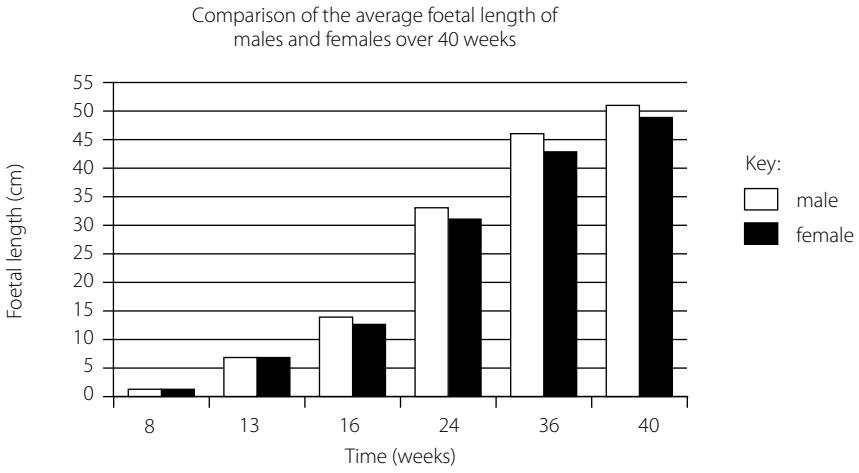
Activity 9 Observing embyonic development and the stages of pregnancy *(Specific Aim 2)*

Learner's Book page 109

Make sure that learners know which stage of development is represented by each micrograph. Check their drawings and labels. (12)

Learner's Book page 109

1



Mark allocation of the graph:

Correct type of graph	1
Caption of graph	1
Correct label and units for *x*-axis	1
Correct label and units for *y*-axis	1
Graphs labelled/key provided for 2 graphs	1
Appropriate width and interval of bars	1
Appropriate scale for *y*-axis	1
Drawing of the bars	1: 1 to 3 bars plotted correctly 2: 4 to 7 bars plotted correctly 3: 8 to 11 bars plotted correctly 4: all 12 bars plotted accurately

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.
- If axes are transposed then marks will be lost for correct labels and units for *x* and *y* axes.

(8)

2
- Average foetal length of both males and females is the same at 8 and 13 weeks.
- Average foetal length of males is greater than the average foetal length of females from 16 to 40 weeks.
- Average foetal length increases for males and females over the 40-week period.

any (2)

PPA » Activity 11 Observing contraceptive devices *(Specific Aim 2)*

Learner's Book page 113

1 Use this as an opportunity to answer learners' questions about sexuality and contraception.

2 Check learners' answers against the text on pages 113 and 114 of the Learner's Book. Allocate 3 marks for each method as follows: 1 mark for the classification of the method, e.g. barrier; 2 marks for describing how the method prevents fertilisation. (33)

» Activity Self assessment

Learner's Book page 116

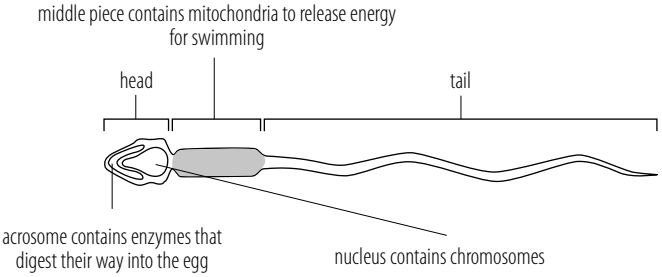
1 **a** C – endometrium / uterus / uterine wall
D – ovary (2)

b 1 – ovulation
2 – fertilisation
3 – mitosis / cell division / growth / cleavage (3)

c **i** 23 (2)

ii 46 (2)

d



(5)

Use the following checklist to mark the drawing of the sperm cell

Criteria	Marks
Caption (Drawing of a sperm cell)	1
Correct proportion	1
Any 3 correct labels (head, middle piece, tail, acrosome, nucleus)	3
TOTAL	**(5)**

e Any two of: shock absorber, prevents physical or mechanical damage, protects the foetus from drying out, insulates the foetus against temperature fluctuations, allows foetal movement for growth and development. (2)

f **i** Oxygen or nutrients or antibodies (1)

ii Carbon dioxide or metabolic waste (1)

2 The diploid zygote moves slowly along the Fallopian tube towards the uterus. The zygote is carried down the Fallopian tube by the rhythmical contraction of the muscles of the Fallopian tube and by the cilia of the ciliated epithelium cells lining the Fallopian tube. As the zygote moves along, it divides by mitosis to form two cells and then four cells and so on until it forms an embryo which consists of a ball of cells. This ball of cells is called the morula stage. More mitotic divisions of the morula stage of the embryo take place until a hollow ball of cells is formed. This hollow ball of cells stage of the embryo is now called a blastocyst. (6)

3 **a** The placenta has two main functions:
- It produces the hormones oestrogen and progesterone.
- It allows the exchange of substances between the mother's blood and the foetal blood. (2)

b The foetus is attached to the placenta by the umbilical cord. The umbilical cord is made up of two arteries, a vein and connective tissue. The arteries transport blood from the foetus into the placenta, and the vein returns the blood to the foetus. The two umbilical arteries carry foetal blood to the placenta, which is low in nutrients and oxygen (deoxygenated blood). The umbilical vein carries foetal blood from the placenta back to the foetus. This blood is rich in nutrients and oxygen (oxygenated blood). (2)

c The amnion secretes the amniotic fluid, which helps to support and protect the embryo against mechanical shock. It also allows the foetus to float and move in this pond so that the foetus lives in a space that is free from the effects of gravity and pressure. The fluid also prevents large scale changes in temperature of the foetus. (2)

4 The birth process begins with gentle contractions of the muscles of the uterus. This first stage of labour lasts for about 12 hours. The second stage begins when the muscular contractions slowly start to get stronger and more frequent. During these strong contractions, the head of the foetus is pushed towards the cervix. This causes the opening of the cervix to stretch. The mucus plug of the cervix is pushed out and the amnion bursts, releasing the amniotic fluid. The rush of amniotic fluid out through the vagina is called "the breaking of the waters". About one litre of amniotic fluid is released. When the cervix is about 10 cm wide, the contraction of the uterus is more forceful and more frequent and the mother assists by pushing downwards in time with the contractions. This forces the baby's head out of the cervix and into the vagina. As soon as the baby's head appears through the vagina, the rest of the baby's body slides out easily. The second stage lasts for about an hour. Once the baby is born and it takes its first breath, there is no longer any need for the baby to be attached by its umbilical cord and the placenta. A midwife or doctor will then clamp the umbilical cord close to where it is attached to the baby and it is then cut. This is a painless procedure since the umbilical cord does not have any nerves. The navel that we all have is the stump of the umbilical cord. The third stage of labour occurs when further contractions push out the placenta and the rest of the umbilical cord through the vagina. This is called the "afterbirth". The third stage lasts for about ten to fifteen minutes. (10)

5 **a** The pill contains artificially produced hormones which prevent the production of eggs/ovulation. (2)

b The male condom acts as a barrier, stops sperm getting into the vagina. (2)

c The IUD prevents fertilised eggs/embryos from becoming attached to the uterine wall. (2)

d In vasectomy the sperm ducts are cut and tied. Semen that does not contain sperm is produced. (2)

e In the rhythm method sexual intercourse is avoided three to four days before and after ovulation. This is between days 10 and 18 of the menstrual cycle. (2)

Unit 3: Genetics and inheritance

Learner's Book pages 120–155
Duration: 16 hours

UNIT 3 Genetics and inheritance

TERM 2

RPA

Activity 1 Normal inheritance *(Specific Aim 2)*

Learner's Book page 124

1 The anthers were removed to prevent self-pollination, which made sure that the female gamete was fertilised by the male gamete from the correct parent plant. (2)

2 A bag was used to cover the flower to control variables, for example to make sure that no other pollen grains pollinated the flower. In this way Mendel was sure which parents were involved in the cross. (2)

3 Self-pollination is the transfer of pollen grains from the anthers to the stigma of the same flower. Cross-pollination is the transfer of pollen from the anthers of one flower to the stigma of another flower of the same species. (2)

4 Mendel controlled his experiments so that he controlled variables. This allowed him to study one trait at a time and analyse this statistically. (2)

Activity 2 Distribution of blood groups *(Specific Aim 1)*

Learner's Book page 130

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. (2)

3 Blood group A: $\frac{35}{100} \times \frac{360}{1}$

$= 126^\circ$

Blood group B: $\frac{15}{100} \times \frac{360}{1}$

$= 54^\circ$

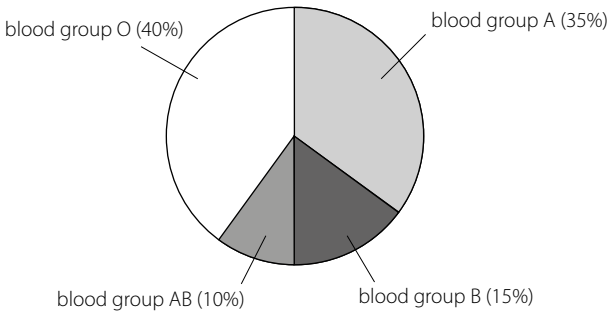
Blood group AB: $\frac{10}{100} \times \frac{360}{1}$

$= 36^\circ$

Blood group O: $\frac{40}{100} \times \frac{360}{1}$

$= 144^\circ$

Percentage distribution of blood groups in a province



Mark allocation of the calculations:

1–3 calculations correct	1
4 calculations correct	2

Mark allocation of the pie chart:

Caption	1
Correct proportion of slices	1: 1–2 correct 2: 3–4 correct
Label/key for each slice	1: 1 correct label 2: 2 correct labels 3: 3–4 correct labels

Note: If the wrong type of illustration is drawn: marks will be lost for drawing the slices in correct proportions.

(8)

Activity 3 Alternative inheritance patterns and genetic disorders

(Specific Aim 1)

Learner's Book page 131

1 The sickle-shaped red blood cells are irregularly / sickle shaped, while normal red blood cells are biconcave discs. The sickle-shaped cells are not as efficient in absorbing and transporting oxygen and carbon dioxide as a normal shaped red blood cell. It is also difficult for these cells to pass through narrow blood capillaries and therefore they cause clogging of these capillaries. (3)

2 If the sickle cells clog the blood capillaries this can cause poor blood circulation and body tissues that do not receive a normal amount of blood eventually become damaged. If the spleen is damaged by lack of blood supply, the affected person is more likely to suffer from infections. Sickle cells are also destroyed more rapidly by the body, so the person becomes anaemic. (3)

3 Studies have shown that children with sickle cell trait who live in malarial areas have a better chance of surviving malaria than children who either have sickle cell disease or who have normal red blood cells. Children with the sickle cell trait have red blood cells that can deform, but their cells do not sickle completely, so they do not suffer from sickle cell disease. In children with the sickle cell trait, the red blood cells that are infected by the malaria parasite are more likely to deform. These deformed red blood cells are cleared from the body faster than normal red blood cells are. This means that the malaria parasite will also be cleared from the body fast and so the child is more likely to surivive an acute malaria infection. (5)

4 There are a number of different ways of treating sickle cell disease. Learners may mention: taking folate daily to help to make new red blood cells; taking penicillin daily as a young child to prevent infection; drinking plenty of water; avoiding very hot or very cold temperatures; avoiding over-exertion and stress; getting plenty of rest; and having regular check-ups. There are also new genetic therapies that are being investigated. For example, people who suffer from sickle cell disease produce normal foetal haemoglobin during development. Drugs that turn on the genes for foetal haemoglobin in adults are being developed. (4)

5 For the father to have blood type A there are two possible genotypes, namely AA and AO. For the mother to have blood type B there are two possible genotypes, namely BB and BO. For the child to have O type blood it can only have a genotype OO. This means that one O allele must come from the father and the other O allele must come from the mother. Therefore, the only possible genotypes of the parents are as follows:

	Father		Mother
P_1:	AO	×	BO
	Meiosis		
Gametes:	A O	×	B O
	Fertilisation		
F_1:	AB AO	BO	OO

This is probably the couple's child. However, it must be noted that this cannot be 100% certain because it is possible that another couple with the same blood groups as the above couple could have parented another child with the same blood group (7)

Additional information

No test can prove absolutely that a particular man is the father of a child, but the paternity tests performed today yield a probability of paternity that is more than 99%. Paternity testing involves analysing the blood of the child, the child's mother, and the suspected father to determine which blood antigens they all have and then using the principles of genetics to determine whether the child could have received its complement of antigens from the parents.

Paternity testing is not solely based on the ABO blood groups. DNA analysis is also used in conjunction with antigen analysis. This combination of tests contributes to the high accuracy of the results.

6

Husband No. 1:	blood type A, genotype is therefore: either AA or AO.
Child No. 1:	blood type O, genotype is therefore OO. Since the child's blood type is O, it means that the father's genotype could only be AO.
Wife:	blood type either AO or BO or OO
Husband No. 2:	blood type B, genotype is therefore either BB or BO
Child No. 2:	blood type AB, genotype is therefore AB. For the child to have a blood type AB it means that the mother had to contribute an A allele because the father contributed the B allele. Hence the genotype of the woman is AO and her blood type is A.

(7)

Learner's Book page 133

1 **a** P (2)
b P and p (2)
c W and w (2)
d T (2)
e T and t (2)

2 **a** genotype (2)
b gamete (2)
c gamete (2)

3 bb

4

P_1	phenotype	tongue roller	×	non-tongue roller	(step 1)
	genotype	Tt	×	tt	(step 2)
	Meiosis				
	Gametes	T and t	×	t	(step 3)
	Fertilisation				
F_1	genotype	Tt		tt	(step 4)
	phenotype	Tongue roller		Non-roller	(step 5)

Max (7 marks)

Some hints or rules:

- The above problem shows that a cross between a heterozygous parent (Tt) and a homozygous recessive (tt) parent produces F_1 offspring that are 50% heterozygous (Tt) and 50% homozygous recessive(tt).
- A cross between a homozygous dominant (TT) parent and a homozygous recessive (tt) parent produces F_1 offspring that are 100% heterozygous (Tt).
- A cross between a homozygous dominant (TT) and a heterozygous (Tt) parent produces F_1 offspring that are 50% homozygous dominant (TT) and 50% heterozygous (Tt).
- A cross between two heterozygous (Tt) parents produces F_1 offspring that are 25% homozygous dominant (TT), 50% heterozygous (Tt) and 25% homozygous recessive (tt).

5

P_1	phenotype	red	×	white	(step 1)
	genotype	RR	×	WW	(step 2)
	Meiosis				
	Gametes	R	×	W	(step 3)
	Fertilisation				
F_1	genotype		RW		(step 4)
	phenotype		pink		(step 5)

(7)

6

P_1	phenotype	red	×	white	(step 1)
	genotype	RR	×	WW	(step 2)
	Meiosis				
	Gametes	R	×	W	(step 3)
	Fertilisation				
F_1	genotype	RW			(step 4)
	phenotype	flower with equal distribution of red and white colour			(step 5)

(7)

Hint:

The solution for incomplete and co-dominance is exactly the same except for the interpretation of the phenotype of the F_1 – generation (step 5).

PPA » Activity 5 Heterozygous and homozygous crosses *(Specific Aim 2)*

Learner's Book page 136

1 Heterozygous black – Bb
Homozygous rough – RR
Therefore the genotype of the parent guinea-pigs is as follows:

P_1: BbRR × BbRR

meiosis

Gametes: BR bR × BR bR

fertilisation

genotype	phenotype	
F_1: BBRR – 1 (25%) homozygous black, homozygous rough	black with rough coat	75%
BbRR – 2 (50%) heterozygous black, homozygous rough	black with rough coat	
bbRR – 1 (25%) homozygous white, homozygous rough	white with rough coat	25%

(7)

2 Heterozygous rough-parents:

P_1: BbRr × BbRr

meiosis

Gametes: BR Br bR br × BR Br bR br

fertilisation

	BR	**Br**	**bR**	**br**
BR	BBRR	BBRr	BbRR	BbRr
Br	BBrR	BBrr	BbrR	Bbrr
bR	bBRR	bBRr	bbRR	bbRr
br	bBrR	bBrr	bbrR	bbrr

Genotype			Phenotype
1 × BBRR	homozygous black	homozygous rough	9 × black with rough coat
2 × BBRr	homozygous black	heterozygous rough	
2 × BbRR	heterozygous black	homozygous rough	
4 × BbRr	heterozygous black	heterozygous rough	
2 × Bbrr	heterozygous black	homozygous smooth	3 × black smooth
1 × BBrr	homozygous black	homozygous smooth	
1 × bbRR	homozygous white	homozygous rough	3 × white rough
2 × bbRr	homozygous white	heterozygous rough	
1 × bbrr	homozygous white	homozygous smooth	1 × white smooth

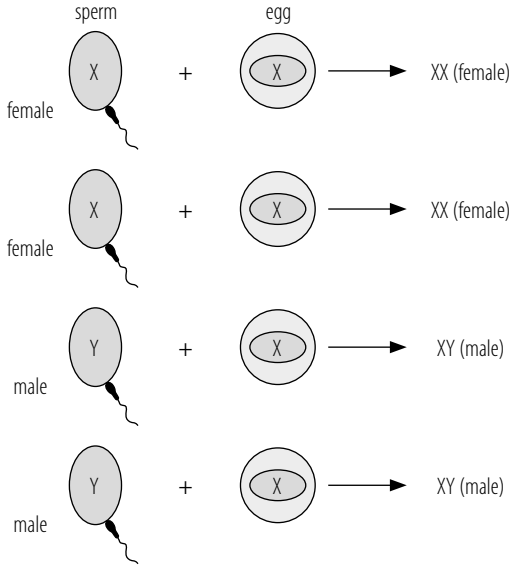
(7)

PPA

Activity 6 Human sex chromosomes *(Specific Aims 1 and 2)*

Learner's Book page 136

1 From Figure 1.3.14 in the Learner's Book the resulting sperm will be X, X, Y and Y, and from Figure 1.3.15 the resulting eggs will all be X. So for fertilisation, the combinations below are possible:



(6)

2 **a** 50% (1)

b 50% (1)

Activity 7 Sex-linked disorders *(Specific Aim 1)*

Learner's Book page 138

1 **a** None of their sons will be haemophiliac. (2)

b None of their daughters will be haemophiliac. (2)

c All of their daughters will be carriers. (2)

2 What is colour-blindness?

Colour blindness (colour vision deficiency) is a condition in which certain colours cannot be distinguished and is most commonly inherited. Red/green colour blindness is by far the most common form. People suffering from this type of colour blindness have difficulty distinguishing red and green. Another form of colour blindness, blue/yellow, also exists, but it is rare.

Colour blindness seems to occur in about 8% to 12% of men of European origin and only in about 0,5% of women. Total colour blindness (seeing only in shades of gray) is extremely rare.

There is no treatment for colour blindness, nor is it usually the cause of any significant disability. However, it can be very frustrating for individuals affected by it. It may, for example, be difficult to distinguish between red and green traffic lights.

Living with colour blindness

People who are colour blind may:

- Experience difficulty reading weather forecasts — especially the weather channel – where certain colours just cannot be distinguished on their weather maps. Maps in general may be difficult to interpret because of the colour coding on the legends.
- LEDs (light emitting diodes) may be difficult to distinguish: Is that glowing indicator light red, yellow, or green?
- Traffic lights, and worst of all, caution lights may also be difficult to interpret: colour blind people always know the position of the colours on the traffic light — in most places it is red on top, yellow in the centre, and green on the bottom. But caution lights present an entirely different problem. In this situation there is only one light; no top or bottom, no right or left, just one light that is either red or yellow — but which is it?
- Purchasing clothing: it may be difficult to colour match clothes.
- Kids and crayons: Colour blindness affects children from the earliest years. At school, colouring can become difficult when the child has to take the blue crayon – and not the pink one — to colour in the ocean.

A colour blind person is generally unable to:

- interpret some chemical reactions
- see that acid turns litmus paper red
- identify a material by the colour of its flame, such as the blue flame produced by lead or the purple flame produced by potassium
- interpret the chemical testing kits for swimming pool water
- interpret the test strips for hard water, soil or water pH tests, all of which rely on subtle colour differences from a band of colours that are used for comparison.

Cooking and foods

When cooking, red colour blind individuals cannot tell whether their piece of meat is raw or well done. Many cannot tell the difference between green and ripe tomatoes or between tomato sauce and chocolate syrup. (4)

Additional information for the teacher

Clinical information about colour blindness

Cones (colour sensitive receptors) containing single visual pigments selective for red, green, and blue light, are present in the normal human eye. Disturbances of colour vision will occur if the amount of pigment per cone is reduced or if one or more of the three cone systems are absent.

Although colour deficient vision may be acquired as a result of some eye disorders, most cases of colour blindness are hereditary. Colour blindness is carried by women and passed on to their sons.

Colour blindness is caused by a malfunction of the retina, which converts light energy into electrical energy that is then transmitted to the brain. Two types of photoreceptor cells in the retina accomplish this conversion: rods and cones. The cones are responsible for encoding colour. Each cone contains structures or visual pigments sensitive to one of three wavelengths of light: red, green and blue. Normal people are able to match all colours of the spectrum using mixtures of only three fundamental colour sensitivities. Defects in colour vision occur when one of the three cone cell colour coding structures fails to function properly. One of the visual pigments may be present and functioning abnormally, or it may be absent altogether.

Information sources:

An article by: Diana H. Heath, M.D., a member of the Morton Plant medical staff, specialising in ophthalmology. http://www.zipmall.com/mpm-artcolorbl.htm

The web page written by Terrance L. Waggoner, O.D., Staff Naval Hospital Pensacola http://members.aol.com/nocolorvsn/color2.htm

3 Duchenne muscular dystropy, also called Lou Gerig's disease. The main symptom is progressive muscle weakness, which eventually leads to paralysis and death because the respiratory muscles cannot produce enough force to allow the person to breathe. (3)

4

P_1	phenotype	normal father	×	normal mother	(step 1)
	genotype	X^HY	×	X^HX^h	(step 2)
	Meiosis				
	Gametes	X^H and Y	×	X^H and X^h	(step 3)
	Fertilisation				
F_1	genotype	$X^H X^H$, $X^H X^h$,	$X^H Y$,	$X^h Y$	(step 4)
	phenotype	2 normal daughters	1 normal son	1 son with haemophilia	(step 5)

(7)

» Activity 8 Mistakes in the code *(Specific Aim 1)*

Learner's Book page 139

1 Learners will have a variety of responses – such as: connecting with the wrong person, the number does not exist, etc. (2)

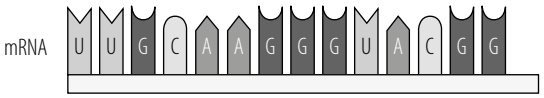
2 Being unable to contact an emergency service such as an ambulance, doctor, fire service, etc, unable to make contact with a prospective employer, etc. (3)

RPA

» Activity 9 Addition and deletion of bases *(Specific Aim 2)*

Learner's Book page 140

1 mRNA

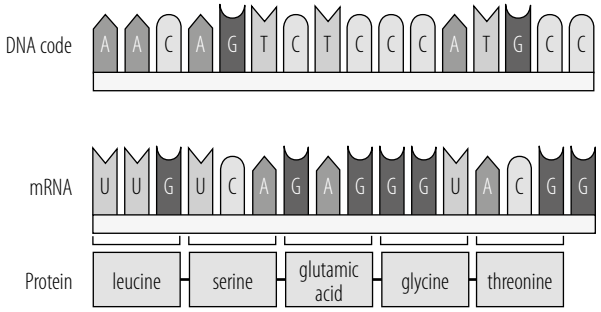


(2)

2 Protein: leucine – glutamine – glycine – tyrosine (4)

3 A different polypeptide is formed (incompletely formed). (1)

4



(5)

5 A different protein is formed. (1)

Activity 10 Chromosomal mutations *(Specific Aims 1 and 3)*

Learner's Book page 142

1 **Insertions** take place when a part of a chromatid breaks off and attaches to its sister chromatid. The result is a duplication of genes on the same chromosome.
Deletions occur when part of a chromosome is left out.
Translocations take place when part of one chromosome breaks off and is added to a different chromosome.
Inversions occur when part of a chromosome breaks off and is reinserted backwards. (8)

2 Factors that cause mutations are:
- X-rays
- UV light
- radioactivity
- some chemical substances. (4)

Activity 11 Genetically modified organisms *(Specific Aim 1)*

Learner's Book page 143

1 To study how genes in plants could be manipulated to produce more protein/food. To trace the development of tissues when stem cells are used to repair damaged organs. (2)

2 There is no right or wrong answer here. What is important is that the learners are able to argue and to substantiate their opinions with information from the learner's book and from elsewhere. (4)

Activity 12 Insulin production *(Specific Aims 1 and 3)*

Learner's Book page 145

1 **a** It is a means by which foreign DNA is transferred into a host cell. (1)

b A vector is involved in steps 3 and 4. (2)

c **i** Two commonly used vectors are viruses and plasmids (2)

ii Mechanical vectors are used to introduce foreign DNA directly into the nucleus of a cell. Examples – a micropipette is used or a gene gun – from which tiny metal bullets coated with pieces of DNA are shot into the cell. (2)

2 These restriction enzymes are bacterial proteins that are capable of cutting both strands of a DNA molecule at certain points. There are a large number of restriction enzymes, each capable of cutting DNA at a specific point in a specific nucleotide sequence. The resulting DNA

fragments are of different lengths. One of the restriction enzymes, known as EcoRI, makes staggered cuts in the double strands of DNA. The result is a set of double stranded DNA fragments with protruding, single stranded ends. These ends can be joined readily to complementary single strands on DNA molecules from another organism to form recombinant DNA. Since they are capable of joining so easily, the ends are referred to as being sticky. (4)

3 Gene splicing is the rejoining of cut DNA fragments. For example, if the plasmid and the foreign DNA have been cleaved with the same restriction enzyme, the sticky ends of the plasmid and of the DNA will match and they will join, reconnecting the plasmid ring. The foreign DNA is recombined into a plasmid or viral DNA with the help of a second enzyme. (5)

4 If the plasmid and foreign DNA have been cut with the same restriction enzyme, the sticky ends of each will match. This allows them to join together and so reconnects the plasmid ring. (2)

5 The process of making more copies of recombinant DNA is a form of cloning. Clones are genetically identical copies. (2)

6 Gene cloning takes place at step 4 in the production of insulin. (1)

7 A transgenic bacterium is a bacterium that is carrying genetic material that it would not normally carry. It contains this material as a result of trangenesis, which is the process of deliberately introducing new genes into the germ line of organisms so that these genes can be inherited. (2)

» Activity 13 Cloning *(Specific Aim 3)*

Learner's Book page 148

1 Answers will vary. Common answers include: all new organisms are genetically identical – they will have all the desired characteristics, organisms that are difficult or slow to breed normally can be reproduced quickly. (4)

2 Answers will vary. Common answers include: if a clone is susceptible to disease or changes in the environment then all the clones will be susceptible, cloning will lead to less variation and less opportunity for variation in the future, ethical issues – particularly around human cloning. (4)

PPA » Activity 14 Mitochondrial DNA and genetic lineages *(Specific Aims 1, 2 and 3)*

Learner's Book page 150

1 mtDNA haplogroups are groups of branches that share a common nucleotide change. They are used to determine the time at which sub-groups of populations split off from the main population and also the time at which another population's gene pool was incorporated into different populations of organisms. (5)

2 Current research suggests that the Khoisan matrilineal ancestry split off from the rest of the human mtDNA pool between 150 000 and 90 000 years ago. (1)

3 At the beginning of the Late Stone Age (LSA), about 40 000 years ago, there was incorporation of genes from additional lines into the Khoisan mtDNA pool. (1)

4 Incorporation of genes from additional lines into the Khoisan mtDNA gene pool shows that there was movement of people from different areas of Africa into the area occupied by the Khoisan. It also shows

that by the time these other groups expanded into southern Africa, the local Khoisan population had already formed small, separately evolving isolated populations. (3)

Activity Self assessment

Learner's Book page 154

1 **Gene:** A small portion of DNA coding for a particular characteristic (2)
Alleles: Alternate/different forms of a gene which occur at the same locus/position on homologous chromosomes (2)
Genotype: Genetic composition/make-up of an organism (2)
Phenotype: The physical appearance of an organism determined by the genotype, e.g. tall, short (2)
Dominant allele: An allele that is shown/expressed in the phenotype when found in the heterozygous (TT) and homozygous (Tt) condition (2)
Recessive allele: An allele that is not shown/masked in the phenotype when found in the heterozygous (Tt) condition – it is only expressed in the homozygous (tt) condition (2)
Heterozygous: Two different alleles for a particular characteristic, e.g. Tt (2)
Homozygous: Two identical alleles for a particular characteristic, e.g. TT, tt (2)
Monohybrid cross: Only one characteristic/trait is being shown in the genetic cross (2)
Dihybrid cross: Dihybrid crosses are crosses between organisms that differ from each other in two traits instead of only one trait (2)
Complete dominance: A genetic cross where the dominant allele masks/blocks the expression of a recessive allele in the heterozygous condition (2)
Incomplete dominance: A genetic cross between two phenotypically different parents produces an offspring different from both parents but with an intermediate phenotype (2)
Co-dominance: A genetic cross in which both alleles are expressed equally in the phenotype (?)
Multiple alleles: More than two alternative forms of a gene at the same locus (2)
Sex-linked characteristics: Characteristics or traits that are carried on the sex chromosomes (2)
Biotechnology: Involves the identification and use of living organisms and their systems to make products that are useful to humankind to improve the chances of survival and the quality of life (2)
Genetic engineering: A field of biotechnology that is used to alter the genome of a living cell for medical, industrial or agricultural purposes (2)
Cloning: Process by which genetically identical organisms are formed using biotechnology (2)

2

P_1	phenotype	black	×	brown	(step 1)
	genotype	Bb	×	bb	(step 2)
	Meiosis				
	Gametes	B and b	×	b	(step 3)
	Fertilisation				
F_1	genotype	Bb	and	bb	(step 4)
	phenotype	black	and	brown	(step 5)

(7)

3 Advantages of genetic engineering:
- production of medication/resources cheaply
- control pests with specific genes inserted into the crop
- using specific genes to increase crop yields/food security
- selecting genes to increase shelf life of plant products

Disadvantages of genetic engineering:
- expensive /research money could be used for other needs
- interfere with nature/immoral/we cannot play God
- potential health impacts
- unsure of long-term effects (8)

4 Stem cells are naturally occurring cells that are not yet fully differentiated. That is, these cells are able to differentiate and specialise into any particular tissue type, such as blood or skin. (2)

5 Any two of:
- Drugs can be tested before trying them in humans.
- Creating stem cell lines that have all the genes that contribute to a particular disease will allow these diseases to be studied in the laboratory.
- Stem cells could be used to regenerate damaged body tissues. Many conditions, which result from damaged tissues, such as diabetes, spinal cord injury, and some types of blindness, may be able to be treated through such cell therapies. (2)

6 The phenotype/physical appearance of an individual is determined by a pair of genes (alleles). A single gene for a particular trait is contributed by each of the parents. That is, one allele must come from the mother through the egg while the other comes from the father through the sperm. The nature of the allelic pair, i.e. whether it is dominant or recessive, will determine the phenotype of a new individual. It is this natural process that determines the appearance or phenotype of an individual. Accidents do not cause changes to a person's genetic material, so any deformities caused by an accident will not be passed on to offspring. (4)

7 Relatives will share a greater proportion of their genetic material than non-relatives. So, the chances of sex-linked diseases and/or the recessive alleles appearing in future generations is greater among relatives. This is because there is more chance of two related individuals who share undesirable recessive traits marrying and producing offspring. (4)

STRAND 2

LIFE PROCESSES IN PLANTS AND ANIMALS (continued)

Unit 3: Responding to the environment: humans
Unit 4: Human endocrine system
Unit 5: Homeostasis in humans
Unit 6: Responding to the environment: plants

Learner's Book pages 158–197
Duration: 16 hours

UNIT 3 Responding to the environment: humans

TERM 2

RPA

Activity 1 Observing and drawing nervous tissue *(Specific Aims 1 and 2)*

Learner's Book page 161
Learners will draw and label a diagram of a neuron. Check their answers against Figure 2.3.2 on page 160 of the Learner's Book.

Use the following checklist to mark the drawing of the neuron:

Criteria	Marks
Caption (Drawing of a neuron)	1
Correct proportion	2
Any 3 correct labels (cell body, dendrites, axon)	3
TOTAL	**(6)**

PPA

Activity 2 Dissection of a sheep's brain *(Specific Aim 2)*

Learner's Book page 164

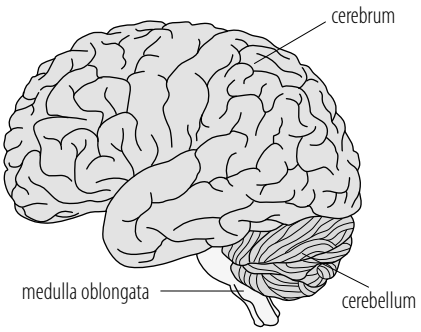
Brain – Model and specimen

1. You need to go to your local butcher or abattoir to order two heads of a sheep/cow.
2. Ask the butcher to remove the skull of one head carefully so that you have an intact brain.
3. With the other head of a sheep/cow, ask the butcher to cut a longitudinal section (L/S) through it.
4. Use the model of the brain together with your specimens to identify the cerebrum, cerebellum, corpus callosum and the medulla oblongata.
5. You may stick pins/flags with letters (A, B, etc) on the different parts of the brain and use this to assess whether your learners can identify these parts of the brain for practical assessment tasks.
6. Other associated questions such as how the brain is protected and the functions of the various parts may also be asked.
7. Do not throw the specimens away, rather put them in a jar with a formalin solution so that you can use them again.

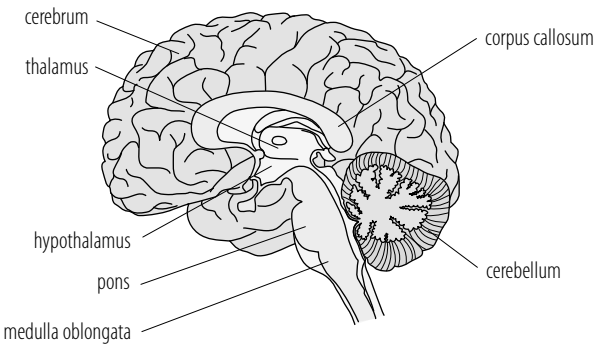
Use the following checklist to mark the drawing of the brain

Criteria	Marks
Caption (Drawing of a longitudinal section through the brain)	1
Correct proportion	2
Any 3 correct labels (cerebrum, cerebellum, medulla oblongata)	3
TOTAL	**(6)**

External structure of the human brain



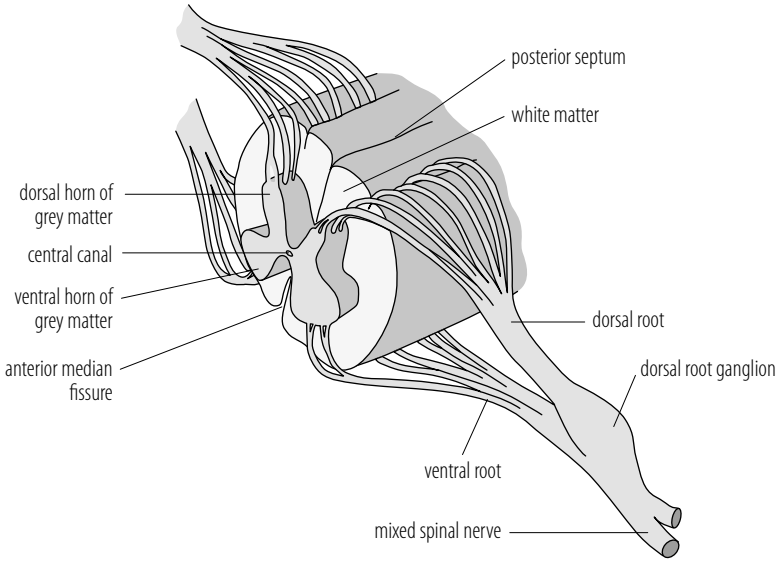
Internal structure of the human brain



[This figure of the human brain is included in case the school has no model.]

Spinal cord – Model and specimen

1. We did an L/S for the brain. Get your butcher to cut you a transverse section (T/S) of a vertebra. This will show how the spinal cord is protected within the vertebrae.
2. Using the model and the specimen, identify the white and grey matter of the spinal cord.
3. As with the brain, use flags/pins with letters on it to identify the different parts of the spinal cord.



Use the following checklist to mark the cross section of the spinal cord

Criteria	Marks
Caption (Drawing of a cross section through the spinal cord)	1
Correct proportion	2
Any 3 correct labels (grey matter, white matter, anterior fissure, posterior septum, central canal)	3
TOTAL	**(6)**

Activity 3 The function of the different parts of the brain *(Specific Aim 1)*

Learner's Book page 165

1 D (1)
2 B (1)
3 C (1)
4 B (1)
5 C (1)

Activity 4 The reflex arc *(Specific Aims 1 and 3)*

Learner's Book page 168

1 **a** A reflex arc is the: functional unit of the nervous system, it is the path along which impulses are transmitted from receptor to effector to bring about responses to stimuli.
A reflex action is: a rapid, automatic response to a stimulus, it is a protective and instinctive reaction and does not need the brain for its initiation. (4)
b 1 – spinal cord; 2 – cell body; 3 – ganglion; 4 – dendrite of sensory neuron; 5 – interneuron (5)
c A synapse (2)
d **i** motor neuron (1)
ii axon (1)
iii transmits impulses from the spinal cord to the effector organs (2)
e Any five of: blinking, coughing, yawning, sneezing, heart beat, peristalsis (5)
f **i** anaesthesia / insensibility or no reflex action (2)
ii paralysis or no motor function (2)
g sensory neuron → interneuron → motor neruon (3)
2 **a** D (2)
b B (2)
c A (2)
d C (2)

PPA

Activity 5 Reaction times *(Specific Aims 2 and 3)*

Learner's Book page 174

1 A stopwatch cannot measure less than a second and also is dependent on the reaction time of the person doing the timing. (2)
2 Age
Gender
Concentration
How good your sight is
Movement around you when doing the investigation
Noise levels
And so on. (3)

3 Do many more than five tries and then calculate the average. Repeat the investigation. (2)

4 Taking incorrect readings from the rule
Catcher not keeping 1 cm distance between the thumb and forefinger consistently
Doing incorrect calculations of reaction time. (2)

5 This depends on learner's reaction time. (4)

6 This also depends on learner's reaction time. (2)

PPA

Activity 6 The mammalian eye *(Specific Aim 2)*

Learner's Book page 178

1 a i Six (three pairs) of muscles hold the eyeball in position. (1)

ii The muscles move the eyeball in all directions: up and down, from side to side, and diagonally. (2)

b The three layers of the wall of the eyeball are the outer fibrous layer, the middle vascular layer and the inner layer of the retina.

- The outer fibrous layer:
  - The sclera is a tough, white, opaque, non-elastic coat of dense fibrous connective tissue.
  - Anteriorly, the opaque sclera becomes transparent, allowing light rays to enter the eye.
  - This part of the sclera is known as the cornea. It is convex anteriorly and contains no blood vessels.
- The middle vascular layer:
  - This is a spongy and pigmented layer, richly supplied with blood vessels.
  - The choroid is a thin, darkly pigmented membrane that lines the inner surface of the sclera and is richly supplied with blood vessels.
  - The ciliary body is the anterior thickened part of the choroid. It connects the iris to the choroid. The ciliary body is circular and consists of about 70 ciliary processes (projections) and a circular band of ciliary muscle. Suspensory ligaments that radiate from the edge of the ciliary body, hold the lens in position.
  - The iris is the foremost extension of the choroid and is a coloured opaque disc. The free edge of the iris forms the frame of a circular opening, the pupil. The iris contains one set of involuntary radial muscles and one set of involuntary circular muscles.
- The inner layer or retina:
  - The retina forms the innermost layer of the eyeball and is actually part of the brain. It is composed mainly of light sensitive nerve cells (receptors).
  - The pigmented layer consists of cuboidal epithelial cells containing melanin granules (dark pigment).
  - The layer of photosensitive receptors consists of rods and cones.
  - The layer of rods and cones is followed by a layer of sensory neurons, each with only one axon and one dendrite.
  - The cones are packed closely in the yellow spot (fovea).
  - The optic nerve leaves the eyeball where there are no light sensitive cells (the blind spot). (15)

c It is advantageous for the retina to be situated at the back of the eyeball because:
- It is well protected from the inside by the vitreous humour and from the outside by the choroid and sclera.
- There is no obstruction for light rays entering the eye until they are focused onto the retina – the cornea, lens, aqueous and vitreous humours are all transparent.
- Light rays can be focused onto the retina to obtain a sharp, clear image with no (or little) effort.
- The retina contains the sensitive photoreceptors (rods and cones). (4)

d Rods and cones function under dim and bright light, respectively. Rods are sensitive to dim light and movements. Cones are responsible for bright light and colour vision. (2)

2 It is recommended that the learners are first given the opportunity to study a laboratory model of an eye before they dissect the eye of a cow or sheep.

a The eyeball is roughly spherical. At the front of the eye the sclera bulges outwards to form the cornea. (2)

b If when viewing the eye from the front, and the opening of the tear glands (lachrymal glands), the tear sac and nasolachrymal duct are on the left side of the eye, then you are looking at a right eye. (2)

c The eyeball is protected by the orbit in which it is situated by fatty tissue, the eyelids and eyelashes, regular blinking, the conjunctiva, the tear gland, and the sclera.
- The eyeball is situated in an orbit (bony socket) of the skull and held in position by six eye muscles.
- The orbit is well padded with fatty tissue and protects all sides of the eye except the front.
- Eyelids and eyelashes protect the front of the eye and prevent foreign particles (dust and small insects) from entering the eye.
- Regular blinking of the eyelids serves to distribute fluid over the eye surface preventing desiccation.
- The conjunctiva, the innermost lining of the eyelid, covers and protects the cornea.
- The tear gland secretes an antiseptic, saline eyewash. Tears remove dust and foreign bodies and destroy bacteria.
- The iris, the coloured part of the eye, protects the eye from bright light.
- The sclera, the white part of the eye, is a tough protective and supporting layer and helps to maintain the shape of the eyeball. (5)

d A light ray passes through the cornea, aqueous humour, lens, vitreous humour, several layers of cells in the retina, and eventually reaches the light-sensitive retinal cells (photoreceptors), namely the rods and cones. (4)

e Numerous mitochondria are found in the iris and the ciliary body. These parts contain muscles. ATP is required for the action of muscles. These energy molecules are produced by mitochondria. (3)

3 **a** Protects the delicate inner structures. (1)

b Maintains the shape of the eyeball. (1)

c Transparent disc in front part of sclera. (1)

d Lens. (1)

e Forms the pupil through which light rays enter. (1)

f Controls amount of light entering the eye / determines the colour of the eye. (1)
g Ciliary body. (1)
h Rods are concerned with black and white vision. (1)
i Cones are concerned with colour vision. (1)
j Transparent jelly-like substance filling the space between the lens and the retina. (1)

Activity 7 Accommodation *(Specific Aim 1)*

Learner's Book page 181

1 A (2)
2 2 (1)
3 Accommodation has taken place because the eye is viewing an object that is within 6 m of it. (2)
4 The ciliary muscle (6) contracts and moves nearer to the lens (4). The tension in the suspensory ligament (5) decreases and the tension in the lens (4) is released. The elastic lens now bulges and becomes more convex. (5)

RPA

Activity 8 The pupillary mechanism *(Specific Aims 1 and 2)*

Learner's Book page 182

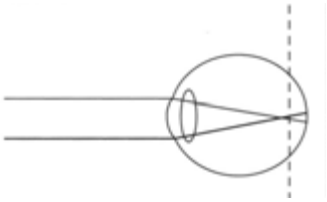
1–5 In bright light, the pupil becomes smaller. In the dark, the pupil becomes larger. The drawings of the pupil should show the above. In 2 and 4 one mark for drawing and one mark for size of pupil.
6 Refer to the Learner's Book (page 180–181) for the explanation of the role of radial and circular muscles in the control of the size of the pupil. (6)

RPA

Activity 9 The eye and accommodation *(Specific Aim 1)*

Learner's Book page 184

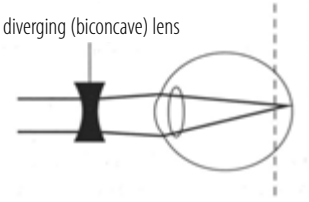
1 **a** The ciliary muscles would be contracted. (3)
b The ciliary muscles would be relaxed. (3)
Refer to the Learner's Book (page 182–183) for explanations.
2 **a** Refer to the Learner's Book (page 182–183). (4)
b **Myopia** (near-sighted person)
The eyeball is longer than normal, causing light rays to come to a focal point in front of the retina. Consequently, the image is blurred.



(2)

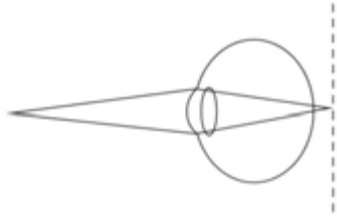
Correction

Near objects can be seen clearly, but distant objects require a diverging lens in front of the retina, that is, concave glasses or contact lenses.



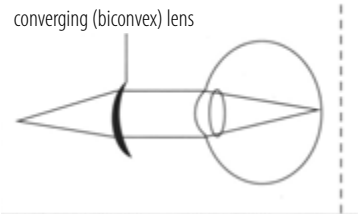
(2)

Hyperopia (far-sighted person)
The eyeball is shorter than normal, and the retina is therefore too close to the lens. When a nearby object is viewed, the image falls behind the retina.



(2)

Correction
Images of distant objects can be focused on the retina and the image is clear. It can be corrected by using converging lenses (convex lenses) to supplement the refractive power of the eye.



(2)

Activity 10 The structure and function of the ear *(Specific Aim 1)*

Learner's Book page 191

1 The pinna – directs sound waves in air and concentrates these at the external auditory opening. (2)
2 The auditory ossicles – play a role in transfer and amplification of vibrations caused by sound waves hitting the tympanic membrane. (3)
3 Air – maintains the air pressure on either side of the ear drum. (3)
4 8 – semi-circular canals (2)
5 Perilymph (1)
6 11 – the cochlea (2)
7 9; sensory; temporal lobe of cerebellum (3)
8 **a** round window (1)
b oval window (1)
9 In the pharynx (2)

Activity Self assessment

Learner's Book page 196

1 • *Sensory neurons*, which conduct impulses from the receptors (sense organs) to the central nervous system (brain/spinal cord). These are also called unipolar or afferent neurons.
• *Motor neurons,* which conduct impulses from the central nervous system to the effector organs (muscles or glands). These are also called multipolar or efferent neurons.
• C*onnector neurons/interneurons*, which link sensory neurons to motor neurons via synapses. These conduct impulses through the brain and spinal cord. (9)

2 A nerve is made up of a cell body that has outgrowths called dendrites, and an axon. The cell body consists of:
• a large nucleus surrounded by cytoplasm

- Nissl granules, which produce chemical substances that transmit nerve impulses – neurotransmitters
- dendrites, which connect neurons with neighbouring neurons and conduct impulses towards the cell body. (5)

3 a
- It controls all voluntary activities including speech.
- It has centres that receive and interpret all the sensations, e.g. vision, taste, smell, hearing and touch.
- It is the seat of the higher mental functions such as memory, judgement and reasoning. (2)

b
- It controls the co-ordination of voluntary muscular movements, e.g. walking and running.
- It contains the centres that control balance, muscle tone and equilibrium. (2)

c
- It controls vitally important reflexes, e.g. breathing, heartbeat and the constriction and dilation of the blood vessels (blood pressure), swallowing and peristalsis.
- It transmits nerve impulses to and from the brain.
- Nerve fibres from the brain to the spinal cord cross from one side to the other in the medulla, hence the right side of the body is controlled by the left side of the brain, and the left side of the body is controlled by the right side of the brain (2)

d The corpous callosum makes co-ordination between the two halves of the cerebrum possible. (2)

4 The reflex arc is the path than an impulse travels along to bring about a response to a stimulus during a reflex action. A reflex action is a rapid automatic response to a stimulus by an organ or receptor. (4)

5 An example of a reflex action is the reflex withdrawal of the hand after being pricked by a drawing pin. The pain receptors in the skin of the finger receive the pain stimulus and convert this into a nerve impulse. The nerve impulse travels along the sensory neuron towards the spinal cord. The sensory neuron enters the spinal cord along the dorsal root of the spinal nerve. In the grey matter of the spinal cord the sensory neuron makes synaptic contact with the connector neuron, which in turn makes synaptic contact with the motor neuron. The impulses are then transmitted along the axon of the motor neuron, which leaves the spinal cord via the ventral root of the spinal nerve to the effector organ, for example a muscle that contracts and pulls the finger away. The brain is made aware of the reflex action by an impulse that travels from the spinal cord to the brain (only *after* the finger has been withdrawn). (10)

6 a Lens changes shape for near and far vision by focusing light rays onto the retina. (2)

b Iris forms the pupil through which light enters the eye, gives the eye its colour and regulates the amount of light entering the eye. (2)

c Retina contains light sensitive rods and cones. Transmits information to brain via optic nerve. (2)

d Transmits impulses from the retina to the cerebrum. (2)

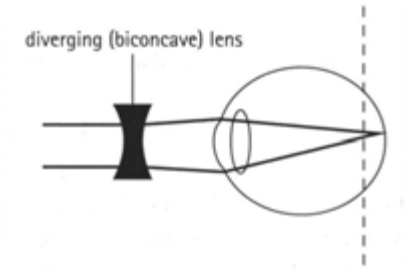
7 Accommodation is the ability of the eye to adjust to distance through curvature of the lens. The lens becomes more convex for near vision. (4)

8
- The iris regulates the amount of light entering the eye.
- It consists of radial and circular muscles that control the size of the pupil.

In bright light:
- The circular muscles contract.
- The radial muscles relax.
- The pupil constricts (becomes smaller).
- Less light enters the eye.

In dim light:
- The radial muscles contract.
- The circular muscles relax.
- The pupil dilates (becomes larger).
- More light enters the eye. (5)

9



(3)

10 **a** Pinna captures and channels sound waves through the auditory canal to the ear drum/tympanic membrane. (2)

b Round window absorbs pressure waves set up in the tympanic canal. (2)

c Semi-circular canals are involved in balance and equilibrium. (2)

d The cochlea houses the organ of Corti, which contains the sense receptors for hearing. (2)

e The ossicles transmit vibrations set up by sound waves from the tympanic membrane to the cochlea. (2)

11
- Sound waves are directed by the pinna through the auditory canal to the ear drum (tympanum), causing the ear drum to vibrate.
- The vibrations of the ear drum are transferred to the ossicles of the middle ear.

The footplate of the stirrup causes the membrane of the oval window to vibrate.
- This sets up pressure waves in the perilymph of the vestibular canal.
- The pressure waves are transferred to the endolymph of the cochlea canal.
- The pressure waves stimulate the hair cells in the organ of Corti.
- The hair cells convert the stimulus to an impulse.
- The impulse is transmitted along the auditory nerve to the cerebrum of the brain where the sound is interpreted.
- The pressure waves pass into the tympanic canal where they are finally absorbed by the round window. (9)

12 The utriculus and sacculus:
- Register information about the position of the head.
- The walls of the utriculus and sacculus are lined by maculae.
- The maculae contain sensory hair cells that are stimulated by otoliths (calcium carbonate crystals).
- Otoliths react to gravitational pull when the head tilts to one side, stimulating the hair cells. (5)

RPA

Activity 1 The control of blood glucose *(Specific Aims 1 and 2)*

Learner's Book page 205

1 The blood glucose concentration drops. Insulin stimulates the body to take up glucose and the synthesis of glucose in the liver is stopped by the action of insulin. (3)

2 Glucagon and adrenalin (2)

3 It takes 120 minutes. (2)

4 The pancreas (1)

Activity 2 An essay on negative feedback *(Specific Aim 1)*

Learner's Book page 206

Learners' essays should contain the following information:
When abnormal levels of glucose are detected by the pancreas, the Islets of Langerhans secrete hormones into the bloodstream

When blood glucose level rises:
Receptor cells called beta cells in the islets of Langerhans detect a rise in blood glucose levels. These receptor cells secrete the hormone *insulin* into the bloodstream.
Insulin is the messenger that travels to the liver, which is the target organ. The liver contains enzymes that convert glucose to glycogen. This decreases the blood glucose level back to normal. Insulin secretion is then inhibited.

When blood glucose level falls:
Receptor cells, called alpha cells, in the islets of Langerhans detect a fall in blood glucose levels. These receptor cells secrete the hormone glucagon into the bloodstream. Glucagon is the messenger that travels to the liver, which is the target organ. The liver contains enzymes that convert glycogen to glucose. This increases the blood glucose level back to normal. Glucagon secretion is then inhibited.

Causes of diabetes mellitus:
- Inadequate secretion of insulin/non-secretion of insulin/production of defective insulin
- Body cells resistant to the action of insulin/inability of the cells to use glucose efficiently

Symptoms:
- Frequent urination
- Extreme thirst
- Fatigue/lethargy/faintness
- Nausea/vomiting
- Weight loss
- Blurred vision
- Slow/non-healing of wounds

Management of diabetes mellitus:

- Exercise
- Eating diet suitable for diabetic person
- Using prescribed medication / drugs for the management of diabetes mellitus

Marks: 17 (content); 3 (synthesis)
Assessing the presentation of the essay

Marks	Descriptions
3	Well structured – demonstrates insight and understanding of question
2	Minor gaps or irrelevant information in the logic and flow of the answer
1	Significant gaps or irrelevant information in the logic and flow of the answer
0	Not attempted/nothing written other than question number/no relevant information

PPA

Activity 3 Research on disorders of the endocrine system *(Specific Aim 2)*

Learner's Book page 206

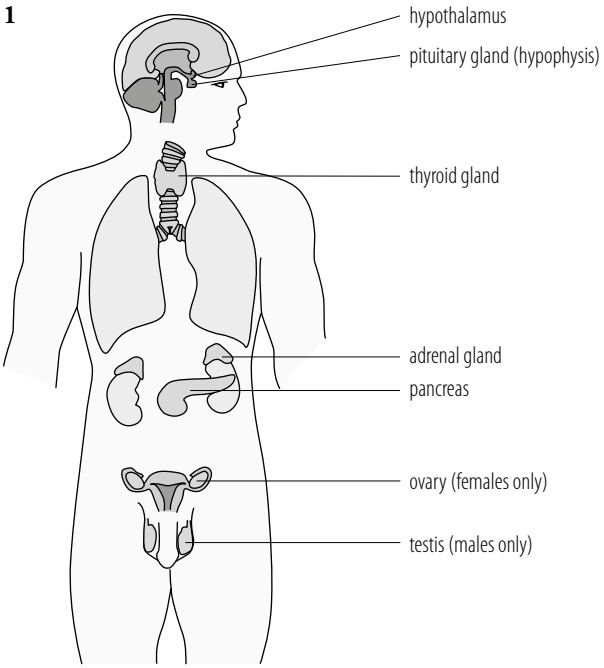
Learners will choose an endocrine disorder, based on the photographs of the different disorders in the Learner's Book.

Marks: 17 (content); 3 (synthesis). Use the assessment table above.

Activity Self assessment

Learner's Book page 208

1



(6)

2 Adrenalin prepares the body to cope with emergency, danger and stress in the following ways:

- The blood vessels of the skin constrict, but the blood vessels to the heart, muscles and brain (important organs during an emergency) dilate, providing more blood.
- It increases the rate at which the heart beats.
- It promotes the conversion of glycogen into glucose in the liver, which is released into the blood to provide energy to the cells.
- It increases the rate and depth of breathing, so providing more oxygen to the cells.
- It increases skeletal muscle tone.
- It raises the metabolic activity of the body cells to release energy. (6)

3 A negative feedback mechanism is one where any change in a factor (for example: level of thyroxine in the blood or level of glucose in the blood) produces an opposite response, which then reverses the change. Negative feedback mechanisms constantly monitor change in this factor and any change is adjusted to maintain a constant level of this factor. (5)

4 All negative feedback control systems involve the following steps:

- Receptor cells detect changes of a particular factor.
- A message is sent to the control centre.
- The control centre responds.
- The control centre sends an instruction to the effector/target organ.
- The effector/target organ responds.
- The effector/target organ carries out a corrective action to bring the factor back to within normal levels.
- Corrective action is then stopped or reversed in order to prevent the correction from going in the opposite direction. (8)

5 For example, blood glucose levels are controlled by the body with a range of from 80–100 mg of glucose per 100 cm^3 (ml) of blood. The two types of receptor cells that control the glucose levels are found in the pancreas. Both the receptor cells are found in the islets of Langerhans situated in the pancreas. When the blood glucose level rises:

- Receptor cells called beta cells (one type of receptor cell) in the islets of Langerhans detect a rise in blood glucose levels.
- These receptor cells secrete the hormone insulin into the bloodstream.
- Insulin is the messenger (carries instructions) that travels in the bloodstream to the liver.
- The liver is the *effector*.
- The liver contains enzymes that converts glucose to glycogen.
- This reduces the glucose level to around its normal level.
  - insulin secretion is then inhibited.

When the glucose level falls:

- Receptor cells called alpha cells (another type of receptor cell) in the islets of Langerhans detect a fall in the blood glucose levels.
- These receptor cells secrete the hormone *glucagon* into the bloodstream.
- Glucagon is the messenger that travels in the bloodstream to the liver.
- The liver is the effector.
- The liver contains enzymes that convert glycogen to glucose.
- This increases the glucose level up to around its normal level.
  - glucagon secretion is then inhibited.

The process above is repeated over and over again. In so doing, the body has *homeostatic control over the blood glucose levels*. (5 × 2) (10)

6 If there is a *decrease* in thyroxine levels in the blood:

- when the thyroxine concentration in the blood decreases to *below* normal levels
- the pituitary gland (control centre) is stimulated
- the pituitary gland secretes *more* TSH (thyroid stimulating hormone)
- high levels of TSH stimulate the thyroid gland (effector/target organ)
- high levels of TSH cause the thyroid gland to secrete more thyroxine
- thus increasing the level of thyroxine in the blood back to normal levels
- TSH returns to normal levels.

If there is an *increase* in thyroxine levels in the blood:

- when the thyroxine concentration in the blood increases *above* normal levels
- the pituitary gland (control centre) is stimulated
- the pituitary gland secretes less TSH (thyroid stimulating hormone)
- low levels of TSH stimulate the thyroid gland (effector/target organ)
- low levels of TSH cause the thyroid gland to secrete less thyroxine
- thus decreasing the level of thyroxine in the blood back to normal levels
- TSH returns to normal levels. (5 × 2) (10)

RPA

Activity 1 ADH and water balance *(Specific Aim 2)*

Learner's Book page 215

1 There is a linear or direct proportional relationship, that is, as the level of ADH rises, tubular reabsorption increases proportionally. (3)

2 Increased ADH has the following effect on the renal tubules:
- ADH increases the number of water-selective channels in the plasma membrane of the distal convoluted tubule and the collecting duct, and increases the permeability of the cell membranes to water.
- This causes more water to leave the tubules by osmosis and enter the medulla of the kidney.
- The water in the medulla is reabsorbed by the blood capillaries which surround the tubule (peritubular capillaries).
- The amount of water in the blood thus increases and concentrated urine is produced and less water is excreted from the body. (5)

3 If the body is losing a lot of water through sweat, more ADH will be produced to reduce water loss in urine. In hot conditions, less (and more concentrated) urine is produced compared to cold days. Also, if a person is unable to get a drink over a long period, high ADH levels will conserve as much water as possible and the volume of urine will be reduced. (4)

4 ADH levels may be low on a cold day because:
- on a cold day, very little water is being lost from the skin as sweat
- the kidney will need to lose more water to maintain the water balance, so less ADH is secreted. (3)

5 Other sources of water are: moisture in food and metabolic water from cellular respiration. Other sources of water loss are: sweating, expired air, faeces and tears. (5)

6 Skin (sweat); kidneys (urine); eyes (tears) (3)

7 Salt balance is maintained in the body as follows:
- uptake of sodium ions occurs in the loop of Henle
- the amount of salt absorbed, is controlled by the hormone aldosterone (produced in the adrenal cortex)
- the adrenal cortex is under the control of the pituitary gland
- the pituitary gland detects salt levels in the blood and stimulates the adrenal cortex to produce the necessary amount of aldosterone. (5)

8 a The effect of drinking a lot of liquid will be to make the blood and body fluids more dilute than usual. This excess liquid will be removed by the kidneys which will form large amounts of dilute urine. (3)

b Excess salt taken into the body must be excreted. This has to be done in solution, so the kidneys will produce an extra amount of urine to take the salt out. This can result in a shortage of water inside the body, and then the thirst response is stimulated. This is why a salty meal often makes you feel thirsty. (3)

c A high protein diet will lead to high amino acid levels. The excess amino acids are then converted into urea (in liver), which is excreted by the kidneys. The urine in this case will have a high urea concentration. (3)

d Living in a hot desert will increase water loss by sweating. The kidneys will therefore excrete less water. The urine formed will be highly concentrated and with the minimum amount of water. (3)

PPA

Activity 2 Investigating the structure of skin *(Specific Aim 2)*

Learner's Book page 218

Learners observe and draw a cross section through mammalian skin. Check their drawings and labels.

2 Use the following checklist to mark the drawing of the skin:

Criteria	Marks
Caption (Drawing of a section through the skin)	1
Correct proportion	2
Any 7 correct labels (epidermis, malpighian layer, dermis, hair follicle, erector muscle, sweat glands, sweat ducts, blood vessels, epidermal hairs)	7
TOTAL	**(10)**

Activity 3 Human skin *(Specific Aim 1)*

Learner's Book page 220

1 Erector muscles, sweat gland, blood vessels, adipose layer, sense receptors. (5)

2 Excretion, osmoregulation and thermoregulation (3)

3 **a** 9 – Ruffini's corpuscle / receptors for heat (2)

b 8 – Krause's end bulge / cold receptors (2)

4 **a** Erector muscles relaxes (2)

b Sweat gland secretes sweat actively (2)

c Blood vessel dilates (2)

Activity 4 Essay *(Specific Aim 1)*

Learner's Book page 221

Learners' essays should contain the following information:

When the body temperature rises becauses it is a hot day:

- High blood temperature stimulates the heat regulating centre (hypothalamus) in the brain.
- Impulses are sent from this centre to the blood vessels in the skin.
- The blood vessels become wider (dilate) – this is called vasodilation:
  - more blood flows through the skin
  - more blood, which carries heat, comes to the surface of the skin
  - therefore more heat is lost from the body
  - the sweat glands produce more sweat
  - more sweat evaporates from the skin's surface
  - more heat is lost through evaporation.

During very hot days, the external environmental temperature can become so high that it causes body temperature to be raised so much that the body's homeostatic control mechanism can no longer cope. Core temperature rises and the person suffers from hyperthermia, which is also called heatstroke or sunstroke.

Ways to prevent hyperthermia:

- Keep hydrated during hot weather conditions – drink plenty of liquids.
- Keep out of the sun.
- Use hats/caps when out in the sun.
- Use a sun-block to protect your skin.

Treatment of hyperthermia:

- Bathe the person in tepid (warm) water. Do not use cold water because this causes vasoconstriction and prevents heat loss.
- Keep the person in a cool place.
- Take off as much of the clothing as possible.
- Give the person plenty of liquids.

Marks: 17 (content); 3 (synthesis)
Assessing the presentation of the essay

Marks	Descriptions
3	Well structured – demonstrates insight and understanding of question
2	Minor gaps or irrelevant information in the logic and flow of the answer
1	Significant gaps or irrelevant information in the logic and flow of the answer
0	Not attempted/nothing written other than question number/no relevant information

» Activity Self assessment

Learner's Book page 223

1 Homeostasis is the process of maintaining a constant and optimal internal environment. It is important to keep the internal environment constant because changes in any of the factors affecting the cells will adversely affect the functioning of the cells. (3)

2 The nervous system and the endocrine system. (2)

3 When the CO_2 level in the blood increases (for example, when you exercise) this causes the pH level of the blood to be lowered. This is because CO_2 combines with H_2O to form carbonic acid. The following events take place:

- Receptor cells in the carotid artery (found in the neck) detect the lowered pH (i.e. high CO_2 levels).
- A message (in the form of nerve impulses) is sent to the nerve centres in the medulla oblongata (the control centre).
- The medulla oblongata responds by sending nerve impulses to the breathing muscles, that is the intercostal muscles (muscles between the ribs) and the diaphragm.
- These muscles contract more actively.
- This increases both the rate and depth of breathing.
- More CO_2 is exhaled (and more oxygen is inhaled).
- The heart is also stimulated to beat faster.
- This increased heart rate facilitates faster transport of CO_2 to the lungs to be exhaled.
- The concentration of CO_2 in tissue fluid and blood decreases back to normal levels.
- The breathing rate and depth and the heart rate get back to normal as a result of negative feedback from the medulla oblongata. (10)

4 Osmoregulation is the control of water balance in the body. When the blood becomes more concentrated (i.e. has less water than normal):

- Receptor cells (osmoreceptors) in the hypothalamus detect changes in the water potential of the blood.
- The hypothalamus sends impulses to the posterior lobe of the pituitary gland.
- The pituitary gland secretes ADH (anti-diuretic hormone).
- ADH passes in the bloodstream to the kidneys.
- The kidneys are the effectors.
- ADH causes the permeability of the renal tubules to increase so that the walls of the renal tubules become more permeable.
- This causes the renal tubules to reabsorb *more* water and pass it to the surrounding blood vessels.
- The blood becomes *more dilute*.
- A smaller volume of concentrated urine is excreted. (10)

5 When the salt (sodium ions) concentration levels in the internal environment (blood and tissue fluid) *decrease* the following occurs:

- Receptor cells in the afferent and efferent arterioles of the glomeruli detect the low salt concentration.
- The adrenal gland is stimulated.
- The adrenal gland secretes the hormone aldosterone.
- Aldosterone promotes the reabsorption of sodium ions from the filtrate in the cells that line the renal tubules from where it is passed into the blood (second capillary network).
- Therefore fewer sodium ions are lost in the urine.
- The sodium ion concentration in the blood is returned back to normal levels. (5)

6 When the body temperature falls because it is a cold day or because the person is ill:

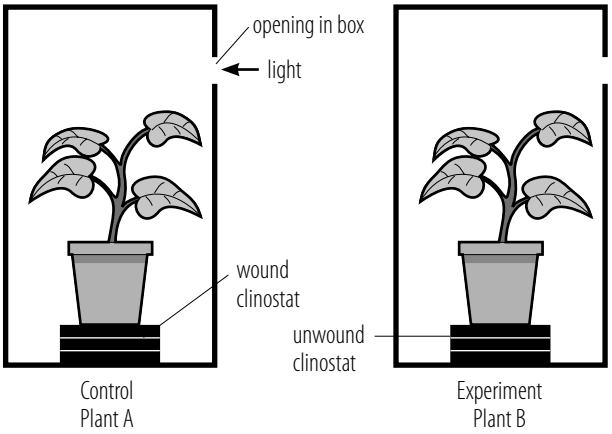
- Low blood temperature stimulates the heat regulating centre (hypothalamus) in the brain.
- Impulses are sent from this centre to the blood vessels in the skin.
- The blood vessels become narrower (constrict) – called vasoconstriction:
  - less blood flows through the skin
  - blood carries heat
  - less blood comes to the surface of the skin
  - therefore less heat is lost from the body
  - the sweat glands produce less sweat
  - and less cooling occurs. (10)

PPA

Activity 1 The effect of unilateral light on the growth of stems (shoots) *(Specific Aim 2)*

Learner's Book page 227

Experimental design:
You will need:
- two potted plants
- two clinostats
- two cardboard boxes, each with a small opening on one side of the box.



Possible answers to statements:
Hypothesis:
Exposure of a plant to light stimulus from one side will cause the plant stem to grow towards the light source.
Aim:
To determine the effect of unilateral light on the growth of a plant stem.
Prediction:
If a stem is exposed to unilateral light then the stem will grow towards the light.
Variables:
Independent: unilateral light
Dependent: direction of stem growth
Fixed/constant factors/variables: same size of plants, same type of soil, exposed to same temperature, same amount of oxygen, etc
Experimental design and fairness/validity of the design:
Experimental design is such that the factor of light that is under investigation was controlled (the independent variable) while all other factors were fixed. The only factor that was not controlled was the growth of the plant (dependent variable). The result is therefore based on the effect of unilateral light on the growth of the stem.
Reliability:
- Several similar experimental set-ups may be used
- Several experimental set-ups with different species of plants may be used.

Assessing hypothesis testing activity: a general score sheet

Criteria	Y	N	Criteria	Y	N
1. Experimental design			**2. The write-up**		
1.1 Identification of a problem			**2.1** Quality of the observation/data (result)		
Stated as a causal relationship			**i** Made accurate observations/ measurements / calculations		
1.2 Stating an hypothesis			**ii** Collected consistent data		
i Linked effect to a variable (cause-effect)			**iii** Completed recording of data in, e.g. table		
ii Identified independent variable/s			**2.2** Drawing reasonable conclusion		
iii Identified dependent variable/s			**i** Identified tendencies and trends in data		
iv Indicates a directional change			**ii** Conclusion/s is/are relevant to the aim /hypothesis		
v Stated in a way that is testable through experimentation					
1.3 Plan and conduct of experiment to test hypothesis					
i Logical aim stated					
ii Provided step-by-step detailed plan					
iii Appropriate control/s set up					
iv Recognised that only one independent factor should be variable					
v Clearly stated precautions					
vi Appropriate use of specific equipment					
vii Identified and criticised limitations to experimental design					
viii Appropriate sample size					
ix Diagram of experimental design					
1.4 Collection and recording of data					
i Indicated the plan for collecting / recording data					
ii Recorded data appropriately (e.g. table, drawing, etc)					
iii Recognised the existence of errors in data					

Note to teacher:
This is an open-ended task in so far as the experimental design is concerned. While a general set of criteria is presented (scoring sheet) in order to assess the general principles of investigative work, it is important to take into account each individual attempt and assess it in terms of the general principles.

Assessing hypothesis testing activity: score sheet for Activity 1

Criteria	Y	N	Criteria	Y	N
1. Experimental design			**2. The write-up**		
1.1 Identification of a problem			**2.1** Quality of the observation/data (result)		
Does exposure to unilateral light have an effect on the growth of stems?			**i** Made accurate observations/ measurements /calculations		
1.2 Stating an hypothesis			**ii** Collected consistent data		
Exposure of a plant to light stimulus from one side will cause the plant stem to grow towards the light source.			**iii** Completed recording of data in e.g. table		
1.3 Plan and conduct experiment to test hypothesis			**2.3** Drawing reasonable conclusion		
Aim: To determine the effect of unilateral light on the growth of a plant stem			**i** Identified tendencies and trends in data		
ii Provided step-by-step detailed plan			**ii** Conclusion/s is/are relevant to the aim/hypothesis		
iii Appropriate control/s set up					
iv Recognised that only one independent factor should be variable					
v Clearly stated precautions					
vi Appropriate use of specific equipment This will depend on the specific design					
vii Identified and criticised limitations to experimental design					
viii Appropriate sample size					
ix Diagram of experimental design					
1.4 Collection and recording of data					
i Data recorded in the form of diagrams and notes					
ii Recorded data appropriately (e.g. table, drawing, etc)					
iii Recognised the existence of errors in data					

Activity 2 The effect of gravity on the growth of roots

(Specific Aim 2)

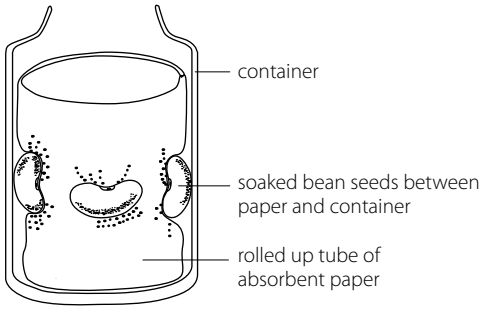
Learner's Book page 228

Experimental design (this is just one example)
You will need:

- 5–6 bean seeds
- water
- a transparent (see-through) container – glass or plastic jar
- cotton wool/absorbent paper (newspaper, paper towel)

Method

1 Soak 5–6 beans in water for 12 hours to start the germination process.
2 Push a wad of cotton wool/absorbent paper into the container.
3 Carefully place the soaked germinating seeds in the middle of the container between the container and the cotton wool/absorbent paper so that they are visible from the outside. Each germinating seed should face a different direction (i.e. each seed should have the micropyle facing up or down or sideways).



4 Add water to the container so that the water is absorbed by the cotton wool/absorbent paper.
5 Place the container in a warm place for a few days.
6 Wet the cotton wool/absorbent paper each day.
7 Observe the tiny roots of the germinating seeds each day.
8 Try to explain why the roots grow downwards in terms of the movement of auxins.

Possible answers to statements:
Hypothesis:
Roots will grow downwards no matter the position of the seeds.
Aim:
To determine the direction of growth of roots
Prediction:
If a germinating seeds are planted either the right way up or the wrong way up then the roots will always grow downwards.
Variables:
Independent: position of the germinating seed
Dependent: direction of root growth
Fixed/constant factors/variables:
Same size of germinating seeds, same amount of cotton-wool/moisture, exposed to same temperature, same amount of oxygen, etc

Experimental design and fairness/validity of the design:
Experimental design is such that the factor of gravity that is under investigation was controlled (the independent variable) while all other factors were fixed. The only factor that was not controlled was the direction of growth of roots (dependent variable). The result is therefore based on the effect of gravity on the growth of the roots.
Reliability:

- Several similar experimental set-ups may be used
- Several experimental set-ups with different species of plants may be used.

Learners can use the general score sheet provided on page C71.

Note to teacher:
This is an open-ended task in so far as the experimental design is concerned. While a general set of criteria is presented (scoring sheet) in order to assess the general principles of investigative work, it is important to take into account each individual attempt and assess it in terms of the general principles.

Assessing hypothesis testing activity: score sheet for Activity 2

Criteria	Y	N	Criteria	Y	N
1. Experimental design			**2. The write-up**		
1.1 Identification of a problem			**2.1** Quality of the observation/data (result)		
Does gravity have an effect on the direction of growth of roots?			**i** Made accurate observations/ measurements /calculations		
1.2 Stating a hypothesis			**ii** Collected consistent data		
Roots will grow downwards no matter the position of the seeds			**iii** Completed recording of data in e.g. table		
1.3 Plan and conduct experiment to test hypothesis			**2.3** Drawing reasonable conclusion		
Aim: To determine the direction of growth of roots			**i** Identified tendencies and trends in data		
ii Provided step-by-step detailed plan			**ii** Conclusion/s is/are relevant to the aim/hypothesis		
iii Appropriate control/s set up					
iv Recognised that only one independent factor should be variable					
v Clearly stated precautions					
vi Appropriate use of specific equipment This will depend on the specific design					
vii Identified and criticised limitations to experimental design					
viii Appropriate sample size					
ix Diagram of experimental design					
1.4 Collection and recording of data					
i Data recorded in the form of diagrams and notes					
ii Recorded data appropriately (e.g. table, drawing, etc)					
iii Recognised the existence of errors in data					

Activity 3 Investigating plant growth substances *(Specific Aim 1)*

Learner's Book page 230

1 a A – Plant placed in darkness – shows elongated internodes (etiolation).
B – Plant receives unilateral light from the right.
C – Entire plant exposed to light from all directions.
D – Plants received unilateral light from the right, then unilateral light from the left and then unilateral light from the right again. (8)

b When light strikes the plant from one side only, auxins move to the darker side of the stem. The auxin concentration is higher on the darker side than on the brightly lit side of the stem. A high concentration of auxins in stems speeds up the growth (i.e. cell elongation). This causes the darker side to grow faster than the brightly lit side, bending it towards the light. (4)

2 a Gibberellins are plant growth substances that promote the elongation of stems so that the plant grows tall. They also stimulate the germination of seeds. (2)

b The decreasing level of ABA promotes an increase in the level of gibberellins. (2)

c Glucose is the fuel that is used during cellular respiration. Energy is released during this process. This energy is used to promote cell division and therefore the germination of seeds. (3)

d Possibly because the starch stored in the seed has been used up already and the seed has become a seedling (germinated plant). (3)

e Water is necessary to hydrolyse starch into glucose, and water is necessary to dissolve the glucose so that it can diffuse into the mitochondria of cells for cellular respiration to take place. (3)

Activity Self assessment

Learner's Book page 234

1 a Auxins are substances that are produced by dividing cells that are found just behind the tips of stems and roots. This area is called the meristem. The auxins move away from the cells in which they are produced to stimulate cell growth. Auxins play an essential role in the co-ordination of growth in plants. The action of auxins can be observed as tropisms. An example of a tropism is the way in which a plant will move either towards or away from an external stimulus such as light or gravity. The reaction to light is called phototropism and the reaction to gravity is called geotropism. (3)

b Gibberellins are plant growth substances that promote the elongation of stems so that the plant grows tall. They also stimulate seed germination. (2)

c Abscisic acid (ABA) acts as an inhibitory plant growth substance. It promotes seed and bud dormancy so that the seeds and buds are protected against unfavourable environmental conditions. It works in opposition to gibberellins. (2)

2 a When light strikes the plant from one side only, auxins move to the darker side of the stem. The auxin concentration is higher on the darker side than the brightly lit side of the stem. A high concentration of auxins in stems accelerates growth (i.e. cell elongation), causing the darker side to grow faster than the brightly lit side, bending the stem towards the light. (3)

b If the root is placed horizontally, auxins move because of the effect of gravity on the lower side of the root. A high concentration of auxins in roots inhibits growth (cell elongation). Growth on the lower side is therefore slower than growth on the upper side of the root. This makes the root grow downwards. (3)

c Apical dominance is caused by the production of auxins in the apical buds. These auxins move down to the lateral buds and inhibit their growth. When the apical bud is removed, (e.g. by pruning the plant), the controlling influence of the apical bud over the growth of the lateral buds is *removed*. Therefore, the lateral branches grow out. This will stop the plant growing tall, but it will branch out more, that is, become bushier. (3)

d A synthetic auxin (called 2,4D) is a herbicide (plant killing substance), which kills broad-leaved weeds. For example, in a lawn, 2,4D kills only the broad-leaved weeds and does not affect the narrow-leaved grass plants. This type of herbicide is said to be selective because it kills only specific plants (the broad-leaved ones) and not others (the narrow-leaved ones). It kills the broad-leaved plants by stimulating uncontrolled growth, which eventually causes the leaf to curl over and the plant to die because this rate of growth cannot be sustained. (3)

3

Phototropism	Geotropism
This is a growth response of a part of a plant to the stimulus of light: • stems grow towards the light stimulus and are therefore *positively phototropic* • roots grow away from the light stimulus and are therefore *negatively phototropic*	This is a growth response of a part of a plant to gravitational pull: • roots grow towards the Earth and are therefore *positively geotropic* • stems grow upwards (away from gravity) and are therefore *negatively geotropic*

(4)

4 Chemical defences

A wide range of chemicals has evolved in plants to keep insects and other herbivores from consuming them. The chemical defences are made up of organic compounds that are not directly involved in the normal growth, development or reproduction of the plants that they are found in. These chemicals are therefore called secondary metabolites. These chemicals play a major role in defences against herbivores, for example they make the cell walls indigestible to herbivores. Chemical defences are classified into three groups:

- nitrogen compounds – found in *Acacia* spp.
- terpenoids – found in juniper and sagebrush
- phenolics – found in oaks.

Mechanical defences

Many plants have external physical structural defences that discourage herbivores from feeding on them. These structural defences are thorns and spines that reduce the amount of the plant that is eaten by herbivores by restricting the herbivores' feeding rate. A good example are the *Acacia* spp., that have dense thorns on the outside branches, but fewer thorns in the middle of the crown, which is comparatively safe from herbivores such as giraffes. (7)

STRAND 4

DIVERSITY, CHANGE AND CONTINUITY

Unit 1: Evolution by natural selection
Unit 2: Human evolution

Learner's Book pages 236–278
Duration: 8 hours

UNIT 1 Evolution by natural selection

TERM 3

There are only two weeks of teaching time allocated for Unit 1. This might prove to be a challenge. Equally challenging may be the concepts included in the content. To assist you, some additional information is included to provide you with a little more background on the topics of this unit.

At the end of the unit, you will find the answers to 15 questions that are in an order that follows the sequence of the content of this unit. **It is strongly recommended that you break these up into three parts for homework, to be spread over a two-week period**. This will help the learner to consolidate and conceptualise the content in stages. Giving them all at the same time, and at the end of the unit, may overwhelm learners. Learners fail to develop the required insight under such stressful conditions.

Evolution as *a process* usually *occurs over extended periods of time*, over millions of years. However, new evidence is emerging that the process may be more frequently punctuated, as you have seen in the content of the Learner's Book. The process of evolution is still in progress in our current life time. The evolution of living organisms is co-ordinated with the evolution of the Earth's surface. Changes in the Earth's climate, its surface structure, atmosphere and other physical and chemical properties are important triggers to the process of evolution.

Evolution can also be expressed as *the descent* (progression) of populations with *modifications* (adaptations) in response to a changing environment. (The words in italics were used in Darwin's time.)

Organisms are continuously subjected to pressures that arise from the interaction between them and their environment. When dramatic changes occur in the particular niche that the population occupies, there are only two choices: adapt to face new challenges, or die out – like the majority of species did during past mass extinctions.

PPA

Activity 1 Class debate and discussion on the evidence for biological evolution *(Specific Aims 1, 2 and 3)*

Learner's Book page 241

For this debate to be successful and of value to learners, it is essential that each learner prepares for it by means of a thorough study of the content covered so far. Ensure that they come to the debate with key ideas from each focus area covering the evidence for evolution for Part 1.

When dividing the class into the two groups, you might consider placing them so that learners who are skeptical about evolution have the opportunity to express their ideas by being part of Group B during Part 2.

You will need to remain totally objective throughout the process.

Try to involve as many learners as possible. Avoid a debate where only a couple of domineering learners participate. Let the speakers rotate as outlined in the guidelines.

It is also recommended that each learner participate in the assessment. If possible, provide each learner with a copy of the assessment check list grid.

Checklist for group assessment

Assessment criteria	Marks
Conducted research with focus and enthusiasm.	4
Produced at least five examples.	5
Critically evaluated responses before speaking out.	4
Handled the statement or counter-argument with confidence.	4
Based all statements on scientific reasoning.	4

» Activity 2 The meaning of a scientific theory *(Specific Aims 1 and 3)*

Learner's Book page 244

The two groups in the class debate the possible differences in perception between the teacher and the learner shown in Figure 4.1.4. Note: this is an informal activity so no marks are allocated.

» Activity 3 Peppered moths and pollution *(Specific Aim 1)*

Learner's Book page 249

1 Changes in the population size of dark peppered moths/and the amount of pollution **over time**. (2)

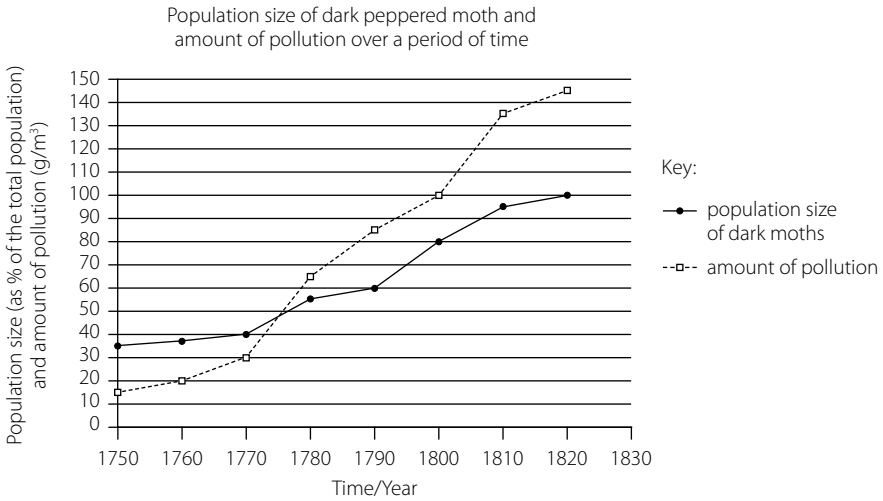
2 Population size of dark moths/amount of pollution. (1)

3 As the pollution increases the number of dark peppered moths increases

OR

As the pollution decreases the number of dark peppered moths decreases. (2)

4



Mark allocation of the graph:

Correct type of graph	1
Caption of graph	1
Correct label for *x*-axis	1
Graphs labelled/key provided for 2 graphs	1
Correct label and **units** for *y*-axis	1
Appropriate scale for *x*-axis	1
Appropriate scale for *y*-axis	1
Drawing of graphs	1: 1 to 8 points plotted correctly 2: 8 to15 points plotted correctly 3: all 16 points plotted correctly
All points joined for graph A	1
All points joined for graph B	1

(12)

Note:
If the wrong type of graph is drawn:
- Marks will be lost for "correct type of graph"
- Marks will be lost for "joining of points"

If graphs are not drawn on the same system of axes:
- Mark the first graph only using the given criteria

If axes are transposed:
- Marks will be lost for labelling of '*x*-axis' and '*y*-axis'

PPA

Activity 4 A game to explore natural selection *(Specific Aims 1, 2 and 3)*

Learner's Book page 253

Classwork:

Learners are required to act out the mechanism of natural selection and its impact on the phenotype of prey populations.

Allow learners to contribute to the materials required for this activity. This is a good opportunity to recycle waste for a learning opportunity. The school's sport coaches may be able to provide stop-watches.

Preparing for the game (investigation):
Follow the guidelines as set out in the Learner's Book.

Method

1 The hypothesis will depend on the materials (simulated organisms) that are selected. In a case where red and green beads are used to simulate red and green butterflies on the soccer field (green wool as substrate), the hypothesis may be: "More red beads will be caught than the green beads" or "The red butterflies are more frequently preyed upon than the green butterflies". (2)

2-4 Follow the procedures outlined in the Learner's Book.

5 Base the conclusions on the results obtained from steps 2–4.

a Answers will vary (2)

b Answers will vary (2)

c Answers will vary (2)

6 In terms of genetics:

a The greater the variation among alleles in a gene pool, the greater the opportunity for individuals in a population to adapt to changes in the environment. (3)

b No. Some adaptations may be neutral (neither an advantage or disadvantage) or they may even be lethal. (3)

c No. Variations that do not exist cannot be selected. If a changing environment exerts pressure on a population to adapt but no suitable gene alleles are available to select, then natural selection cannot occur and the population cannot adapt. (3)

d The hypothesis is either rejected or accepted on the basis of the results obtained. (1)

e Repeat the investigation several times to confirm the overall trend. (2)

7 **a** "Natural selection" and "variations exist among individuals of a population". (2)

b "Breeding patterns in a population", "carrying capacity of the habitat" i.e. limited resources, and "inheritance of characters". (3)

Table 4.1.1 Result sheet for natural selection investigation game

	Total prey caught	Total of colour A	Total of colour B
1st catch			
2nd catch			
3rd catch			
Average			

Brain teaser:

- Alleles that code for thicker and longer fur. Also alleles that code for a thick layer of subcutaneous fat (fat layer under the skin).
- Thick fur coat and that nature will provide. This assumption is wrong because natural selection depends on gene allele variation and not deliberate desires for change.

PPA » **Activity 5 Research an example of artificial selection** *(Specific Aims 1 and 2)*

Learner's Book page 258

This activity requires time. It is advisable that you issue this task to the learners at least 2–3 weeks ahead of the deadline for submission.

If you are an educator in an isolated rural school, then it is strongly recommended that you build up a classroom library of suitable reference materials for learners to borrow and return. If the school has a computer centre, then learners can use the internet to access information. If neither of these resources are available, then encourage learners to consult with local farmers who are conducting breeding experiments. Local magazines such as *The Farmers Weekly* and *Die Landbou Weekblad* often contain articles on the subject of artificial selection. Approach local farmers to donate their used magazines to the school to add these resources to your classroom library.

It is also advisable that you monitor the learner's progress by asking them to submit intermediate stages of the investigation for formative assessment. This will allow you to provide formative guidance from start to end. It will also ensure that less diligent learners do not leave this task to the last minute, and produce an inferior product.

Guide learners through the processes outlined in 1 and 2. This is quite a challenging and complex investigation that will require your empathetic guidance and support.

Insist on the guidelines for a formal scientific report, as outlined in step 2.

1 Answers will vary. (10)

2 Title (1)
Aim or hypothesis (2)
Methods (4)
Results (4)
Discussion (2)
Conclusion (2)
List of references (2)

Activity 6 The way a species forms *(Specific Aim 1)*

Learner's Book page 261

1 Speciation (1)

2 In diagram 1 the rabbits were able to interbreed/genes can flow freely in the population. In diagram 2 the two populations were separated by the river/geographic barrier. The two populations cannot interbreed/no gene flow. Within each of the two separated populations there was variation. Each group underwent natural selection independently as a result of varying environmental conditions. Each group becomes genotypically and phenotypically different. In diagram 3 the geographic separation no longer exists but the two populations do not interbreed/no gene flow even though they can mix because of the presence of reproductive isolating mechanism. They are now two different species. (10)

Activity 7 Baobabs in Africa, Madagascar and Australia *(Specific Aim 1)*

Learner Book page 266

1 Southern Africa, north Australia and Madagascar are all remnants (fragments) of the ancient super continent of Gondwana. This may imply that the ancestral species of baobab trees may have originated in Gondwana and that their descendants dispersed to these countries during continental drift. Alternatively, seeds may have dispersed to these countries by drifting along ocean currents, or may have been taken to new locations by early seafarers, along trade routes. *Note: there are differing hypotheses about the origins of baobabs. We do not as yet have sufficient proof that this actually happened.* (3)

2 As in the case of the Galápagos finches and tortoises, adaptive radiation may have occurred to give rise to six species of baobabs. This is due to geographic isolation of the small land mass of Madagascar, surrounded by the Indian Ocean. Changing climatic conditions and other environmental factors may have stimulated selection pressure and this may have triggered the rapid speciation of the ancestral baobab into new species of baobabs on Madagascar. *(This would apply whether or not baobabs originated in Madagascar.)* (5)

Learner's Book page 277

1 A possible definition: The genetic changes that occur in a line of species to form new adaptations that may help the survival of a species. (4)

2 Examples of evidence for biological evolution:

a E.g. The intermediate stage fossil, *Tiktaalik*, shows how frogs developed from fish, or the intermediate stage fossils of therapsid that show how mammals evolved from reptiles, or the intermediate stage fossils that show that birds developed from dinosaurs, or the intermediate stage fossils that shows the evolutionary link between primates and humans. (2)

b The homologous body plans that can be seen in, e.g. the front limb of all vertebrates. (2)

c The appearance of ancient fossils of, e.g. *Glossopteris* tree species that are now found in some continents that were united before the split of Gondwana. (2)

d The similarities between DNA in the chromosomes of all plants and animals. (2)

3 Fossils only form under rare conditions where decomposition is prevented. E.g. mud from floods that cover dead bodies to shut out air, decomposers and scavengers. Only the hard parts of bodies fossilise, e.g. bones and teeth. Also, if punctuated equilibrium occurred in a species, the range of intermediate forms of such species changed relatively quickly mostly in isolated locations. This makes it difficult to find such fossils or impossible if these intermediate stages never formed fossils. (3)

4 A hypothesis is still an attempt to answer a question about the natural world. Hypotheses require a great deal of testing, experimentation and research. A theory is a set of facts and answers derived from previous hypotheses, backed by evidence. This can be used to make predictions on how aspects of the natural world function. (2)

5 Lamarck claimed that acquired characteristics are inherited by subsequent generations. Knowledge of genetics showed that only genes can transfer characteristics from one generation to the next. Characteristics acquired in the phenotype of an individual's life time cannot be inherited because they are not present in the genotype. (2)

6 The two key principles of Darwin's theory of evolution:

- Species evolve from ancestral species.
- Evolution occurs by natural selection. (2)

7 **a** Dogs were bred from wolves. Perhaps tame wolf puppies were adopted by hunter-gatherers and then reared to protect these early humans. Alternatively, very tame wolves started to follow early humans to obtain scraps of left over food. Either way, this very small group of wolves adopted humans as part of their pack. Because their gene pool was homogenous and small, inbreeding caused the selection of alleles that coded for tameness. In the process, linked alleles that code for juvenile appearance of puppies were also selected. In time, wolf puppy features became more and more prominent so that a subspecies (dogs) became established. From time to time, these ancestral dogs also mated with wolves in the wild. This resulted in heterozygous hybrids. This may explain the differences in appearance of different ancient dog populations. Much later, when humans became farmers or settled in villages, active artificial selection was used to breed dogs for a wide range of purposes.

For example, the best guard dogs were selected to breed dogs for protecting humans and their livestock. Since then, in modern times, dogs have been selected for other factors such as pets, for hunting, for size preference, and so on. (5)

b Maize originated in Mexico, as a hybrid from a giant grass called teosinte. A series of genetic mutations must have occurred to produce the strikingly different form of the prototype maize that resulted over a long period of time. American Indian hunter-gatherers probably recognised this maize proto-type as a source of food and when they settled later, began to plant it around their dwellings. This created conditions for artificial selection because they were likely to have selected the best kernels for planting. These early forms of maize became very popular and were rapidly spread throughout America, and later also to Europe and Africa. At this stage, the reproduction of maize was already entirely dependent on humans. This is because the kernels (fruits) are hidden on the cob and not visible to wild animal dispersal agents. Also, the kernels do not drop to the ground for dispersal agents to find. More modern farmers used artificial selection to breed larger and more productive fruit for harvesting. In time, continuous inbreeding weakened crop yield. Maize was then cross-bred back with the original teosinte. This was necessary to establish more heterogenous strains for better crop yield. Over the last few decades, modern technology was added to selective breeding. This involves the genetic engineering of maize DNA to produce even more productive and tougher plants. These GM techniques also provided opportunities for engineering other characteristics, e.g. creating maize crops that are more resistant to droughts, pests and diseases. (5)

8 a The five main observations in Darwin's theory of natural selection:

- There are variations in characteristics of individuals in a population and these can be inherited.
- More offspring are produced than can survive on available resources.
- There is competition for limited resources, i.e. there are struggles for survival.
- Natural selection allows only the ''fittest'' to survive and breed.
- Through natural selection, the evolution of a new species is possible. (5)

b These five observations applied to a population of mice in a warehouse:

- There are differences in the appearance and behaviour in every mouse in this population.
- Mice have very large litters of young but only a few will survive to maturity.
- Food becomes scarce when the population numbers start to exceed the carrying capacity, i.e. the amount of grain seeds to feed on. Competition will intensify and only the toughest or most skilled mice will find enough food to survive and breed.
- Thus, nature selects the alleles of those mice that are best adapted to survive the environmental resistant factors, e.g. the limited food resource.
- By natural selection, new mice variations will become more common in the gene pool of this population, so the population will change. (5)

9 a Cattle horn lengths and the amount of fruit on one tomato plant. These are continuous because these traits occur in a continuous range of variations of horn length/fruit productivity. (4)

b Albinism and haemophilia are discontinuous. The alleles that carry these conditions are either present or absent in a genome. There are no intermediate forms of these alleles. So there cannot be a range of these conditions. (4)

10 a Natural selection can only occur in a population where alleles that can code for appropriate adaptations are present in the gene pool. (2)

b Two errors: Natural selection is *not* a goal directed force. It also cannot ensure species' survival. If the appropriate gene alleles are absent in the gene pool, the species may become extinct. (2)

11 A group of similar organisms that share the same gene pool and are able to interbreed to produce fertile young. (4)

12 Geographical isolation is important in most forms of speciation, so that natural selection can make a more significant impact on a smaller gene pool. If the population remains in contact with the rest of the species, the gene pool will be so large that any new adaptations soon become diluted by inbreeding with the remaining members of the species. (3)

13 E.g. Darwin's finches.
The Galápagos Islands, where Darwin's finches occur, formed millions of years ago, from rising volcanoes. Thirteen species of finches can be found in the area, each occupying a different niche. Each species has its own unique gene pool. They differ mostly in beak shape and size, in their food preferences, size of the body and behaviour.

Research shows that these species are all related to an ancestral species on the mainland of South America, 1 000 km away from the Galápagos Islands. This ancestor was a seed eating ground finch. A single breeding pair may have been blown, by storm winds, to land on the original volcanic island. Geographical isolation prevented inbreeding with the mainland species. When the population became too large for the amount of seeds available, speciation occurred to form two new species, tree finches and ground finches.

Because the early colonisers carried only a sample of alleles of the ancestor, natural selection occurred relatively rapidly. In the absence of predators, new foods in new habitats could be explored freely. Selection pressure was the greatest among alleles that coded for diversity in beak shape and size, body size and behaviour.

Adaptive radiation led to the current eight tree species. These are spread out on different islands, most feeding on different insects but some eat fruit, leaves and seeds. The sizes and shapes of the insect feeders' beaks are in accordance with the size of the insects that they feed on. One species uses a cactus spine to extract insects out of tree bark. The ground finches also radiated into new species, most feeding on seeds of different sizes and toughness. Again, the size of beak, of different species, ranges according to the size and toughness of the type of seeds they eat. A few ground species feed on cactus fruits and flowers. (20)

14 a It prevents the flow of gene alleles between two closely related species. This maintains the unique gene pool of a species. (3)

b
- Breeding at different times of the year, e.g., brown trout species breed in autumn, but the closely related rainbow trout breeds in spring. Thus, sperm and eggs of the two species cannot meet to fuse.
- Species specific courtship behavior of male mallard ducks. They perform a ten-step dance that is only recognised by female mallard ducks. This limits mating to closely related species.
- Adaptations to different pollinators. Flowers of the gladiolus family have different structural arrangements, colours and nectaries that attract different pollinators. This is to ensure that only pollen from the same species is rubbed off on the stigma.
- Prevention of fertilisation. Insects usually secure their abdomens by means of, e.g. hooks. Differences in the structures of these hooks prevent mating with other species.
- Infertile offspring, e.g. in mules, prevent the formation of a mule species. Functional gametes cannot form so further offspring cannot arise from the mating between closely related species such as horses and donkeys. (5 × 5) (25)

15 a Resistance to insecticides by pest insects, e.g. mosquitoes, resistance of bacteria to antibiotics, differentiation in body size and beak shape and size in finches, resistance in HIV to antiretroviral drugs. (4)

b Resistance by pest insects to insecticides, e.g. mosquitoes. Mutant alleles, that code for neutralising the toxin in DDT, were present in some mosquito genomes. These were selected by nature to provide resistance in survivors. Soon the survivors bred up in numbers to establish a population of mosquitoes that are resistant to DDT as an insecticide. Thus, nature has selected favourable alleles from the gene pool to bring about adaptations that improve the survival of mosquitoes.

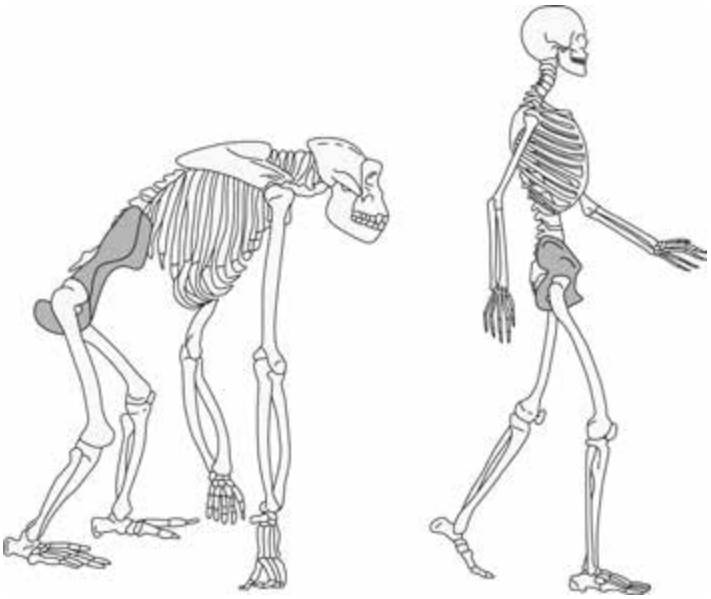
Resistance of bacteria to antibiotics. Mutant alleles, that code for blocking the killing effect of the antibiotic, were present in a few bacteria when the use of antibiotics started. Nature selected for such alleles and soon the resistance to antibiotics spread throughout the pathogen population. Natural selection for favourable mutant alleles is so effective that some TB bacterial strains have now become indestructible "superbugs".

Differentiation in body size and beak shape and size in finches. The original colony of finches on the Galápagos Islands had mutant alleles that code for, e.g. more suitable adaptations in beak size and shape. These alleles were selected to increase the chances of survival. By developing new beak sizes and shapes, finches could explore new types of food sources to reduce competition among the species. Adaptive radiation of new species created conditions for the evolution of several new species.

Resistance in HIV to antiretroviral drugs. With the introduction of antiretroviral drugs, some HIV had mutant alleles that conferred resistance to these drugs. These resistant viruses multiply quickly to replace those viruses that were killed. Because viruses multiply at an incredibly fast rate, new alleles that code for resistance to antiretrovirals arise continuously. (4 × 4) (16)

Activity 1 Comparison between a human and a gorilla *(Specific Aim 1)*

Learner Book page 285



You can photocopy the diagram of the gorilla and the human. Allocate one mark for each complete label. Maximum total marks (10)

Labels:

Gorilla	Human
C-shaped spine	S-shaped spine
Long, narrow pelvis	Short, bowl-shaped pelvis
Hip socket faces sideways	Hip socket faces downwards
Short, splayed legs and long arms	Long legs with hinge joint at knee, shorter arms
Long palms, long curved fingers	Small palm, straight fingers, long opposable thumb
Long opposable big toe on foot	Foot with straight toes, big toe not opposable

PPA

Activity 2 Poster presentation: Three major phases in hominid evolution from six million years ago to the present *(Specific Aims 1 and 2)*

Learner's Book page 299

See text for Activity 3 below. Learners follow the process outlined in the Learner's Book and produce a poster presentation.

Checklist for mark allocation:

Criteria	Marks
Draw map	5
Correct fossil sites named	10
Major hominin fossils at each site named	10
Dates of fossil	5
Table	10

PPA

Activity 3 Poster presentation: The evolution of the genus *Homo*

Specific Aims 1 and 2)

Learner's Book page 301

You can chose between Activities 2 and 3. However, it would also be possible to combine the two activities into one as a learning exercise. It would be sensible to start either (or both) of them at the start of Term 3 and use the map of Africa and the marked sites to teach the hominin specimens, their dates, where they were found and the important palaeontologists who were involved in uncovering the story of humankind.

You can then use the features of the different hominins, in either of the activities, to emphasise the evolutionary patterns that are seen in the different species. Concentrate on: features suggesting at least partial bipedalism, cranial cavity size and so brain size, dentition, prognathism and brow ridges.

The annotated maps and tables produced can be used in revision towards the end of Term 4.

Checklist for mark allocation:

Criteria	Marks
Map with sites of *Homo* finds	10
Species of *Homo* and date	10
Significant features of fossil *Homo*	5
Timeline	5

PPA

Activity 4 Evolutionary trends in hominins *(Specific Aims 1 and 2)*

Learner's Book page 307

2

Species	Length of arms	Structure of hands and feet	Teeth	Cranium size
Australopithecus spp.	Relatively long and ape-like (except Little Foot – shorter arms) (1)	Long, opposable thumb, curved hand bones. Diverging big toe on foot (1)	Show omnivorous diet, but large molars used for crushing suggest tough vegetable matter (1)	400–500 cm^3 (1)
Homo spp.	Still relatively long arms in some species to shorter arms (1)	Opposable thumb, short palm with curved hand bones. Foot with less diverging big toe, more suited for bipedal gain	Show ominvorous diet, smaller molars than *Australopithecines*. Smaller premolars indicate softer diet (1)	650–1 000 cm^3 (1)

(8)

3 Learners should mention bipedalism, less use of trees in *Homo* spp. than in *Australopithecus* spp. and more ability to move well upright, and remain upright when moving fast, opposable thumb giving increasing dexterity – feature of both genera, but better developed in *Homo*, changing dentition suggesting softer diet and possibly more meat, increasing brain size. (5)

PPA

Activity 5 Different cultural and religious explanations for the origin and development of life on Earth *(Specific Aims, 1, 2 and 3)*

Learner's Book page 309

Learners will find out about different creation stories and myths around the world. The internet is a good source if this is available, or your local library.

Activity Self assessment

Learner's Book page 311

1

Great apes	Humans
The head is in front of the body, so the foramen magnum in the skull lies at the back of the skull facing backwards (1)	The head is above the body, so the foramen magnum is at the base of the skull facing downwards. (1)
C-shaped spine to support its trunk hanging below the body (1)	S-shaped spine to balance the weight above the hips (1)
Pelvis is long and narrow (1)	Pelvis is short and bowl-shaped to support the trunk above (1)
The socket from the head of the femur in the hip faces sideways (1)	Hip socket faces downwards and outwards so that the weight of the body is transmitted directly through this joint (1)
Short legs that splay out sideways and very long arms (1)	Long legs, with a straight hinge joint at the knee (1)
Hands have long palms, a short thumb and long, curved fingers for knuckle walking. foot has an opposable big toe (1)	Foot has straight toes and the big toe is not opposable (1)
Brain volume: 390 cm^3 (1)	1 350–1 500 cm^3 (1)
Prognathus jaw shape, heavy brow ridges, nuchal crest (1)	Less protruding chin and flatter facial profile (1)
Genetically extremely similar (1)	Genetically extremely similar (1)
Use simple tools (1)	Use and manufacture complex tools (1)
Complex behaviour common to both (1)	Complex verbal language humans only (1)

(22)

The number of differences in mitochondrial DNA (mtDNA) between two populations is a measure of the time that has passed since the two populations split from a common ancestor. The differences are measured as mutations in the DNA. The longer ago that the split took place, the more time has passed for mutations to take place and so the more differences there will be between the mtDNA of the two populations.

This difference between the mtDNA can be used as a molecular clock to provide a date at which the two populations split in the past. The rate at which the "clock ticks" – the rate of the accumulation of mutations – can be worked out by looking at fossil and archaeological evidence that will, independently, show differences in the two populations and the dates at which they split. (4)

3 Oldowan stone tools – used for cutting. (1)

4 The use of colour (ochre) and decoration (shells) suggests a complex society in which modern behaviour patterns were emerging – which also required a language. (4)

5 Human genetics provides the evidence that all living populations of humans had African ancestors. The main evidence has come from studies of mtDNA. Scientists have compared mtDNA from living human populations across the world and have constructed a mtDNA family tree for modern humans. There is also evidence from the Y-chromosome, inherited through the male line and non-sex genes in the nucleus, which shows that all modern human populations outside Africa have a very recent origin (50 000 to 70 000 years ago) and have African roots. (5)

6 **a** *Ardepithicus* is a very early hominin genus. Two species have been described: *Ardepithecus ramidus* (dated to 4,4 million years ago) and *Ardepithecus kadabba* (dated to 5,6 million years ago). They were both found in the Middle Awash region of Ethiopia.

Ardepithecus ramidus was found by Tim White and his colleagues, who found 17 hominin fossils: a fragment of a mandible, the remains of a cranial base, many teeth and two fragmented pieces of limb bones. Early in 1995 more than 90 fragments making up around 45% of an adult skeleton were found. Scientists think that this species of hominin lies near the point in hominid evolution where the hominins split off from the line leading to the apes. (2)

b Species of *Australopithecus* had small bodies and small brains. They lived during the Pliocene and had a mixture of ape-like and human features. Fossil australopithecines are rare. In the Rift Valley region their fossils are found in open air sites within sediments and they can be dated fairly accurately using the volcanic ash that they are found in.

The best known australopithecine fossil is "Lucy", which is a fossil of *Australopithecus afarensis*, a species that lived about four million years ago. Lucy was found in 1974 at Hadar in the Awash Valley in Ethiopia. (2)

c *Homo* spp. – range of different species, from *H. habilis*, *H. erectus* to *H. heidelbergensis* (latter probably intermediate between *H. habilis* and *H. sapiens*). Increasing brain size, increasingly bipedal, used tools, showed complex behaviour, were the first hominin species to leave Africa. (2)

7 The Cradle of Humankind is in Gauteng and contains 12 major fossil sites and many minor ones.

List of major sites and finds:

- Sterkfontein – *Australopithecus africanus* and other *Australopithecus* species, *Homo habilis*, *Homo ergaster/erectus*
- Kromdraai, Swartkrans, Drimolen – *Paranthropus robustus*, *Homo ergaster/erectus*
- Plover's Lake – *Homo heidelbergensis* (6)

8 Creationism is the belief that the text of the Bible is literally correct and that the Earth and humans were created in six days and that the Earth is very young, generally thought to be around 6 000 years old. Intelligent design is a form of creationism that puts forward the idea that the universe and living things were created by an intelligent being and not by an undirected process of natural selection. (4)

SECTION D

ASSESSMENT

Note: The tasks, tests and examinations included in this section of the Teacher's Guide are exemplars and may be used as is, or may be adapted by the teacher to suit their purposes and circumstances.

PROGRAMME OF FORMAL ASSESSMENT FOR GRADE 12

<table>
<tr><th colspan="3">School based assessment – during the year</th><th>Trial: End-of-year Internal Examination</th><th>End of year External Examinations</th></tr>
<tr><th>Term 1</th><th>Term 2</th><th>Term 3 and Term 4</th><th colspan="2">Term 4</th></tr>
<tr><td>1 × test
minimum 50 marks</td><td>1 × test
minimum 50 marks</td><td>1 × test
minimum 50 marks</td><td rowspan="4">2 × written papers:

P1: 150 marks
2,5 hours

P2: 150 marks
2,5 hours

Total: 300 marks</td><td rowspan="4">2 × written papers:

P1: 150 marks
2,5 hours

P2: 150 marks
2,5 hours

Total: 300 marks</td></tr>
<tr><td>1 × practical
20–40 marks</td><td>1 × practical
20–40 marks</td><td>1 × practical
20–40 marks</td></tr>
<tr><td colspan="3">The practical tasks must cover the range of skills as indicated under Specific Aim 2</td></tr>
<tr><td></td><td>Mid-Year Exams or Controlled test
150 marks
2.5 hours</td><td>1 × Project / Assignment
100 marks
(may be done in any term but will count for Term 3 mark)

E.g. Fieldwork in Environmental Studies</td></tr>
<tr><td>33%</td><td>33%</td><td>33%</td><td></td><td></td></tr>
<tr><td colspan="3">Convert to 50%</td><td>Convert to 50%</td><td></td></tr>
<tr><td colspan="4">Convert to 25 % for final mark</td><td>Counts for 75 % of final mark</td></tr>
</table>

Monitoring and moderation

- Monitoring/auditing:
  - This involves checking for compliance with respect to the subject requirements /prescription as per the policy.
  - It can be done by non-specialists/non-Life Sciences educators.

- Moderation
  - Moderation refers to the process that ensures that the assessment is fair, valid and reliable.
  - Comprehensive and appropriate moderation practices must be in place for the purposes of quality assurance.
  - This is a detailed process involving: the evaluation of the tasks, assessment criteria, assessment tool, with respect to its quality, standard and appropriateness.
  - Must be done by a specialist Life Science educator who is not only knowledgeable about Life Sciences content knowledge, but also about the assessment practices in Life Sciences and the requirements as per the policy documents.

The following are the five purposes of moderation:

1. Moderation should ascertain whether the subject-specific content and skills are sufficiently covered. This is done by checking the weighting grid with respect to the topics.
2. The moderator must ensure that the various levels of cognitive demand are reflected in the tasks – by moderating the weighting grid.
3. The moderator must ensure that assessment and marking are of an acceptable standard and consistency by re-marking the learner evidence.
4. The moderator must ensure that assessments in different schools are comparable.
5. The moderator must identify areas in which the teacher may need further support and development.

Moderation process

Include: standardisation, internal, external moderation and verification

- Standardisation involves the common understanding of the requirements and cognitive demands of each task as stipulated in the CAPS document prior to the task being set and given to learners.
- Verification – number and type of of tasks, marks, duration.
- Internal and external moderation: to quality assure the following:
  - appropriateness of assessment tools
  - quality of the application of the marking/assessment tool by remarking
- The subject teacher may share expectations and interpretations of standards in order to clarify their marking:
  - Feedback in the form of reports
  - There may be interventions such as: re-mark, re-do, adjust marks to all learners.

Reflection and reports

Identify issues relating to pupil performance, curriculum coverage and teaching and learning. Review effectiveness of in-school standardisation and moderation procedures:

- Teacher portfolios and evidence of learners' responses are moderated.
- The tasks, memoranda, assessment criteria, weighting grid, diagnostic analysis, etc, must be quality assured in the teacher's portfolios.
- The learners' responses must be re-marked.

Moderation involves making a judgement with respect to the quality and standard of the tasks as well as the quality and standard of the marking of the learners' responses:

- This judgement could result in the adjustment of marks.
- Interventions maybe suggested.
- Moderation includes monitoring/auditing.
- The first level of moderation, which is at the school, must occur before the learners execute the tasks, to ensure appropriate quality and standard.

Levels of moderation

There are five levels:

1 School-based moderation
2 District/subject advisor moderation
3 Provincial moderation
4 National DBE
5 Umalusi

Evidence of moderation includes the following :

- Signature of moderator
- Date when moderation took place
- Comments with constructive feedback
- Qualitative feedback in reports
- Differentiation with respect to different levels of moderation, e.g. different colours of pen

LIFE SCIENCES MODERATION CHECKLIST - Grade 12

TEACHERS PORTFOLIO
Does the teachers portfolio contain the following:
• CAPS policy document
• the assessments tasks
• marking memo, rubrics, etc.
• diagnostic analysis for controlled tests/exams
• class mark sheets
• proof of monitoring and moderation form
Is the portfolio neatly organized for easy reference?

PRACTICALS
Are total marks a minimum of 30?
Is it based on the knowledge area/ topic as prescribed?
Are instructions in the assessment tasks clear?
Are assessment tasks well presented (technical details such as spacing, clear, large diagrams etc)?
Does the practical cover the range of skills such as: following instructions, handling equipment, making observations, recording data, measuring, interpreting information, planning investigations?

PROJECT/ASSIGNMENT
Is the max mark 100?
Are instructions in the tasks clear to provide learners with sufficient guidance?
Are assessment tasks well presented (technical details such as spacing, clear, large diagrams etc)?

TESTS AND EXAMS
Is the weighting grid available for internally set tests and exams?
Are the class tests a minimum of 50?
Do the assessment tasks make use of a wide range of question types?
Are cognitive levels appropriately weighted (40% level A, 25% level B, 20% level C and 15% level D)?
Are all Specific Aims appropriately addressed?
Are instructions in assessment tasks clear?
Are assessment tasks well presented (technical details such as spacing, clear, large diagrams etc)?
Was the diagnostic analysis appropriately done?

MONITORING AND MODERATION AT SCHOOL LEVEL
Have assessment tasks been moderated at school level (signed and dated)?
Has implementation of PoA been monitored at school level
Are monitor's and/or moderator's reports in the teacher's file?

MARKING AND RECORDING OF MARKS
Is the marking memo accurate?
Does the memo make allowance for alternative responses?
Does the marking memo have the mark allocation and mark distribution for each question?
Is there a correlation between mark allocation, level of difficulty and time allocation e.g. 1 mark for terms, 2 marks for MCQ etc.?
Is marking done according to marking memo/rubric?
Are the marks correctly added?
Are the marks correctly entered and computed / converted in the mark sheet ?

LEARNERS COLLECTION OF EVIDENCE
Does it contain the assessment tasks?
Does it contain the relevant responses / answer scripts?
Is the collection of evidence neatly organised for easy reference?
Are the sequence of tasks / responses same as in the teachers' portfolio?
Is there evidence (signed and dated) of learners' responses being moderated?

A sample report form:

Name of school: _____

Term: _____ Year: _____

Name of learner: _____ Grade and div: _____

Date of birth:_____

SUBJECT	TERM 1	TERM 2	TERM 3	TERM 4
	%	%	%	%
Language 1: Home Language				
Language 2: HL/FAL				
Life Orientation				
Mathematics/ Mathematical Literacy:				
Choice Subject 1:				
Choice Subject 2:				
Choice Subject 3:				
Number of days absent				
School re-opens on:				

Comments

	Signature	Date	Comments
Teacher			
Principal			
Parent/guardian			

Rating code	Description of achievement/ competence	Percentage
7	Outstanding	80–100
6	Meritorious	70–79
5	Substantial	60–69
4	Adequate	50–59
3	Moderate	40–49
2	Elementary	30–39
1	Not achieved	0–29

SCHOOL STAMP

School: _____

LIFE SCIENCES GRADE 12 MARK-SHEET/record sheet

Teacher: _____ Grade 12 Div:_____ Year:_____

No.	Exam No.	Surname and Initial	TERM 1				TERM 2					TERM 3				TERM 4				Final Marks			
																Preliminary/Trial Exams				T5	T6	T7	T8
						T1					T2				T3				T4				
			Test	Prac	Total	Convert to 33%	Test	Prac	Mid Year Exams	Total	Convert to 33%	Test	Project / Assignment	Total	Convert to 33%	Paper 1	Paper 2	Total	Convert to 50 %	T1+T2 + T3	Convert T5 to 50%	T4 + T6	Convert T7 to 25 %
Maximum Marks									150				100			150	150	300					
1																							
2																							
3																							
4																							
5																							
6																							
7																							
8																							
9																							
10																							
11																							
12																							
13																							
14																							
15																							
16																							
17																							
18																							
19																							
20																							

Grade 12 Examinations

The examination will consist of two examination papers of 2½ hours and 150 marks each.

The weighting and assessment of topics in Paper 1 and Paper 2 will be as follows:

Paper 1

TOPIC	TIME (weeks)	WEIGHTING	
		%	MARKS
Term 1			
Meiosis	1	7	11
Reproduction in vertebrates	0,5	4	6
Human reproduction	3	21	31
Term 2			
Responding to the environment (humans)	4	27	40
Term 3			
Human endocrine system	1,5	10	15
Homeostasis in humans	1	7	11
Responding to the environment (plants)	1	7	11
Term 4			
Human impact on the environment (Grade 11)	2,5	17	25
TOTALS	**14,5**	**100**	**150**

Paper 2

TOPIC	TIME (weeks)	WEIGHTING	
		%	MARKS
Term 1			
DNA: Code of life	2,5	19	27
Meiosis	1	7	12
Term 2			
Genetics and inheritance	4	30	45
Term 3			
Evolution through natural selection	2	15	23
Term 3/4			
Human evolution	4	29	43
TOTALS	**13,5**	**100**	**150**

The weighting per topic is a guideline; slight devations in respect of the number of marks allocated to a topic are acceptable. The purpose of providing the weighting is to ensure that all topics are covered with approximately the correct weighting.

Life Sciences Weighting Grid – Grade 12 FORMAL TESTS

Question number	Cognitive ability levels				Test 1				Test 2		Test 3				
	A	B	C	D											
					DNA code of life	Meiosis	Reproduction in vertebrates	Human reproduction	Genetics and inheritance	Responding to the environment (humans)	Human endocrine system	Homeostasis	Responding to the environment (plants)	Evolution by natural selection	Human evolution
Actual marks															
Norm %	40	25	20	15	32	24	8	16	52	48	16	12	12	26	34
Marks	20	12,5	10	7,5	16	12	4	18	26	24	8	6	6	13	17
Total	50				50				50		50				

A = knowing science B = understanding science C = applying scientific knowledge D = evaluating, analysing, synthesising

Life Sciences Weighting Grid – Grade 12 MID-YEAR EXAMINATION

Question number	Cognitive ability levels				DNA Code of Life	Meiosis	Genetics and inheritance	Reproduction in vertebrates	Human reproduction	Responding to the environment (humans)
	A	B	C	D						
Actual marks										
Norm %	40	25	20	15	17	12	27	3	18	23
Marks	60	37,5	30	22,5	30	30	20	5	27	35
Total	150									

A = knowing science B = understanding science C = applying scientific knowledge D = evaluating, analysing, synthesising

Life Sciences Weighting Grid – Grade 12 PAPER 1

Question number	Cognitive ability levels				Meiosis	Reproduction in vertebrates	Human reproduction	Responding to the environment (humans)	Human endocrine system	Homeostasis in humans	Responding to the environment (plants)	Human impact on the environment (Gr 11)	TOTAL
	A	B	C	D									
Actual marks													
Norm %	40	25	20	15	7	4	21	27	10	7	7	17	100%
Marks	60	37,5	30	22,5	11	6	31	40	15	11	11	25	150

A = knowing science B = understanding science C = applying scientific knowledge D = evaluating, analysing, synthesising

Life Sciences Weighting Grid – Grade 12 PAPER 2

Question number	Cognitive ability levels				DNA: the code of life	Meiosis	Genetics and inheritance	Evolution through natural selection	Human evolution	TOTAL
	A	B	C	D						
Actual marks										
Norm %	40	25	20	15	19	7	30	15	29	100%
Marks	60	37,5	30	22,5	27	12	45	23	43	150

A = knowing science B = understanding science C = applying scientific knowledge D = evaluating, analysing, synthesising

ANALYSIS OF TESTS/EXAMS

Test: _____ **Teacher:** _____

Grade: _____

1. STATISTICAL ANALYSIS

	Class	Class	Class	Class	Class	Class
Number wrote						
Number passed						
Number failed						
Median						

2. DIAGNOSTIC ANALYSIS

(Identify the questions where learners have performed poorly and indicate the reason/s for the poor performance. The reason could relate to teaching, learning or both or any other.)

Question number	Description of specific errors	Remedial measures/intervention strategies

LIST OF SKILLS/SUB-SKILLS FOR SPECIFIC AIM 2

1 Follow instructions
2 Handle equipment or apparatus
3 Make and record observations in different ways
4 Record information or data in a variety of ways
5 Measure
6 Interpret, do calculations and represent information in different ways
7 Design/plan investigations or experiments by:
- **7.1** Identifying a problem
- **7.2** Hypothesising
- **7.3** Selecting apparatus/materials
- **7.4** Identifying variables
- **7.5** Suggesting ways of controlling variables
- **7.6** Planning an experiment
- **7.7** Suggesting ways of recording results
- **7.8** Understanding the need for replication or verification

Skills assessed in the Exemplar Formal Practicals, Project and Assignment

Formal practicals or project and practical exam	Skills and sub-skills													
	1	2	3	4	5	6	7.1	7.2	7.3	7.4	7.5	7.6	7.7	7.8
T1: Practicals	✓	✓	✓	✓		✓								
T2: Practicals	✓		✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
T3: Practicals		✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
T3–4: Project	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
T3–4: Assignment	✓			✓		✓								

Formal Assessment Tasks Grade 12

Term 1: Formal Test 1

Marks: 75 **Time: 1 hour**

Instructions and information

1. Answer ALL the questions.
2. Write ALL the answers in the ANSWER BOOK.
3. Start each question at the top of a NEW page.
4. Number the answers correctly according to the numbering system used in this question paper.
5. Present your answers according to the instructions of each question.
6. ALL drawings should be done in pencil and labelled in blue or black ink.
7. Draw diagrams or flow charts only when asked to do so.
8. The diagrams in this question paper are NOT all drawn to scale.
9. Non-programmable calculators, protractors and compasses may be used.
10. Write neatly and legibly.

Section A

Question 1

1.1 Various options are given as possible answers to the following questions. Choose the correct answer and write only the letter (A to D) next to the question number for example **1.1.8 d**.

1.1.1 The process in which male gametes are formed in humans is called . . .

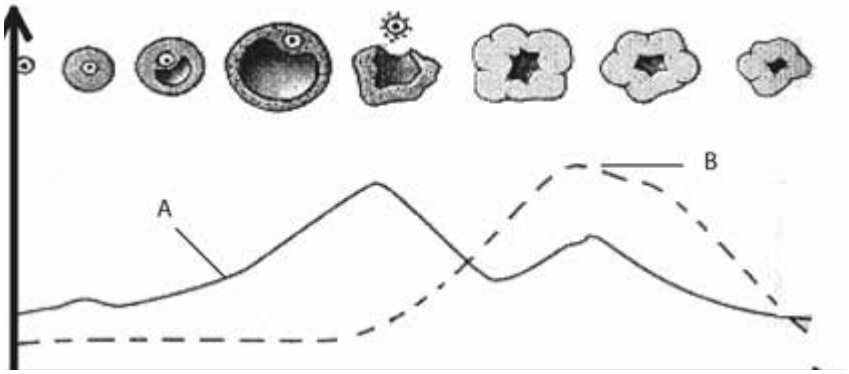
a vasectomy
b spermatogenesis
c oogenesis
d mitosis

1.1.2 Below is a set of events following fertilisation in humans. Which is the correct order of events?

1 The embryo is embedded in the uterine wall in humans.
2 A zygote is formed in the fallopian tube.
3 Cell division occurs to form a ball of several hundred cells.
4 The blastocyst remains free for several days in the uterus.

a 2, 3, 4, 1
b 2, 1, 3, 4
c 3, 2, 4, 1
d 1, 3, 2, 4

Questions **1.1.3** and **1.1.4** refer to the graph below, which shows the growth of the follicle and the ovarian hormone levels.



1.1.3 Which hormones are represented by A and B?

a Progesterone and LH
b FSH and LH
c Oestrogen and progesterone
d Oestrogen and FSH

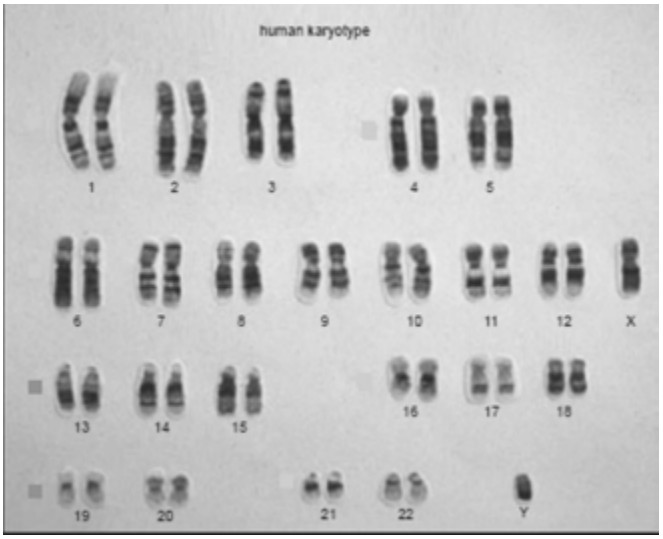
1.1.4 What is the follicle called after day 14?

a Primary follicle
b Graafian follicle
c Secondary follicle
d Corpus luteum

1.1.5 Each somatic (body) cell in the human has . . .

a 23 different chromosomes
b 46 similar chromosomes
c 23 pairs of chromosomes
d 46 pairs of different chromosomes

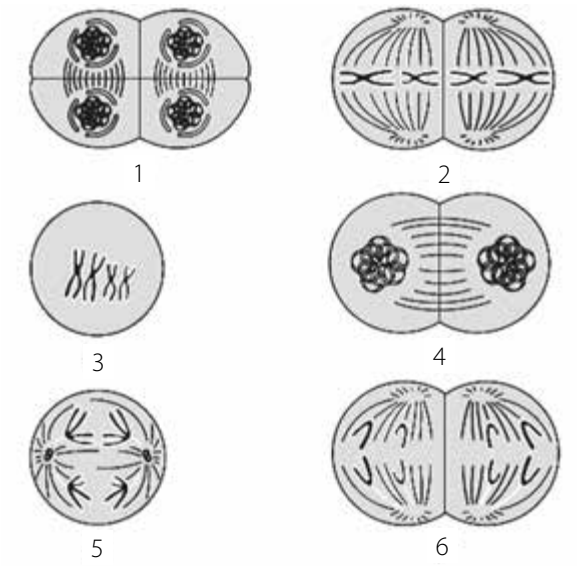
1.1.6 The photograph below represents a human karyotype prepared from a sample of foetus cells collected during amniocentesis



It is reasonable to conclude that . . .

a the foetus is a female
b the child will develop Down syndrome
c the foetus is a male
d there are 46 autosomes

1.1.7 The diagrams below represent six different phases of meiosis taking place in a cell with four chromosomes.



The correct sequence of different phases in which the abovementioned division takes place is . . .

a 1,2,3,4,5,6
b 6,2,5,4,1,3
c 3,5,4,2,6,1
d 3,4,5,6,1,2

(7 × 2) **[14]**

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

1.2.1 Structure in the sperm cell containing enzymes that break down the membrane of the ovum

1.2.2 The release of an ovum from a follicle

1.2.3 The period from fertilisation to birth

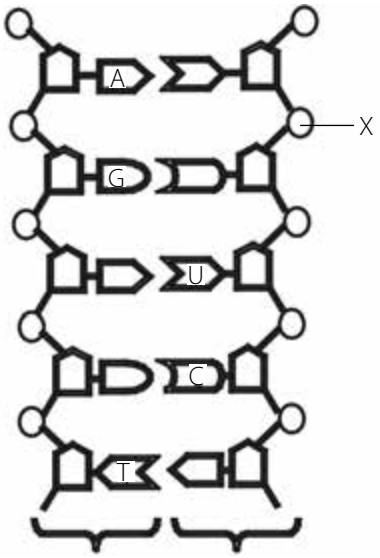
1.2.4 Hormone produced in females to stimulate milk production

1.2.5 Monomers or building blocks of a nucleic acid

1.2.6 The process by which sperms and eggs are produced

[6]

1.3 The diagram below represents two different nucleic acid molecules found in the cells of organisms during the process of protein synthesis. Answer the questions based on it.



1.3.1 Name the molecules 1 and 2 (2)

1.3.2 Give a reason for your answer in question **1.3.1**. (2)

1.3.3 Identify the part labelled X. (1)

[5]

Total Section A: [25]

Section B

Question 2

2.1 The first seven triplets of nitrogenous bases that form part of the gene coding for one chain of the haemoglobin protein that makes up red blood corpuscles in humans is shown below.

DNA Template	CAC	GTG	GAC	TGA	GGA	CTC	CTC
Base triplet number	1	2	3	4	5	6	7

2.1.1 How many of the following are coded for in the DNA template sequence above:

a Diferent types of t-RNA molecules that are required to form the polypeptde from this piece of DNA (1)

b Amino acids (1)

2.1.2 Write down the mRNA sequence from triplet number 4 to triplet number 7 for the DNA template above. (4)

2.1.3 Using the table below, determine the amino acid sequence coded by triplet number 4 to triplet number 6.

Anticodons on tRNA coding for the amino acid	Amino acid coded for
CUC	Glutamate
GUG	Histidine
GGA	Proline
GAC	Leucine
UGA	Threoline
CAC	Valine

(3)

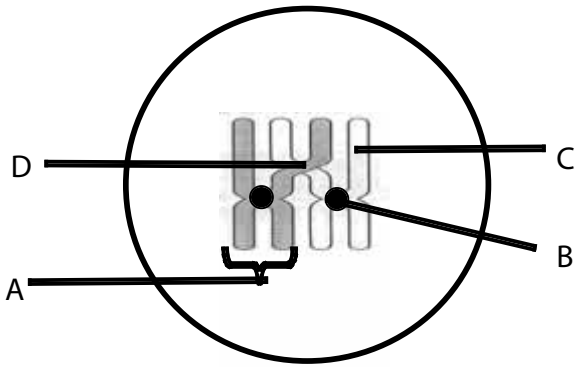
2.1.4 If the T in the 6th triplet of bases changed to A in the DNA template above:

a Write down the new amino acid (using the table above) that this 6th triplet now codes for (1)

b Name the type of gene mutation that has occurred (1)

[11]

2.2 The diagram below represents a process taking place during a type of cell division.



2.2.1 Identify the type of cell division taking place. (1)

2.2.2 Give a reason for your answer to Question **2.2.1**. (2)

2.2.3 Provide labels for parts A and D. (2)

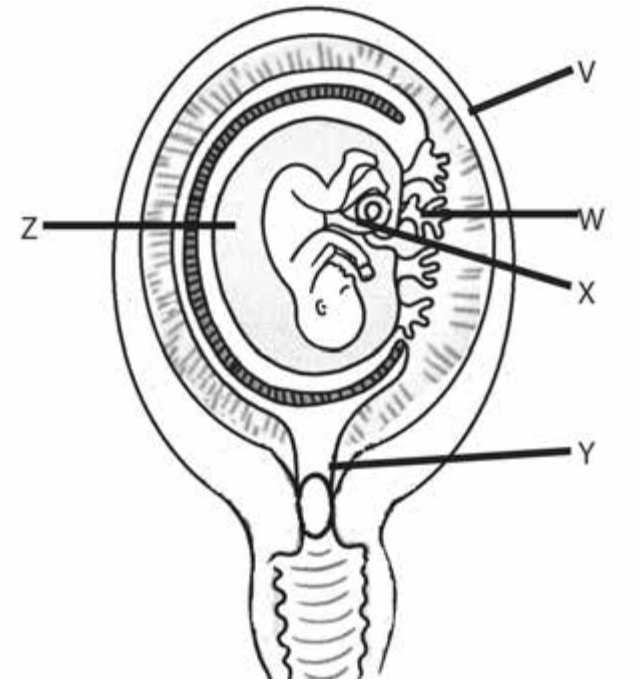
2.2.4 Name the process that is illustrated in the diagram above. (1)

2.2.5 State ONE importance of the process named in Question **2.2.2**. (1)

2.2.6 Draw a diagram of the structure labelled A to show its appearance immediately after the process named in Question **2.2.2**. (4)

[11]

2.3 The diagram below represents a developing foetus in a human body.



2.3.1 Identify the part labelled X. (1)
2.3.2 State ONE function of the fluid labelled *Z*. (1)
2.3.3 Explain ONE way in which the part labelled V is structurally suited to perform its function during the process of birth. (2)
2.3.4 Name TWO systems in the baby's body that take over the functions of part W once the baby is born. (2)
2.3.5 Explain what prevents another ovum from being produced while the foetus is developing in a human body (2)
[8]

Total Question 2: [30]
Total Section B: [30]

Section C

Question 3

Write an essay in which you explain how negative feedback mechanisms occur in the hormonal control of the menstrual cycle of a woman when fertilisation does not occur.

Factual content : (17)
Synthesis:(3)

NB: No marks will be awarded for answers in the form of flow charts or diagrams.

Total Question 3: [20]
Total Section C: [20]

Formal Assessment Tasks Grade 12 (Memo)

Term 1: Formal Test 1
Marks: 75
Time: 1 Hour

Section A
QUESTION 1

1.1

1.1.1 **b**
1.1.2 **c**
1.1.3 **c**
1.1.4 **d**
1.1.5 **c**
1.1.6 **c**
1.1.7 **c**

(7 × 2) **[14]**

1.2

1.2.1 acrosome
1.2.2 ovulation
1.2.3 gestation
1.2.4 prolactin
1.2.5 nucleotides
1.2.6 gametogenesis **[6]**

1.3

1.3.1 1- DNA
2- mRNA/RNA (2)
1.3.2 DNA contains the nitrogenous base thymine (T)
RNA contains the nitrogenous base uracil (U) (2)
1.3.3 phosphate (1)
[5]

Total Section A: [25]

Section B
QUESTION 2

2.1

2.1.1 **a** 6
B 7 (2)
2.1.2 ACU CCU GAG GAG (sequence must be correct) (4)
2.1.3 Threonine proline glutamate (sequence must be correct) (3)
2.1.4 **a** valine
b point mutation (2)
[11]

2.2

2.2.1 meiosis (1)
2.2.2 presence of homologous chromosomes/crossing-over occurring (2)
2.2.3 A – chromosome; D – chiasma/chiasmata (2)
2.2.4 crossing over (1)
2.2.5 It introduces genetic variation (1)
2.2.6 A double stranded chromosome with the strands joined by a centromere, there is evidence of crossing over

(4)

[11]

2.3

2.3.1 umbilical cord (1)
2.3.2 one of: it helps to support and protect the embryo against mechanical shock, it allows the foetus to float and move in this medium that is free from gravity and pressure (1)
2.3.3 one of: it is muscular allowing it to increase in size as the embryo grows, it is muscular which makes it easier for it to contract during the birth process (1)
2.3.4 two of: circulatory system, excretory system, respiratory system (2)
2.3.5 High levels of progesterone inhibit further ovulation during pregnancy (2)
[8]

Total Question 2 : [30]

Section C
QUESTION 3

Learner's essays should contain the following information:

- The pituitary gland secretes FSH which stimulates the development of a primary follicle in the ovary.
- The developing Graafian follicle secretes oestrogen with causes the lining of the uterus to start to thicken.
- At around day 13 the pituitary gland starts to secrete luteinising hormone (LH).
- The sharp rise in LH causes ovulation to occur on day 14.
- The remains of the Graafian follicle develops into the corpus luteum which starts to produce progesterone.
- Progesterone inhibits the production of FSH so that the ovaries are no longer stimulated to produce another follicle therefore no more ova are released while there is an ovum in the Fallopian tube that may be fertilised.
- When fertilisation does not occur the corpus luteum degenerates and stops producing progesterone.
- The pituitary gland is no longer inhibited in its production of FSH and a new Graafian follicle can start to develop.
- Oestrogen that is produced by the developing follicle stimulates the initial thickening of the endometrium.
- Later, progesterone, produced by the corpus luteum, continues to thicken and maintain the lining of the uterus in preparation for a pregnancy.
- When fertilisation does not occur the corpus luteum degenerates and stops producing progesterone and the thick endometrium is no longer maintained.
- Menstruation occurs.

Assessing the presentation of the essay

Marks	Description
3	Well structured – demonstrates insight and understanding of question
2	Minor gaps or irrelevant information in the logic and flow of the answers
1	Attempted but with significant gaps and irrelevant information in the logic and flow of the answers
0	Not attempted/nothing written other than question number/no correct information

Content (17)
Synthesis (3)
[20]

Formal Assessment Task Grade 12

Term 1: Practical Task 1

Marks: 30 **Time : 1 Hour**

Instructions

- Work individually and independently.
- Each candidate is given a piece of pumpkin from which to extract some DNA.
  The following materials are also provided:
    - distilled water
    - liquid dishwashing detergent
    - table salt
    - alcohol (chilled by placing the alcohol in a test tube in a beaker containing ice cubes)
    - blender or plastic bowl
    - 3 × plastic/polystyrene cups
    - tape
    - metal spoon
    - 2 × plastic spoons
    - measuring cup
    - filter paper/strainer
    - 250 ml beaker
    - medicine dropper
    - source of enzyme – such as meat tenderiser or pineapple juice
    - glass rod/straw
- Conduct this practical in a step-by-step manner.
- For each step write down what its purpose is and also say why a certain material/substance is being used.
- Also write down what your observations are at each step.
- At the end of the practical call your teacher to show him/her the end product.

Expected answers

Step 1: Preparation of the extraction solution
Use of detergent, salt, distilled water
Step 2: Preparation of pumpkin pulp
Pumpkin completely pulped
Step 3: Extracting the DNA
Crushed pumpkin added to detergent solution
Purpose of detergent
Purpose of salt
Step 4: Process of filtration and collection of filtrate
Step 5: Removing the proteins
Use of enzyme (meat tenderiser or pineapple juice)
Need for enzyme
Step 6: Precipitating the DNA
Use of cold alcohol – purpose
Step 7: Final product

Sequence of steps: 3 – all 7 steps in correct sequence
2 – at least 4 steps in correct sequence
1 – 2 steps in correct sequence only

Formal Assessment Tasks Grade 12

Term 2: Formal Test 2

Marks: 75 **Time: 1 hour**

Instructions and information

1. Answer ALL the questions.
2. Write ALL the answers in the ANSWER BOOK.
3. Start each question at the top of a NEW page.
4. Number the answers correctly according to the numbering system used in this question paper.
5. Present your answers according to the instructions of each question.
6. ALL drawings should be done in pencil and labelled in blue or black ink.
7. Draw diagrams or flow charts only when asked to do so.
8. The diagrams in this question paper are NOT all drawn to scale.
9. Non-programmable calculators, protractors and compasses may be used.
10. Write neatly and legibly.

Section A

Question 1

1.1 Various options are given as possible answers to the following questions. Choose the correct answer and write only the letter (**a** to **d**) next to the question number for example **1.1.7 d**.

1.1.1 A recessive allele . . .

a Always leads to a genetic disorder
b Is never expressed in the phenotype
c Is not expressed when in a genotype with a dominant allele
d Produces the same phenotype when homozygous as when heterozygous

1.1.2 The particular position of a gene on a chromosome is called . . .

a a locus
b an allele
c genetics
d homologous

1.1.3 Which one of the following correctly represents the sex chromosomes in a human male and the chromosome in his sperm cell that contributes to forming male offspring?

	Human male	Sperm cell
a	XY	Y
b	XY	X
c	XX	Y
d	XX	X

1.1.4 Two parents have children with the following blood groups:

Child	Blood group
1	A
2	O
3	AB
4	B

If the father has blood group A, what blood group must the mother have?

a Blood group A
b Blood group B
c Blood group O
d Blood group AB

1.1.5 A pregnant woman was told by a genetic counsellor that her baby had equal chances of having blood type A or blood type AB. This means that the genotypes of the woman and her husband must have been . . .

a $I^A I^A$ and $I^B I$
b $I^A I^B$ and $I^B I$
c $I^A I$ and $I^B I^B$
d $I^A I^B$ and $I^A I$

1.1.6 A ring of DNA (plasmid) is taken from a bacterial cell to produce insulin. The steps below are NOT in the correct order.

1 The gene for insulin is removed from a cell of a human pancreas.
2 The bacteria make clones of themselves and produce insulin.
3 The insulin gene is put into the plasmid and into a new bacterial cell.
4 The bacterial plasmid is cut using enzymes.

The correct order of steps is…..

a 3, 2, 4, 1
b 1, 2, 4, 3
c 1, 4, 3, 2
d 4, 2, 1, 3

(6 × 2) **[12]**

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

1.2.1 All the genes in all the chromosomes of a particular species

1.2.2 An arrangement of black bars representing DNA fragments that can be used to determine whether people are related

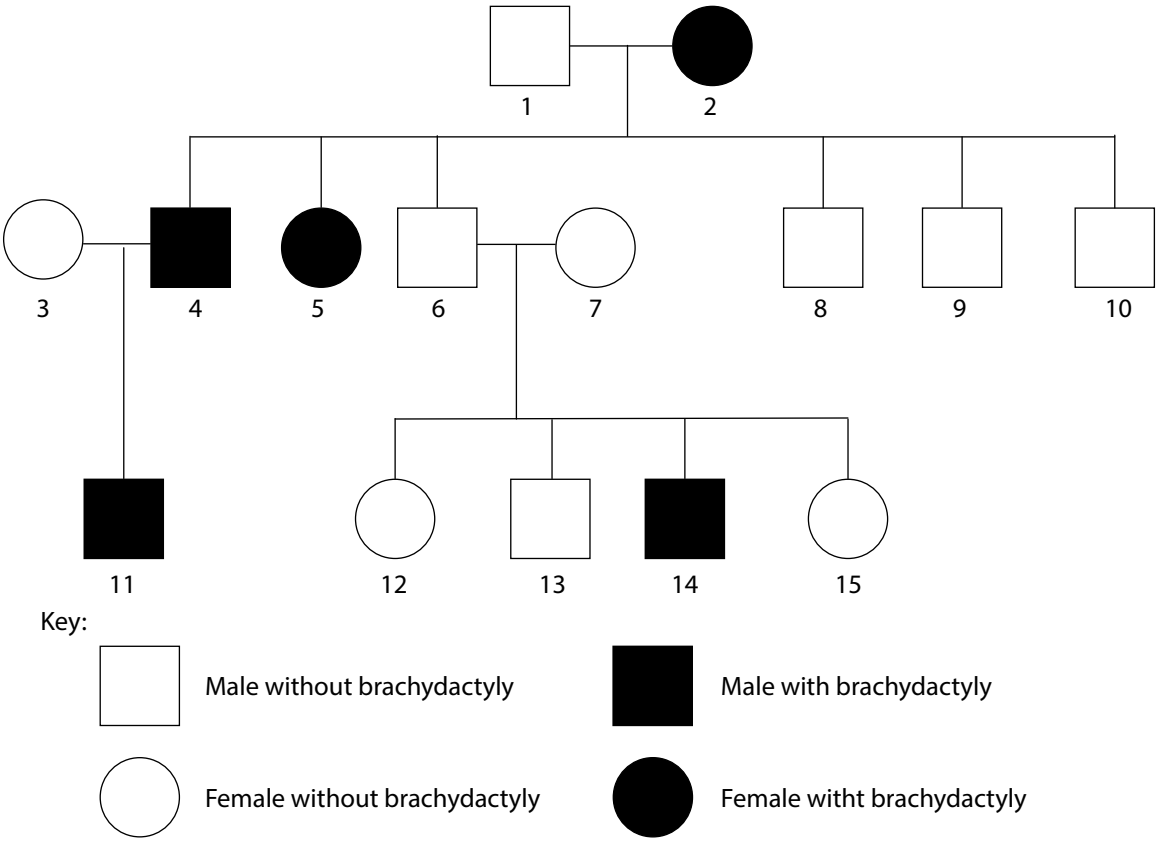
1.2.3 The physically and physiologically expressed characteristics of an organism determined by its genotype and also by its environment

1.2.4 Paired chromosomes that are similar in structure and in the set of genes they carry

1.2.5 A sex-linked condition where blood fails to clot properly

[5]

1.3 Study the pedigree diagram below of a family in which some individuals have the rare inherited condition known as brachydactyly. People with this condition have short fingers and toes.



1.3.1 From the above diagram, state whether brachydactyly is caused by a dominant or recessive allele. (2)

1.3.2 Use the letters B and b and write down the possible genotypes of the following individuals:

a 1 (2)

b 14 (2)

1.3.3 What are the chances of parents 3 and 4 having another child with this condition? (2)

[8]

Total Section A: [25]

Section B

Question 2

2.1 A geneticist wanted to find out which corn colour is dominant in a species of maize. The species has two phenotypes for colour, yellow and white. She performed four genetic crosses and recorded the colour of the offspring as shown in the table below.

Genetic crosses	Parent phenotypes	Offspring phenotypes
1	yellow x yellow	All yellow
2	white x white	51 white and 17 yellow
3	white x yellow	32 white and 34 yellow
4	white x white	All white

2.1.1 According to the results, which colour is dominant? (1)

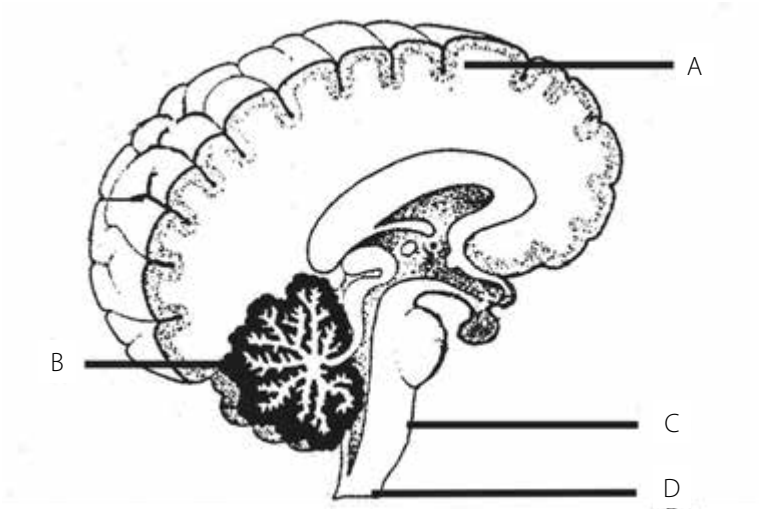
2.1.2 Which ONE of the genetic crosses (1, 2, 3 or 4) from the table allows the conclusion suggested in Question **2.1.1**? (1)

2.1.3 Give a reason for your answer to Question **2.1.2** (2)

2.1.4 Use the symbols G and g to represent genetic cross 2. Also indicate the proportions of the F_1 phenotypes. (5)

[9]

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



Write down only the letter (A–D) of the part that is involved with each of the following:

2.2.1 Controls heartbeat (1)

2.2.2 Contains the centres that control balance, muscle tone and equilibrium (1)

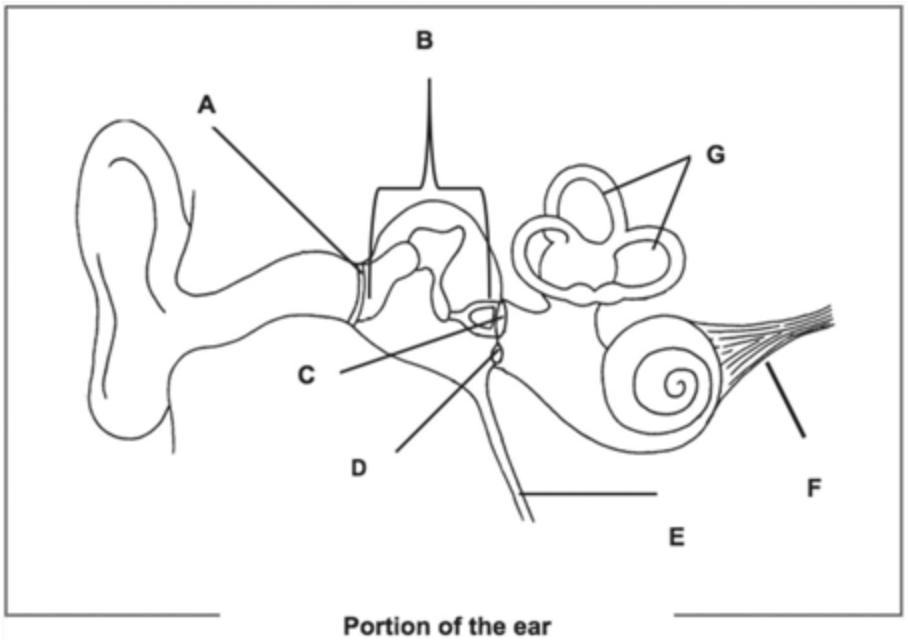
2.2.3 Has centres that interpret what you see (1)

2.2.4 Co-ordinates voluntary muscle movements (1)

2.2.5 Has grey matter on the inside and white matter on the outside (1)

[5]

2.3 Study the diagram below showing a portion of the human ear and answer the questions that follow.



Portion of the ear

2.3.1 Provide labels for parts A and G. (2)
2.3.2 State ONE function for parts B, D, and F respectively. (3)
2.3.3 How are parts A and C together suited for the amplification of sound? (3)
2.3.4 Explain what would happen if part E is blocked with mucus. (3)
[11]

Total Question 2: [25]
Total Section B: [50]

Section C

Question 3

Some communities find DNA manipulation or genetic engineering very disturbing. Write an essay expressing your views as to why this may be the case.

Factual content : (17)
Synthesis: (3)

NB: No marks will be awarded for answers in the form of flow charts or diagrams.

Total Question 3: [20]
Total Section C: [20]

Formal Assessment Tasks Grade 12 (Memo)

Term 2: Formal Test 2
Marks: 50
Time: 1 Hour

Section A

QUESTION 1

1.1.1 **c**
1.1.2 **a**
1.1.3 **a**
1.1.4 **b**
1.1.5 **a**
1.1.6 **c** (6 × 2) **[12]**

1.2
1.2.1 genome
1.2.2 DNA profiling/fingerprinting
1.2.3 phenotype
1.2.4 homologous
1.2.5 haemophilia **[5]**

1.3
1.3.1 recessive allele (2)
1.3.2 1– Bb (2)
14 – bb (2)
1.3.1 50% chance (2)
[8]

Total Question 1: [25]
Total Section A: [25]

Section B

QUESTION 2

2.1
2.1.1 white (1)
2.1.2 2 (1)
2.1.3 A cross between two heterozygous dominant individuals will result in a phenotypic ratio of 3:1 – which is indicated as the offspring phenotype (2)

2.1.4

P_1	phenotype	white	×	white	.....(step 1)
	genotype	Gg	×	Gg	.....(step 2)
	Meiosis				
	Gametes	G g	×	G g	.....(step 3)
	Fertilisation				
F_1	genotype	GG Gg Gg		gg	.....(step 4)
	phenotype	white		yellow	.....(step 5)

(5)
[9]

2.2
2.2.1 C (1)
2.2.2 B (1)
2.2.3 A (1)
2.2.4 B (1)
2.2.5 C /D (1)
[5]

2.3
2.3.1 A – Tympanic membrane/ tympanum/eardrum
G – Semi-circular canals (4)
2.3.2 B – One of: transmit vibrations from the tympanic membrane to inner ear/amplifies sound waves
D – One of: prevents pressure build up of waves/absorbs pressure wave set up by tympanic canal of the inner ear/ eases sound waves out of inner ear/prevents sound waves from moving backwards in perilymph
F – carries impulses to the brain (3)
2.3.3 Tympanic membrane/A has a larger surface area than the oval window/C (3)
2.3.4 Ossicles will not vibrate freely to transmit vibrations to the inner ear/causing partial deafness
OR
Cannot equalise pressure on either side of tympanic membrane leading to pain/middle ear infection/ a burst eardrum/vibrations not being transmitted/ partial deafness (3)
[11]

Total Question 23: [25]
Total Section B: [50]

Section C

QUESTION 3

Through DNA technology it is possible to do the following:
- produce recombinant DNA
- modify naturally occurring DNA
- perform polymerase chain reaction (PCR) analysis
- perform DNA fingerprinting
- determine the sequence of bases of DNA.

DNA manipulation is disturbing to people who do not like to think of people as physical and chemical machines. In addition, people find it disturbing for the following reasons:

The safety of the human population
The main concern is with the safety of food because of the vectors that are used for transforming plant cells. These vectors contain antibiotic-resistant genes. These genes enter the transformed plants with the desired genes. The genetically modified tomato, "Flavr Savr" contains such a gene. The concern is that anyone who eats this tomato may pick up the bacteria that carried the genetic modification. These bacteria could then get into the environment with human faeces and the genes may spread to other, potential harmful bacteria. If these harmful bacteria were then to infect humans, then antibiotics will not be able to help the patient because the bacteria would be resistant to these antibiotics.

Safety of the environment
Developing herbicide resistant plants may encourage the use of greater amounts of herbicides.

Other crops that are resistant to disease, drought or other types of environmental stress, might similarly spread their resistance to weeds, producing weeds that might overrun agricultural areas very rapidly.

Genetically engineered fish, such as the giant salmon, in theory, are well contained in fish farms. However, in practice the small salmon are known to be carried by birds and dropped in other waters, while the larger salmon are known to have escaped. If these salmon enter the sea, they could affect the balance of the already endangered wild salmon populations. In addition, this could upset natural food chains.

Animals and ethics
One of the aims of genetic engineering is to increase the growth rate and yield of animals that provide food for humans and/ or are of economic value, such as pigs, sheep, cattle and poultry. There is however, a concern about the way that humans exploit animals for food and for development of medical products. Use

of a hormone known as BST in dairy cattle in the US carries an increased risk of mastitis in the dairy cattle. The use of animals in medical experimentation also involves a certain amount of suffering. An example is the oncomouse, the first transgenic animal to be patented. This oncomouse has an oncogene added to it. The oncogene causes cancer. These mice develop cancer and are used in cancer research.

Patenting
Large, multinational companies have developed genetically engineered seeds and sold these to farmers. However, they have patented these seeds and prevented the farmers from re-sowing the seeds from the genetically engineered crops. This means that the farmers have to buy new seed every year. Similarly these companies have tried to remove farmers' rights to breed from transgenic animals.

Insurance
There is a concern about how life insurance companies will use the results of genetic tests. Should they, for example, refuse insurance or raise premiums for people with an increased chance of dying from a particular disease, such as cystic fibrosis or muscular dystrophy?

Cloning
Genetic engineering raises the issue of breeding many identical copies of animals, including transgenic animals, showing desirable features. One of the ethical concerns is that the techniques could be applied to humans. Should we now be allowed to create designer babies?

Assessing the presentation of the essay

Marks	Description
3	Well structured – demonstrates insight and understanding of question
2	Minor gaps or irrelevant information in the logic and flow of the answers
1	Attempted but with significant gaps and irrelevant information in the logic and flow of the answers
0	Not attempted/nothing written other than question number/no correct information

Content (17)
Synthesis (3)
[20]

Formal Assessment Tasks Grade 12

Term 2: Practical Task 2

Marks: 30 **Time : 1 Hour**

1 Use the model and/or specimen of the brain. Stick labelled pins/flags on the following parts of the brain model/specimen:
Flag/pin A – medulla oblongata
Flag/pin B – cerebellum
Flag/pin C – cerebrum

1.1 Name the parts of the brain indicated by A, B and C. (3)
1.2 State ONE function of parts A, B and C. (3)
1.3 State TWO ways in which the brain is protected in the human body. (2)
[8]

2 Use the model of the spinal cord. Stick labelled flags/pins on the following parts:
Flag/pin D – white matter
Flag/pin E – grey matter
Flag/pin F – dorsal root

2.1 Name the parts indicated by D and E. (2)
2.2 Is C the ventral or dorsal root? (1)
2.3 Give a visible reason for your answer. (2)
2.4 State TWO functions of the spinal cord. (2)
[7]

3 The following investigation was carried out by two learners to calculate their reaction time.

- One learner held a ruler with his thumb and one finger and allowed the ruler to fall down vertically.
- The second learner caught the ruler when it was dropped by the first learner and measured the distance the ruler had fallen.
- This was done FIVE times and the results are shown in the table below:

Trial no.	Distance (*D*) fallen by ruler (in cm)
1	28
2	26
3	22
4	21
5	20

3.1 What general conclusion can you state from the results in the table? (2)
3.2 Why could the learners not use a stopwatch to measure reaction time? (2)
3.3 State ONE way in which the reliability of this investigation could be improved. (2)
3.4 State TWO ways in which the validity of the investigation could have been compromised by the two learners. (2)
3.5 State any TWO factors that could affect reaction time. (2)
3.6 Use the following formula to calculate the reaction time for Trial number 5.
Reaction time $= \sqrt{\frac{2D}{A}}$
Where D = distance dropped by the ruler (in cm) and
A = acceleration due to gravity (980 cm.s^{-2}) (3)
3.7 Explain the significance of having a fast reaction time in terms of safe following distance when you are driving a car. (2)
(15)

TOTAL: [30]

Expected answers

1

1.1 A – medulla oblongata
B – cerebellum
C – cerebrum (3)

1.2 A – controls involuntary actions like breathing, heartbeat, etc
B – contains the centres that control balance, muscle tone and equilibrium/co-ordinates voluntary muscular movements, e.g. walking, jumping etc
C – controls all voluntary activities, e.g. speech/has centres that receive and interpret all the sensations/seat of the higher mental functions such as memory, judgement and reasoning (3)

1.3
- by the skull
- membranes/meninges, which enclose cerbro-spinal fluid (2)

[8]

2

2.1 D – white matter
E – grey matter (2)

2.2 dorsal root (1)

2.3 presence of ganglions/cell bodies of sensory neurons/swollen portions (2)

2.4
– serves as a reflex centre for reflex actions, e.g. knee jerk/blinking
– pathway for impulses to and from the brain (2)

[7]

3

3.1 The more times you try catching the ruler, the faster your reaction time. (2)

3.2 A stopwatch cannot measure less than a second and also is dependent on the reaction time of the person doing the timing. (2)

3.3 One of: do many more than five tries and then calculate the average, repeat the investigation. (2)

3.4 Any two of: taking incorrect readings from the ruler, catcher not keeping 1 cm distance between the thumb and forefinger consistently, doing incorrect calculations of reaction time. (2)

3.5 Any two of: age, gender, concentration, eyesight, movement around you when doing the investigation, noise levels around you. (2)

3.6 Reaction time $= \sqrt{\frac{2 \times 20}{980}}$
$= 0.20$ seconds (3)

3.7 The faster your reaction time, the quicker you can stop/brake when the car in front stops/brakes. (2)

[15]

Total: [30]

Formal Assessment Tasks

Grade 12: Mid-year Examination

Marks: 150 **Time : 2 hours 30 minutes**

Instructions and information

1. Answer ALL the questions.
2. Write ALL the answers in the ANSWER BOOK.
3. Start each question at the top of a NEW page.
4. Number the answers correctly according to the numbering system used in this question paper.
5. Present your answers according to the instructions of each question.
6. ALL drawings should be done in pencil and labelled in blue or black ink.
7. Draw diagrams or flow charts only when asked to do so.
8. The diagrams in this question paper are NOT all drawn to scale.
9. Non-programmable calculators, protractors and compasses may be used.
10. Write neatly and legibly.

Section A

Question 1

1.1 Various options are given as possible answers to the following questions. Choose the correct answer and write only the letter (**a** to **d**) next to the question number for example **1.1.6 d.**

1.1.1 During oogenesis four haploid cells are formed. How many of these haploid cells develop into an ovum/ova?

a 4
b 2
c 3
d 1

1.1.2 Which feature of the DNA molecule listed below is NOT always the same?

a the order of the bases on a single chain of molecule
b the arrangement of the sugar-phosphate groups
c the pairing of adenine with thymine and guanine with cytosine
d the weak hydrogen bonds between the bases

1.1.3 Two parents have children with the following blood groups:

Child	Blood group
1	A
2	O
3	AB
4	B

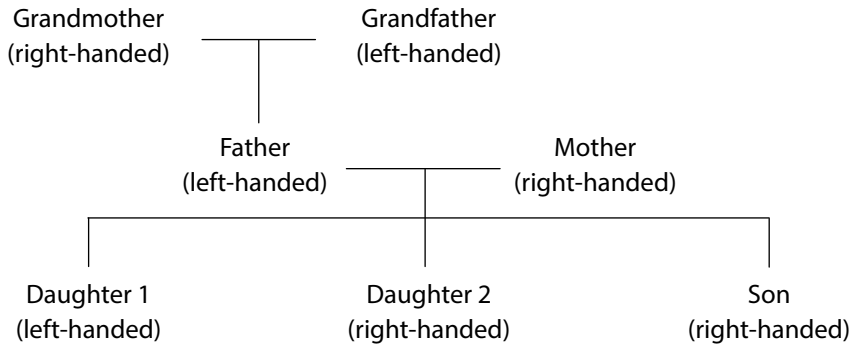
If the father has blood group A, what blood group must the mother have?

a Blood group A
b Blood group B
c Blood group O
d Blood group AB

1.1.4 Each somatic (body) cell in the human has . . .

a 23 different chromosome
b 46 similar chromosomes
c 23 pairs of chromosomes
d 46 pairs of different chromosomes

1.1.5 In a human family, the gene for right-handedness (R) is dominant over the gene for left-handedness. The pedigree diagram of three generations is shown below:



Which is the correct expression of the genotypes of the following three individuals shown in the pedigree diagram?

	Grandmother	Mother	Daughter 1
a	Rr	Rr	RR
b	Rr	RR	rr
c	RR	Rr	rr
d	Rr	Rr	rr

(5 × 2) **[10]**

1.2 Give the correct **biological term** for each of the following descriptions. Write only the term next to the question number (**1.2.1** to **1.2.10**) in your ANSWER BOOK.

1.2.1 The meiotic process by which female gametes are formed in humans.
1.2.2 A pair of identical chromosomes found in diploid cells.
1.2.3 The two parts of a chromosome held together by a centromere.
1.2.4 The process by which the DNA molecule duplicates itself.
1.2.5 A type of disorder where every cell of an organism has an extra pair of chromosomes.
1.2.6 The monomer units that link to nucleic acids.
1.2.7 A condition where one allele is fully expressed in the phenotype and the other is masked.
1.2.8 The type of development in birds where the young are incapable of moving around after hatching.
1.2.9 Fertilisation that takes place inside the body of a female.
1.2.10 The structure that the Graafian follicle develops into after ovulation.

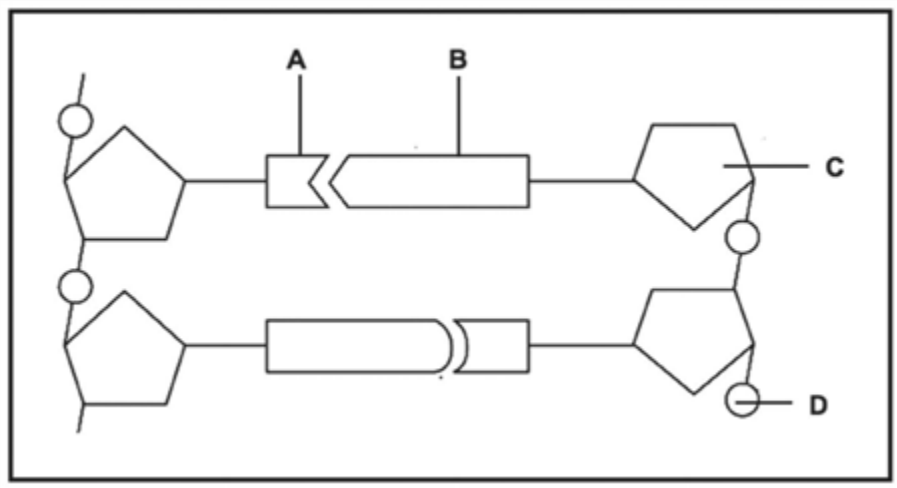
[10]

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. Write A only, B only, both A and B or none next to the question number (**1.3.1** to **1.3.6**) in your ANSWER BOOK.

Column I	Column II
1.3.1 Characterises blood grouping	A: Multiple alleles B: Co-dominance
1.3.2 An organism's complete set of DNA	A: Genotype B: Genome
1.3.3 A sudden change in the sequence of nitrogen bases in DNA	A: Translation B: Transcription
1.3.4 Two different alleles of a gene are equally expressed in the phenotype	A: Incomplete dominane B: Complete dominance
1.3.5 Method of reproduction in which the foetus is nourished through an umbilical cord	A: Ovipary B: Vivipary
1.3.6 A cell which has a single set of chromosomes	A: Diploid B: Haploid

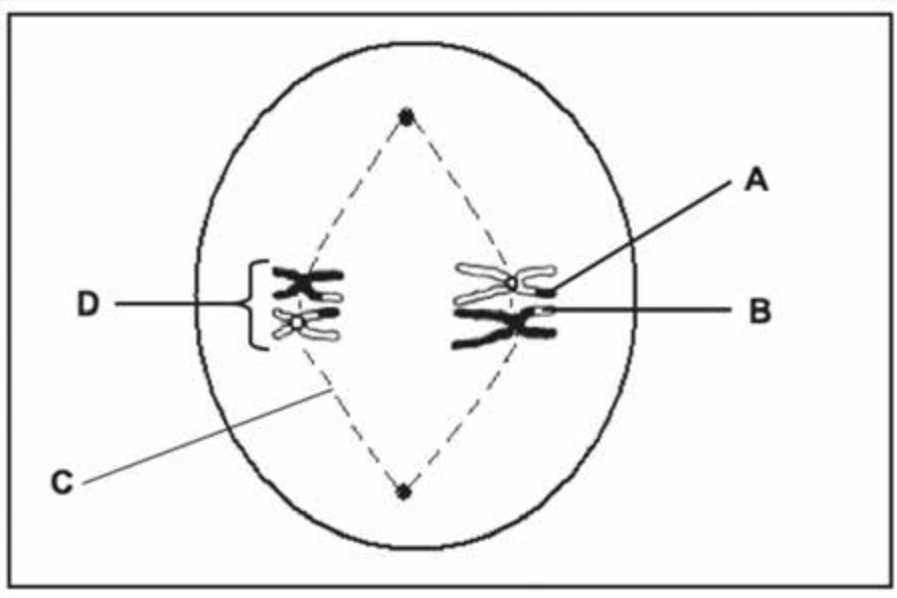
(6 × 2) [12]

1.4 The diagram below shows a short section of a DNA molecule.



1.4.1 Identify part C and part D respectively. (2)
1.4.2 Name the type of bond that joins A and B. (1)
1.4.3 Give ONE visible reason for identifying the above molecule as DNA. (1)
1.4.4 Name TWO structures in a non-dividing human cell where DNA is found. (2)
[6]

1.5 The diagram below represents an animal cell in a phase of meiosis.



1.5.1 Label C and D. (2)
1.5.2 **a** Identify the phase represented in the diagram above. (1)
b Give a reason for your answer to QUESTION **2.1.2 a**. (2)
1.5.3 Name the process which resulted in parts A and B being different from each other. (1)
1.5.4 Describe how the process referred to in QUESTION **2.1.3** occurs. (3)
1.5.5 State the importance of the process named in QUESTION **2.1.3**. (1)
1.5.6 **a** How many cells will be formed at the end of the first division of the cell drawn in the diagram above? (1)
b How many chromosomes will each daughter cell have when the cell, drawn in the diagram above, has completed meiosis? (1)
[12]

Total Section A: [50]

Section B

Question 2

2.1 During their work to establish the structure of DNA, Watson and Crick were interested in the proportion of nucleotides in the DNA of skin cells from a particular organism. They considered the results from three different samples done in the same laboratory, as shown in the table below.

	Percentage of each nucleotide		
Nucleotides in DNA	Sample 1	Sample 2	Sample 3
A	29	31	30
T	31	29	30
C	21	20	19
G	19	21	20

2.1.1 Why did Watson and Crick consider results from three samples? (1)

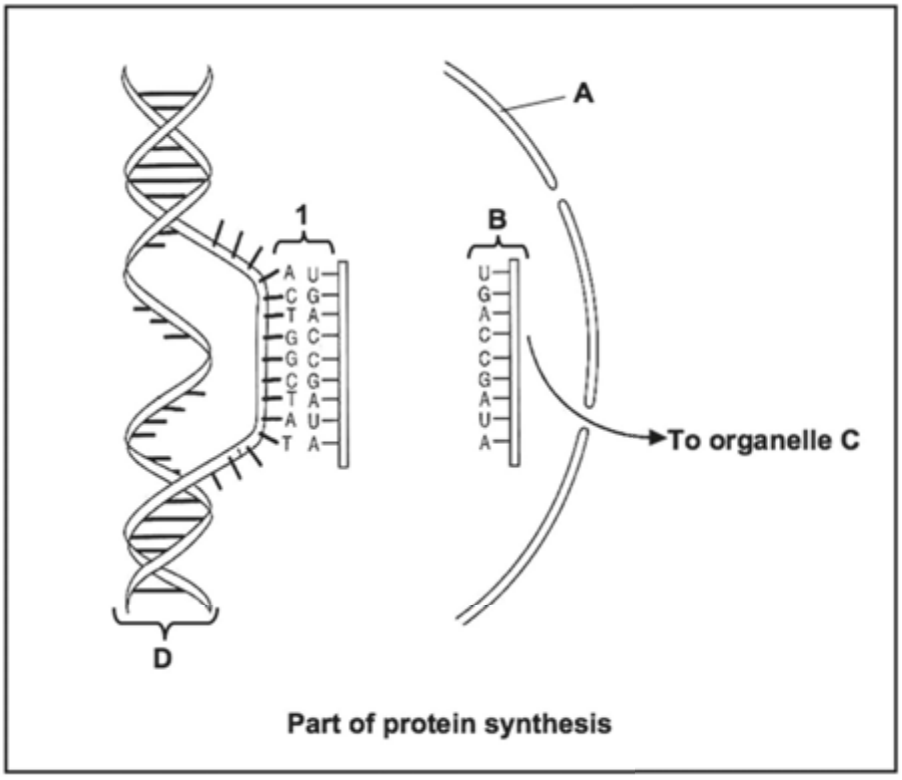
2.1.2 What is the ratio of adenine to thymine in the overall experiment? (1)

2.1.3 Give a reason for your answer to QUESTION **2.1.2**. (1)

2.1.4 Draw a pie chart illustrating the percentages of the different nucleotides in sample 1. Show ALL working. (8)

[11]

2.2 Study the diagram below which shows part of the process of protein synthesis.



2.2.1 Provide labels for structures A, B and D respectively. (3)

2.2.2 State ONE function of molecule D. (1)

2.2.3 Which part of protein synthesis takes place at 1? (1)

2.2.4 Name the type of proteins that control the process named in QUESTION **2.2.3**. (1)

2.2.5 Identify organelle C. (1)

2.2.6 Name the part of protein synthesis that takes place at organelle C. (1)

[8]

2.3

2.3.1 List THREE advantages of using genetically modified organisms for food. (3)

2.3.2 There are red-flowered, white-flowered and pink-flowered varieties in a certain plant. The results of two crosses are shown in the table below.

Crosses	Number of plants of each colour		
	Red	Pink	White
Red x White	0	115	0
Pink x pink	40	80	40

Using the symbols R (red) and W (white) for the alleles for flower colour, represent a genetic cross to explain the results in the table for the cross between two pink-flowered plants. (6)

[9]

2.4 Some people have the ability to roll their tongues (rollers) while other people cannot roll their tongues (non-rollers).

Richard carried out an investigation to find out if there was a difference between the numbers of boys and girls who were rollers. In this investigation Richard tested 120 boys and 100 girls. Of the boys 100 were rollers and of the girls 80 were rollers.

2.4.1 Formulate a hypothesis for this investigation. (3)

2.4.2 State TWO ways in which the reliability of this investigation could be improved. (2)

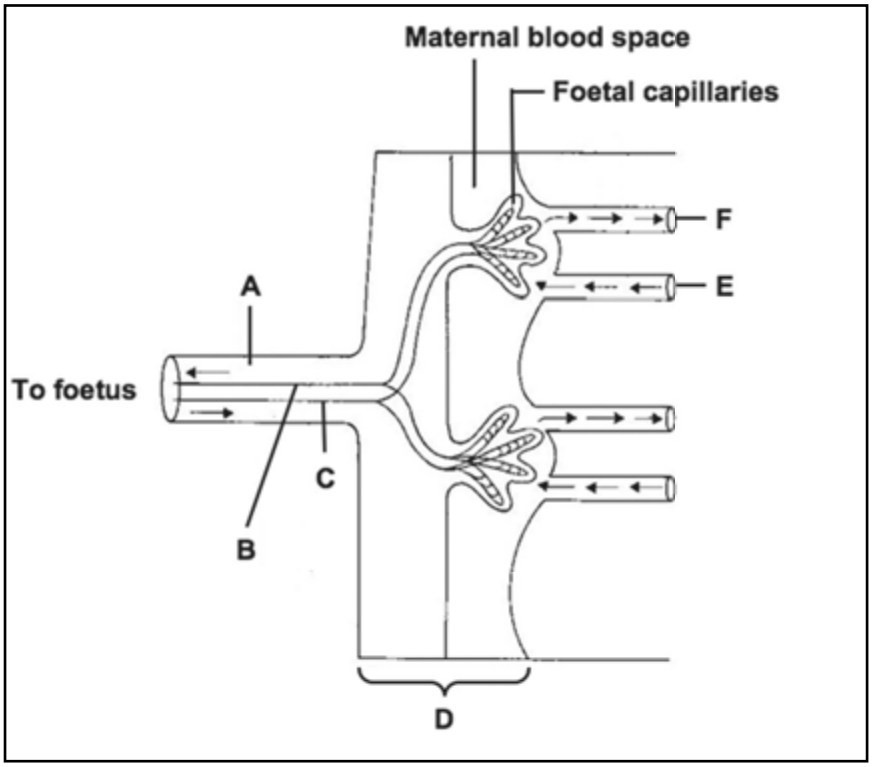
[5]

2.5 Tabulate THREE differences between meiosis I and meiosis II. [7]

Total Question 2: [40]

Question 3

3.1 The diagram below shows the circulation of blood in the wall of the uterus of a pregnant woman. The arrows indicate the direction of flow of blood.



3.1.1 Label structures A and D. (2)

3.1.2 Which blood vessel, B, C, E or F, carries the following:

a Food to the foetus (1)

b Blood from the mother (1)

3.1.3 The foetal capillaries are located inside numerous finger-like villi. Explain why this is useful. (2)

3.1.4 Name and describe the role of the TWO glands and their hormones in preparing part D for pregnancy. (5)

[11]

3.2 Records of human fertility for the period 1941 to 1990 have shown changes in the sperm counts of normal men. The table below summarises the changing percentages of men with high or low sperm counts over a period of 50 years.

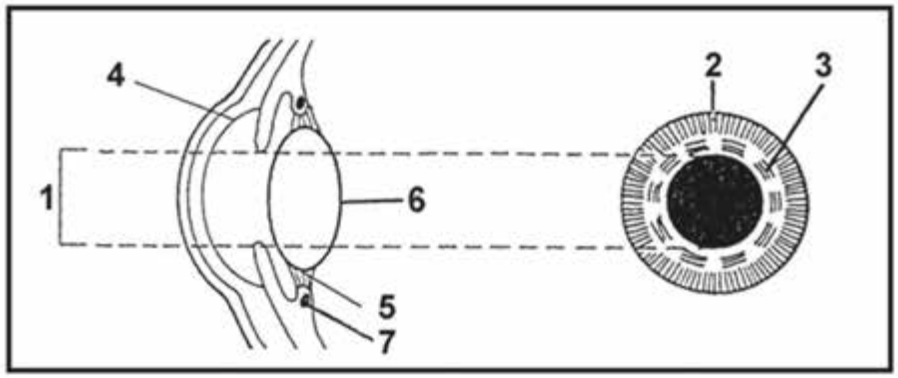
Time period	Men with high sperm counts (%)	Men with low sperm counts (%)
1941–1950	50	4
1951–1960	45	5
1961–1970	28	11
1971–1980	21	14
1981–1990	15	18

3.2.1 On the same system of axes, draw TWO sets of bar graphs to compare the percentages of men with a high sperm count with those with a low sperm count from 1941 to 1990. (11)

3.2.2 Describe the trend for men with low sperm counts and compare it with those with high sperm counts over the 50-year period. (2)

[13]

3.3 Study the diagrams below that illustrate a longitudinal section and anterior view of the human eye of a person looking at a nearby object in dim light, and answer the questions that follow.



3.3.1 Label parts 4 to 7. (4)

3.3.2 Explain the changes that will take place in parts 1, 2 and 3 if the person walks into bright light from dim light. (6)

3.3.3 Explain the changes that take place in parts 5 to 7 when the person is looking at a distant object. (6)

[16]

Total Question 3: [40]

Total Section B: [80]

Section C

Question 4

Different parts of the human brain interpret hearing and balance. Describe how hearing and balance due to to gravitational pull takes place and name the part of the brain involved in each.

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

Total Section C: [20]

GRAND TOTAL: [150]

Formal Assessment Tasks Grade 12
Mid-Year Examination
Memorandum of Answers

Marks: 150
Time: 2 hours 30 minutes

Section A
QUESTION 1

1.1
1.1.1 **d**
1.1.2 **a**
1.1.3 **b**
1.1.4 **c**
1.1.5 **d** (5 × 2) **[10]**

1.2
1.2.1 oogenesis
1.2.2 homologous
1.2.3 chromatids
1.2.4 replication
1.2. 5 Down's syndrome
1.2.6 nucleotides
1.2.7 dominance
1.2.8 altricial
1.2.9 internal
1.2.10 corpus luteum **[10]**

1.3
1.3.1 Both
1.3.2 B only
1.3.3 None
1.3.4 None
1.3.5 B only
1.3.6 B only (6 × 2) **[12]**

1.4
1.4 1 C – deoxyribose/(sugar) (2)
D – phosphate
1.4.2 (Weak) hydrogen bond (1)
1.4.3 It is double stranded/base pairs are present/(ladder-like) (Mark first ONE only) (1)
1.4.4 nucleus/chromosomes/chromatin/mitochondrion (2)
[6]

1.5
1.5.1 C – spindle threads/spindle fibres
D – homologous chromosomes/bivalent/tetrad/homologues (2)
1.5.2 **a** Metaphase 1 (1)
b Chromosomes are aligned at the equator in homologous pairs/bivalent/tetrad/homologues (2)
1.5.3 Crossing over (1)
1.5.4 Homologous chromosomes/bivalent/tetrad line up at the equator and exchange genetic material (3)
1.5.5 One of:
- Chromatids from homologous chromosomes overlap/cross
- Part/s of one chromatid become exchanged/genetic material for part/s of its homologous partner
- Promotes genetic variation in the gametes/offspring will be different from the parents (1)

1.5.6 **a** 2 (1)
b 2 (1)
[12]
Total Section A: [50]

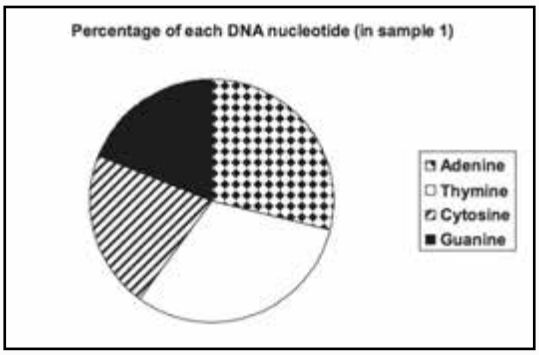
Section B
QUESTION 2

2.1
2.1.1 To increase the reliability of the results (1)
2.1.2 1:1/(90:90) (1)
2.1.3 In a DNA molecule, thymine always pairs with adenine/thymine and adenine are complementary bases (1)
2.1.4 $\frac{29}{100} \times 360^{o} = 104{,}4^{o} / 104^{o}$

$\frac{31}{100} \times 360^{o} = 111{,}6^{o} / 112^{o}$

$\frac{21}{100} \times 360^{o} = 75{,}6^{o} / 76^{o}$

$\frac{19}{100} \times 360^{o} = 68{,}4^{o} / 68^{o}$



Mark allocation of the graph (8)

Calculations/working to determine the correct proportions	2 marks: All four calculations correct 1 mark: 1 to 3 calculations correct
Correct type of graph (pie chart)	1
Title of graph	1
Proportions accurate for each sector/slice labelled /key	4 marks: All four sectors correct (use transparency template) (1 × mark/ sector)

[11]

2.2
2.2.1 A – Nuclear membrane
B – mRNA/RNA
D – DNA (3)
2.2.2
- Carrying hereditary characteristics from parents to their offspring
- Controls the synthesis (manufacturing) of proteins
- Controls the structure and functioning of cells

(Mark first ONE only) (1)
2.2.3 Transcription (1)
2.2.4 Enzymes (1)
2.2.5 Ribosome (1)
2.2.6 Translation (1)
[8]

2.3

2.3.1
- Reduce the need for the use of chemicals/less harmful to the environment
- Selecting the best genes to produce better resistant crops
- Stronger offspring to withstand harsh environmental conditions
- Using specific genes to increase crop yields/livestock improvement for food security
- Selecting genes to increase shelf life of plant products
- Selecting genes that delay/accelerate ripening of fruits
- Using specific genes to improve nutritional value
- Using specific genes to introduce new traits in crops

(Mark only THREE) (3)

2.3.2

P_1 phenotype Pink × Pink
genotype RW × RW
Meiosis
Gametes R W × R W
Fertilisation
F_1 genotype RR RW RW WW
phenotype 1 Red 2 Pink 1 White*

Parents/P_1 and offspring/F_1
Meiosis and fertilisation
(* 1 Compulsory mark + any 5 other) (6)

OR

P_1 phenotype Pink × Pink
genotype RW × RW

Meiosis

Gametes	R	W
R	RR	RW
W	RW	WW
1 mark for correct gametes 1 mark for corect genotypes		

Fertilisation
F_1 phenotype 1 Red 2 Pink 1 White*
Parents/P_1 and offspring/F_1
Meiosis and fertilisation
(* 1 Compulsory mark + any 5 other) (6)
[9]

2.4

2.4.1 More boys than girls can roll their tongues
OR
More girls than boys can roll their tongues
OR
Equal number of boys and girls can roll their tongues (3)

2.4.2 Use the same number of boys and girl
Increase the sample size
Repeat the investigation (2)
[5]

2.5

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
Homologous chromosomes in prophase I	Chromosomes occur singly in prophase II

any 3 × 2 + 1 table **[7]**
Total Question 2: [40]

QUESTION 3

3.1

3.1.1 A – umbilical cord
D – placenta (2)

3.1.2 **a** B (1)
b E (1)

3.1.3 The villi increase the surface area across which exchange of substances can take place between foetal blood and maternal blood. (2)

3.1.4 The Graafian follicle in the ovary produces oestrogen.
The corpus luteum in the ovary produces progesterone.
Both hormones thicken the endometrium/make it more glandular and vascular/for implantation (5)
[11]

3.2

3.2.1 Graph (11)

Correct type of graph	1
Title of graph	1
Correct label and units for X-axis	1
Graphs labelled/key provided for 2 graphs	1
Correct label and units for Y-axis	1
Appropriate width and interval of bars	1
Appropriate scale for Y-axis	1
Drawing of the graphs	1: 1 to 3 bars plotted correctly 2: 4 to 6 bars plotted correctly 3: 7 to 9 bars plotted correctly 4: all 10 bars plotted correctly

3.2.2 The percentage of men with low sperm counts has increased from 1941 to 1990.
The percentage of men with high sperm counts has decreased from 1941 to 1990. (2)
[13]

3.3

3.3.1 4 – cornea
5 – suspensory ligaments
6 – lens
7 – ciliary body/ciliary muscles (4)

3.3.2 Circular muscles/3 contracts
Radial muscles/2 relax
Pupil/1 constricts (becomes smaller)
Less light enters the eye max. (6)

3.3.3 Ciliary muscles/7 relax
Suspensory ligaments/5 exert a pull on the lens/6
Tension on the lens increases
The lens become less convex/more flattened
The refractive power of the lens decreases
A clear image is now formed on the retina

max. (6)

[16]

Total Question 3: [40]

Total Section B: [80]

Section C
QUESTION 4

Hearing

- Sound waves are directed by the pinna through the auditory canal to the ear drum/tympanum, causing the ear drum to vibrate
- The vibrations of the ear drum are transferred to the ossicles of the middle ear
- The footplate of the stirrup causes the membrane of the oval window to vibrate
- This sets up pressure waves in the perilymph of the vestibular canal
- The pressure waves are transferred to the endolymph of the cochlea canal
- The pressure waves stimulate the hair cells in the organ of Corti
- The hair cells convert the stimulus to an impulse
- The impulse is transmitted along the auditory nerve to the CEREBRUM of the brain where the sound is interpreted
- The pressure waves pass into the tympanic canal where they are finally absorbed by the round window. Max. (10)

Balance due to gravity

- The utriculus and sacculus register information about the position of the head
- The walls of the utriculus and sacculus are lined by maculae
- The maculae contain sensory hair cells that are stimulated by otoliths (calcium carbonate crystals)
- Otoliths react to gravitational pull when the head tilts to one side, stimulating the hair cells
- The hair cells release impulses which are transmitted along the vestibular branch of the auditory nerve to the CEREBELLUM, informing the brain of the new position of the head. Max. (7)

Assessing the presentation of the essay

Marks	Description
3	Well structured- demonstrate insight and understanding of question
2	Minor gaps or irrelevant information in the logic and flow of the answers
1	Attempted but with significant gaps and irrelevant information in the logic and flow of the answers
0	Not attempted/nothing written other than question number/no correct information

Synthesis (3)
Content (17)

Total Section C: [20]

GRAND TOTAL: [150]

Formal Assessment Task Grade 12

Project/Assignment

Environmental Studies: human impact on the environment

Solid waste disposal

Duration: 3 months, Terms 3–4 **Marks: 100**

Introduction

In many parts of the world municipal waste generated by households is dumped into landfills. A large part of this waste is in the form of packing materials. These packing materials are used for food, clothing and other household items. Some of these materials are in the form of paper bags, plastic bags, polystyrene and cardboard, etc. As landfill sites are filled up and there are fewer available we need to change the kind of waste that is generated. One of the ways to do this is to ensure that these packing materials can decompose or can be recycled.

Different materials decompose differently and at different rates, depending on a number of factors, such as light, temperature, oxygen, etc. One important factor is the presence of water. Many landfill sites are sealed with plastic (and covered at night), so water doesn't seep into the waste. It has been shown that adding water to waste sites increases their rate of decomposition.

Design an investigation to determine which type of material will be most suitable for the packaging of household items.

Note to teacher:
This is an open-ended task in so far as the experimental design is concerned. While a general set of criteria is presented (scoring sheet) in order to assess the general principles of investigative work, it is important to take into account each individual attempt and assess it in terms of the general principles.

Guidance to learners:

1. Identify and state the problem to be investigated.
2. Identify all variables.
3. State a hypothesis for your investigation.
4. Present a step-by-step plan to conduct the investigation, including any controls.
5. Indicate any precautions that need to be taken.
6. Indicate how you will collect your data.
7. Indicate how you will record your data.
8. Analyse your results.
9. Draw conclusion/s from your results.
10. How can the design of the investigation be improved to obtain more valid results?

Assessing hypothesis testing activity: a general score sheet

Criteria	Y	N	Criteria	Y	N
1. Experimental design			**2. The write-up**		
1.1 Identification of a problem			**2.1** Quality of the observation/data (result)		
i Stated as a causal relationship			**i** Made accurate observations/ measurements/calculations		
1.2 Stating a hypothesis			**ii** Collected consistent data		
i Linked effect to a variable (cause-effect)			**iii** Used correct units		
ii Identified independent variable/s			**iv** Completed recording of data in, e.g. table		
iii Identified dependent variable/s			**2.2** Analysis of results		
iv Indicates a directional change			**i** Translated quantitative data into, e.g. graph		
v Stated in a way that is testable through experimentation			**ii** Labelled axes correctly		
1.3 Plan and conduct of experiment to test hypothesis			**iii** Chose appropriate axes for the relevant variables		
i Logical aim stated			**iv** Provided appropriate title for graph		
ii Provided step-by-step detailed plan			**v** Plotted points accurately		
iii Appropriate control/s set up			**vi** Joined points appropriately		
iv Recognised that only one independent factor should be variable			**2.3** Drawing reasonable conclusion		
v Clearly stated precautions			**i** Identified tendencies and trends in data		
vi Appropriate use of specific equipment			**ii** Conclusion/s is/are relevant to the aim /hypothesis		
vii Identified and criticised limitations to experimental design					
viii Appropriate sample size					
ix Diagram of experimental design					
1.4 Collection and recording of data					
i Indicated the plan for collecting / recording data					
ii Recorded data appropriately (e.g. table, drawing, etc)					
iii Recognised the existence of errors in data					

Assessing hypothesis testing activity: score sheet for Term 3–4 Project

Criteria	Y	N	Criteria	Y	N
1. Experimental design			**2. The write-up**		
1.1 Identification of a problem			**2.1** Quality of the observation/data (result)		
How long does it take for packing materials to decompose?			**i** Made accurate observations/ measurements /calculations		
1.2 Stating a hypothesis			**ii** Collected consistent data		
e.g. Paper bags decompose faster under moist condions OR Not all types of packing materials decompose, etc			**iii** Used correct units		
			iv Completed recording of data in, e.g. table		
			2.2 Analysis of results		
			i Translated quantitative data from e.g. table into e.g. bar graph to make comparison		
			ii Labelled axes correctly		
1.3 Plan and conduct experiment to test hypothesis			**iii** Chose appropriate axes for the relevant variables		
i Aim: To determine the rate of degrading/decomposition/ breakdown of packing materials.			**iv** Provided appropriate title for graph		
ii Provided step-by-step detailed plan			**v** Plotted points accurately		
iii Appropriate control/s set up			**vi** Joined points appropriately		
iv Recognised that only one independent factor should be variable			**2.3** Drawing reasonable conclusion		
v Clearly stated precautions			**i** Identified tendencies and trends in data		
vi Appropriate use of specific equipment			**ii** Conclusion/s is/are relevant to the aim/hypothesis		
vii Identified and criticised limitations to experimental design					
viii Appropriate sample size					
ix Diagram of experimental design					
1.4 Collection and recording of data					
i Indicated the plan for collecting/ recording data – depends on design, e.g. could weigh the contents, describe observations, etc					
ii Recorded data appropriately (e.g. table, drawing, etc)					
iii Recognised the existence of errors in data					

See assessment criteria for different types of graphs

This will depend on the specific design

Formal Assessment Task Grade 12

Term 3: Formal Test 3

Marks: 20 **Time: 1 hour**

Essay

Explain six strategies to reduce the amount of air pollution entering the atmosphere as a result of human activity.

You will be marked as follows:
Factual content: 17 marks
Synthesis: 3 marks
Total: [20]

Formal Assessment Tasks Grade 12 (Memo)

Term 3: Formal Test 3
Marks: 20
Time: 1 hour

Possbile answers:
Strategies to reduce greenhouse gases resulting from human activity:

- Introduce legislation to control air pollution
- Monitor emissions from industries to ensure that legislation is being followed
- Impose heavy fines to discourage repeated acts of pollution
- Provide incentives to companies/subsidise the purchase and use of clean energy to encourage them to reduce air pollution
- Educate people about the bad effects of air pollution
- Research new technologies to find more efficient methods of energy production without releasing greenhouse gases, for example solar panels, wind turbines
- Increase the use of public transport/more fuel efficient cars/ bicycles so that less fuel is burnt
- Increasing the efficiency of electricity use at home/industries which will decrease the amount of coal burnt in electricity production
- Switch from fuels that produce a lot of greenhouse gases (coal) to those that produces less (natural gas) as alternative energy source
- Preventing deforestation/loss of other functioning ecosystems will prevent carbon stored in vegetation from being released in the environment
- Restoring forest/ wetlands/other ecosystems will remove carbon dioxide from the air because plants absorb carbon dioxide

Assessing the presentation of the essay

Marks	Description
3	All SIX issues explained with little/no irrelevant information
2	FOUR to SIX issues stated with some irrelevant information
1	ONE to THREE issues stated with some irrelevant information
0	Not attempted/ No relevant information provided

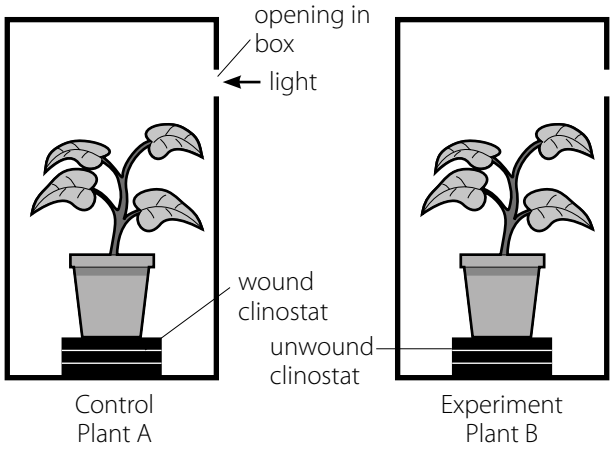
Facts: 17
Synthesis: 03
Total: 20

Formal Assessment Tasks Grade 12

Term 3: Practical Task 3

Marks: 30 **Time : 1 Hour**

1 Set up the apparatus shown below:



1.1 What is the purpose of setting up this apparatus – aim of the investigation? (2)

1.2 What is the purpose of a control plant being set up? (2)

1.3 Why was a wound-up clinostat used in the control? (2)

1.4 State the result you would expect to occur after a few days in:

1.4.1 Plant A (2)

1.4.2 Plant B (2)

1.5 Explain the result you expect in Plant B. (5)

[15]

2 Set up a microscope slide in a microscope of the human skin/use a model of a human skin.

2.1 Draw and label a small portion of the section through the skin. (10)

2.2 Describe how the human skin controls the body temperature on a day when the environmental temperature is 10 °C. (5)

[15]

Total: [30]

Expected answers

1.1 To investigate phototropism (2)

1.2 The purpose of the control is to show that the bending of the stem is caused by light from one side only (unilateral light). (2)

1.3 The clinostat is wound so that it eliminates the effect of the unilateral light on the plant stem. This means that all parts of the stem receive equal amounts of light. (2)

1.4 **1.4.1** The plant grows straight upright. (2)

1.4.2 The stem bends toward light/the opening in the box. (2)

1.5 When light strikes the plant from one side only, auxins move to the darker side of the stem. The auxin concentration is higher on the darker side than the brightly lit side of the stem. A high concentration of auxins in stems accelerates growth (i.e. cell elongation), causing the darker side to grow faster than the brightly lit side, bending the stem towards the light. (5)

[15]

2.1 Use the following table to assess the drawing of the human skin. (10)

Criteria	Description	Mark
Correct representation	Does the drawing look like that which is under the microscope, i.e. are the shape, size, proportion and position of all parts correct?	1
Caption	Is there a suitable caption?	1
Labels	Are all visible parts correctly labelled? dermis, epidermis, sweat gland, blood vessel Are all the labels one below the other?	4 1
Magnification/scale	Is this indicated in the caption of the drawing?	1
Rules for biological drawings	The pencil lines of the drawing are neat and continuous. There is no crossing over of label lines.	1 1

2.2

- Low blood temperature stimulates the heat regulating centre/hypothalamus of the brain.
- Impulses are sent from this centre to the blood vessels of the skin.
- The blood vessels become narrower (constrict) – called vasoconstriction.
- Less blood flows through the skin.
- Less blood carrying body heat comes to the surface of the skin.
- Therefore less heat is lost from the body.
- The sweat glands produce less sweat.
- Less sweat evaporates from the skin's surface and less cooling occurs. (5)

[15]

Total: 30

Formal Assessment Task – Grade 12

Assignment: Environmental Studies

Human impact on the environment: Solid waste disposal

Marks: 60 **Time: 1 Hour**

1 In many parts of the world municipal wastes, which are generated by households, are dumped into landfills. A large part of this waste is in the form of packaging materials, which are used for food, clothing and other household items. Some of these materials are in the form of paper bags, plastic bags, polystyrene, cardboard, etc.

Study the information in the table below and then answer the questions.

Material	Approximate time taken to completely break down
1 Plastic bag	10–20 years
2 Paper bag	1 month
3 Paper	3 weeks
4 Cardboard	4 weeks
5 Aluminium can	80 years
6 Cold drink bottle – glass	500 years to 2 million years
7 Polystyrene/Styrofoam	never

1.1 Define the concept biodegradable. (3)

1.2 Represent the approximate decomposition time for items 2 to 4 by means of a bar graph. (8)

1.3 State ONE conclusion that can be derived from the information in the above table. (2)

1.4 Explain why materials such as paper and cardboard decompose faster than plastic and glass. (6)

1.5 What type of wastes should households generate? (1)

1.6 State FIVE ways in which the above type of wastes could be used to benefit humankind. (5)

[25]

2 Study the following table showing the amount of medical waste produced by three provinces over a number of years.

Year	Amount of medical waste (tons)				
	1995	**1997**	**1999**	**2001**	**2003**
Province A	357	398	410	426	452
Province B	283	290	300	312	330
Province C	230	240	245	270	290

2.1 Which province has shown the most rapid increase in the amount of medical waste produced? (1)

2.2 What was the percentage increase of medical waste produced by the province named in QUESTION **2.1** over the period 1995 to 2003? Show ALL working. (3)

2.3 Give TWO negative effects of dumping medical waste. (2)

[6]

3 The use of non-biodegradable detergents contributes to pollution. Study the table below showing the domestic and industrial use of non-biodegradable detergents in a province over a period of time.

The use of non-biodegradable detergents in thousands of tons in a certain province in South Africa between 1994 and 2004

Year	Domestic use (thousand tons)	Industrial use (thousand tons)
1994	10,5	2,5
1996	14,0	3,8
1998	29,0	6,0
2000	34,0	6,5
2002	34,1	6,9
2004	37,5	7,4

3.1 Which ONE of the two categories of use (domestic or industrial) contributed more to detergent pollution in this period? (2)

3.2 How much detergent was used in 2000? (2)

3.3 Between which years did the use of domestic detergents increase most rapidly? (2)

3.4 Describe the trend that you observe in the domestic use and industrial use of detergents. (3)

[9]

4.1 The following table shows the total amount of solid waste and the amount of recyclable material dumped in a South African city landfill site over a number of years.

Year	Total amount of solid waste (millions of tons)	Amount of recyclable material in solid waste (millions of tons)
2003	1,49	0,78
2004	1,59	0,82
2005	1,80	1,20
2006	1,93	1,30

4.1.1 Describe the general trend in the total amount of waste produced and the amount of recyclable materials dumped from 2003 to 2006. (4)

4.1.2 Explain TWO advantages of recycling. (4)

[8]

4.2 The table below shows the composition of household waste from a community.

Type of waste	Percentage composition
Organic matter	30
Plastic	25
Paper	15
Glass and tin	10
Other	20

Draw a pie chart to represent the data in the table above. Show ALL working. (12)

[20]

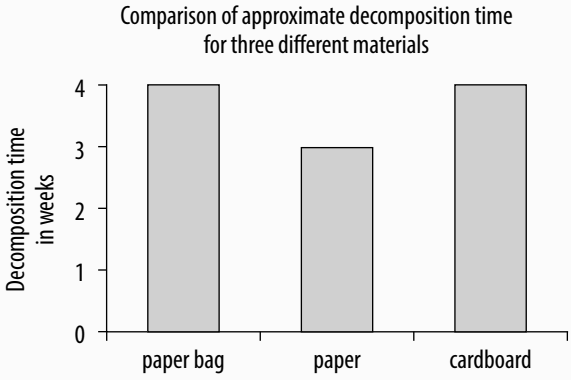
Formal Assessment Task Grade 12
Assignment Memo
Environmental Studies
Human impact on the environment: Solid waste disposal

Marks: 60
Time: 1 Hour

QUESTION 1

1.1 Involves the breakdown of substances, both organic and inorganic by the action of microbes. (3)

1.2



Mark allocation of the graph	
Correct type of graph	1
Caption for graph	1
Correct label for *x*-axis and correct label for *y*-axis	1
Graphs labelled/key provided for 2 graphs	1
Appropriate scale for *y*-axis	1
Drawing of bars	1 mark for each bar plotted correctly (3)

(8)

1.3 Materials break down at different rates. (2)

1.4 Paper and cardboard are "natural" (from tree) refuse and decomposes much quicker than man-made material. The natural material is able to undergo autolysis. Autolysis, or "self-digestion," is the consumption of an organism by its own acids and enzymes. This is what speeds the decomposition process of living, or once living, organisms. Even paper will decompose over the period of a few months because it came from a tree.
"Unnatural" or man-made like glass bottles contain no acids or enzymes, they do not undergo autolysis and therefore take much longer to breakdown. Decomposition also depends on the chemical composition of these items. (6)

1.5 Biodegradable material (1)

1.6 Any five of:
- Take less time to break down than other solid materials
- Are made from biomass – organic compounds are completely renewable
- Are better for the environment, dispersing very few greenhouse gases
- Often require less than half as much energy to manufacture
- Are non-toxic
- Reduce our dependence on foreign countries' fossil fuels
- Reduce the costs of solid waste disposal
- Divert waste from already overcrowded landfills, thereby reducing groundwater and air pollution via methane

(5)
[25]

QUESTION 2

2.1 Province A (1)

2.2 $\frac{(290 - 230)}{230} \times 100 = 26\%$ (3)

2.3 Any two of:
- Pollution and contamination of water sources
- Toxic discharge affects aquatic flora and fauna
- Decomposition of waste – Bad smell/odours
- Aesthetically unattractive
- Causes eutrophication (2)

[6]

QUESTION 3

3.1 Domestic use (2)

3.2 40,5 thousand tons (2)

3.3 Between 1996 and 1998 (2)

3.4 Both show an increase from 1994 to 2004 (3)

[9]

QUESTION 4

4.1

4.1.1 Both the total amount of waste produced and the amount of recyclable material increased from 2003 to 2006. (4)

4.1.2 Any two of:
- People collect and sell waste at buy-back centres, creating economic benefits/jobs.
- People who collect waste and take it to recycling depots contribute to sustainable use of materials.
- Recycling saves energy and therefore reduces the amount of energy used to make new products.

(any 2 × 2) (4)

4.2 Calculations of sectors for pie chart.

Organic matter: $\frac{30}{100} \times \frac{360}{1} = 108°$

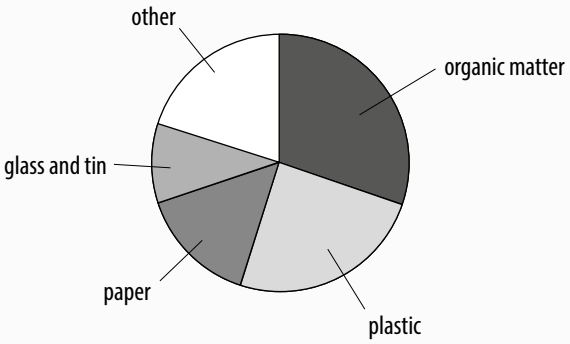
Plastic: $\frac{25}{100} \times \frac{360}{1} = 90°$

Paper: $\frac{15}{100} \times \frac{360}{1} = 54°$

Glass and tin: $\frac{10}{100} \times \frac{360}{1} = 36°$

Other: $\frac{20}{100} \times \frac{360}{1} = 72°$

Percentage composition of different types of waste



Rubric for the mark allocation of the graph

Calculation/working to determine the correct proportions	1 mark for each calculation including the correct answer (5)
Correct type of graph	1
Title of graph	1
Correct proportions for each labelled sector/slice	1 mark for each sector/slice (5)

(12)

Note:
If the wrong type of graph is drawn: marks will be lost for "correct type of graph" as well as for drawing of sectors in correct proportion.

[**20**]

Life Sciences Grade 12

Trial Examination Paper 1

Marks: 150 **Time : 2 hours 30 minutes**

Instructions and information

1. Answer ALL the questions.
2. Write ALL the answers in the ANSWER BOOK.
3. Start each question at the top of a NEW page.
4. Number the answers correctly according to the numbering system used in this question paper.
5. Present your answers according to the instructions of each question.
6. ALL drawings should be done in pencil and labelled in blue or black ink.
7. Draw diagrams or flow charts only when asked to do so.
8. The diagrams in this question paper are NOT all drawn to scale.
9. Do not use graph paper.
10. You may use a non-programmable calculator, protractor and compasses where necessary.
11. Write neatly and legibly.

Section A

Question 1

1.1 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**.

1.1.1 Which of the following terms matches its related description?

a Implantation – embedding of a fertilised egg
b Fertilisation – release of semen from the penis
c Ovulation – fluid containing spermatozoa
d Semen – joining of an egg and a spermatozoon

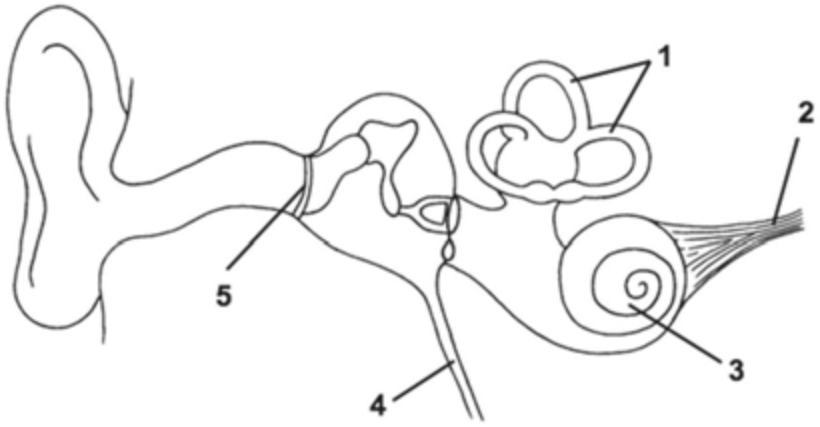
1.1.2 During oogenesis four haploid cells are formed. How many of these haploid cells develop into an ovum/ova?

a 4
b 2
c 3
d 1

1.1.3 Which of the following represents the correct order of the parts through which spermatozoa pass?

a Testis → vas deferens → epididymis → ureter
b Vas deferens → seminal vesicles → ureter
c Testis → epididymis → vas deferens → urethra
d Vas deferens → prostate gland → urethra

QUESTIONS **1.1.4** and **1.1.5** refer to the diagram below, which shows the structure of the human ear.



1.1.4 Which part is responsible for balance?

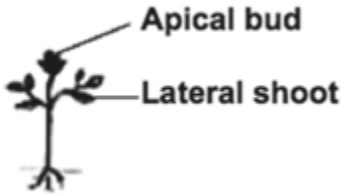
a 3
b 1
c 4
d 5

1.1.5 Which part contains the organ of Corti?

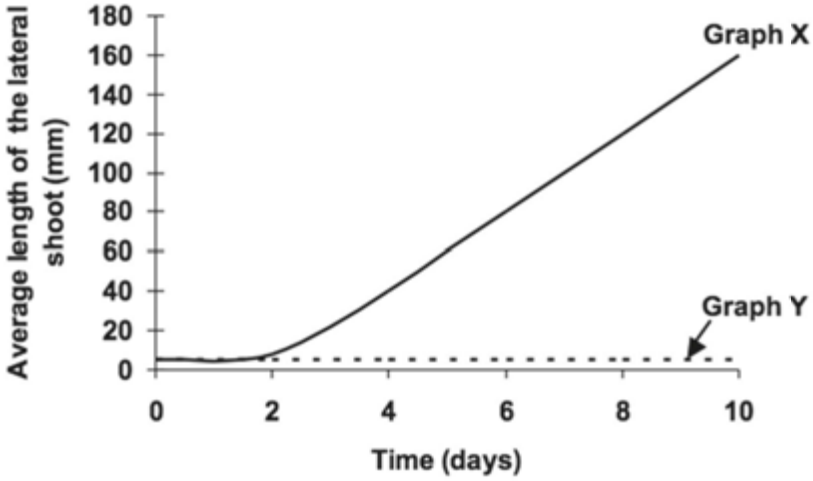
a 1
b 2
c 3
d 4

QUESTIONS **1.1.6** and **1.1.7** refer to the information below.

The diagram below shows the position of the lateral shoot and the apical bud in a plant.



A learner investigated the growth of lateral shoots in bean plants. Two groups of 20 plants were used. One group had their apical buds removed and the other group was left unchanged. Every two days the total length of the lateral shoots was measured and the average lateral shoot length calculated for each group. The result for each group is shown in the graph below.



1.1.6 From this data you may reasonably conclude that ...
- **a** graph X represents the group that had their apical buds removed
- **b** roots produce a substance that stimulates lateral shoot growth
- **c** graph Y represents the group that had their apical buds removed
- **d** lateral shoots produce a substance that stimulates apical bud growth

1.1.7 The conclusion drawn from the above results would NOT be valid if ...
- **a** a large sample was used
- **b** apical buds were removed from all 40 plants
- **c** the plants used were not identical to each other
- **d** the measurement of growth of the lateral buds was done in millimetres instead of centimetres

1.1.8 The hatching of fertilised eggs in the body of the female, such that the young are born alive, is called …
- **a** external fertilisation
- **b** oviparous
- **c** viviparous
- **d** ovoviviparous

1.1.9 Diabetes is caused by an ...
- **a** Over-secretion of adrenalin
- **b** Under-secretion of insulin
- **c** Over-secretion of aldosterone
- **d** Under-secretion of glucagon

1.1.10 When the pupil of the human eye constricts, the receptor and effector are respectively the ...

a yellow spot/fovea and the ciliary muscle
b pupil and the circular muscle of the iris
c pupil and the radial muscle of the iris
d yellow spot/fovea and circular muscle of the iris (10 × 2) **[20]**

1.2 Give the correct **biological term** for each of the following descriptions. Write only the term next to the question number (**1.2.1** to **1.2.7**) in your ANSWER BOOK.

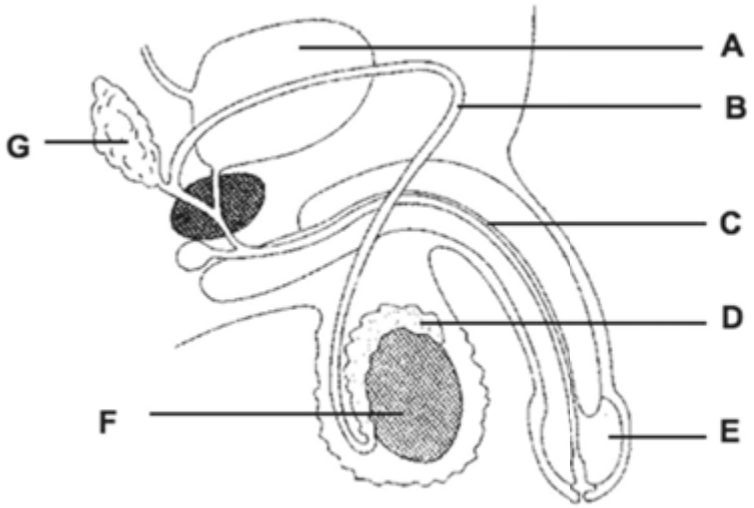
1.2.1 The type of development in birds where the young are incapable of moving around after hatching
1.2.2 Compares human demands with the planet's ecological carrying capacity to meet those demands
1.2.3 The fibrous outgrowths of a neuron that transmits nerve impulses to the cell body of the same neuron
1.2.4 A phenomenon where an increase in one hormone inhibits the secretion of another hormone
1.2.5 A disease in which the hormonal control of blood glucose is defective because of a deficiency of insulin
1.2.6 The structure that develops from the remains of the Graafian follicle after ovulation
1.2.7 The part of the head of a spermatozoon containing enzymes [7]

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. Write A only, B only, both A and B or none next to the question number (**1.3.1** to **1.3.7**) in your ANSWER BOOK.

Column I		Column II
1.3.1	Method of reproduction in which the foetus is nourished through an umbilical cord	A: Ovipary B: Vivipary
1.3.2	Hormone secreted by the pituitary gland/hypophysis	A: Aldosterone B: FSH
1.3.3	The results of an increase in the amount of carbon dioxide in the atmosphere	A: Global warming B: Acid rain
1.3.4	Fertilisation in fishes	A: Internal B: External
1.3.5	Hormone that remains at a high level during pregnancy	A: Progesterone B: FSH
1.3.6	No photoreceptors	A: Blind spot B: Yellow spot
1.3.7	Process that reduces the chances of fertilisation	A: Contraception B: Conception

(7 × 2) **[14]**

1.4 Study the diagram of the male reproductive system below.



The structure of the male reproductive system

1.4.1 Write down the LETTER (A to G) and the NAME of the following:

c The part where meiosis takes place (2)

b The part that transports semen and urine to the outside of the body (2)

c The part where immature sperm cells are stored (2)

1.4.2 Name the male hormone that is responsible for the development of secondary sexual characteristics during puberty. (1)

1.4.3 Write down the LETTER (A to G) of the following:

a The part where the hormone mentioned in QUESTION **1.4.2** is produced (1)

b The part which is cut surgically during male sterilisation (1)

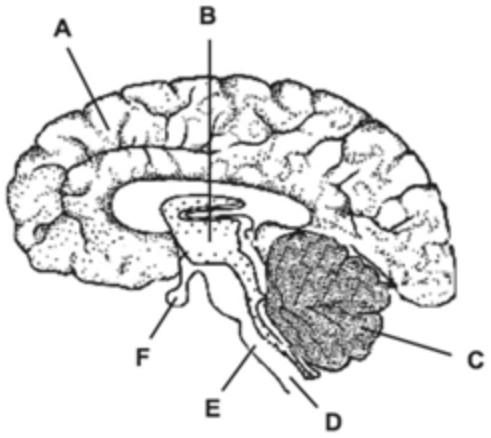
[9]

Total Section A: [50]

Section B

Question 2

2.1 Study the diagram representing the structure of the human brain below.



The structure of the human brain

2.1.1 Identify the parts labelled:
a C (1)
b E (1)

2.1.2 Write down the LETTER (A to F) of the part which controls body temperature. (1)

2.1.3 Explain how the body would be affected if the part labelled F did not secrete TSH. (4)
[7]

2.2 In an investigation a learner was asked to put a cotton thread through the eye of a needle 10 times with both eyes open and then with only the right eye open. This was done under the same light intensity and at a distance of 50 cm from the eyes. The results are recorded in the table below.

	TIme taken to thread the needle in seconds (s)	
Attempts	**Two eyes open**	**Only right eye open**
1	12	38
2	12	35
3	10	37
4	11	36
5	9	34
6	9	33
7	10	30
8	8	31
9	7	29
10	7	28

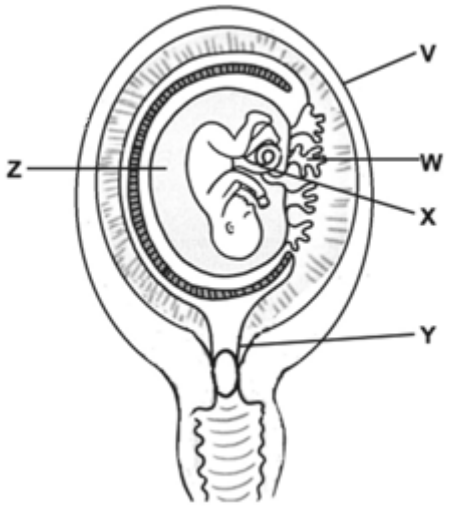
2.2.1 Apart from the factors mentioned, state TWO other factors that had to be kept constant during the investigation. (2)

2.2.2 State a general conclusion that can be drawn for the results above. (2)

2.2.3 Give a reason why more than one attempt was made in this investigation. (1)

2.2.4 Describe the changes that would take place in the eye if the distance between the needle and the eye were reduced from 50 cm to 20 cm. (4)
[9]

2.3 The diagram below represents a developing foetus in a human body.



2.3.1 Identify the parts labelled:
- **a** X (1)
- **b** Y (1)

2.3.2 State ONE function of the fluid labelled Z. (1)

2.3.3 Explain how the part labelled V is structurally suited to perform its function during the process of birth. (2)

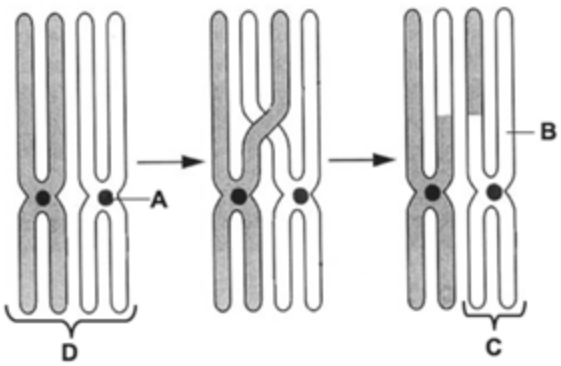
2.3.4 Name TWO systems in the baby's body that take over the functions of part W once the baby is born. (2)

2.3.5 Explain what prevents another ovum from being produced while the foetus is developing in a human body. (2)

[9]

2.4 Describe how the human skin maintains the core body temperature on a day when the environmental temperature is around 40 °C. **[5]**

2.5 Study the diagram below showing a process during meiosis.



Process during meiosis

2.5.1 Label structures A, B, C and D. (4)

2.5.2 Which process is illustrated in the diagram? (1)

2.5.3 During which phase of meiosis does the process named in QUESTION **2.5.2** take place? (1)

2.5.4 What is the benefit of the process named in QUESTION **2.5.2**? (1)

2.5.5 Name and describe ONE other way in which meiosis is able to produce the same benefit as the one named in QUESTION **2.5.4** (3)

[10]

Total Question 2: [40]

Question 3

3.1 A type of bacterium called *Escherichia coli* (*E. coli*) normally lives in the large intestine of humans. To determine whether *E. coli* is present in water, a chemical indicator is used.

If the chemical indicator changes from a clear red colour to a cloudy yellow colour, this indicates that *E. coli* is present.

In an investigation conducted by a group of Grade 12 learners, samples taken from THREE rivers (X, Y, and Z) were investigated for the presence of *E. coli*. Samples were taken from each river and put into a glass bottle which contained the clear red indicator solution. The bottle was then incubated at 37 °C for two days.

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

Colour of chemical indicator	River X	River Y	River Z
Before incubation	Clear red	Clear red	Clear red
After incubation	Clear red	Cloudy yellow	Clear Red

3.1.1 State TWO safety precautions that the learners should take when conducting this investigation. (2)

3.1.2 Suggest ONE reason for incubating the sample at 37 °C. (2)

3.1.3 Which river/s (X, Y or Z) showed the presence of *E. coli*? (1)

3.1.4 Give a reason for your answer in QUESTION **3.1.3** above. (2)

3.1.5 Explain ONE way that *E. coli* could have got into the river/s stated in QUESTION **3.1.3** (2)

[9]

3.2 Deforestation is the destruction of forests by the removal of trees in large numbers. The table below shows statistics related to deforestation in different regions from the years 1990 to 2000.

Region	Total land area (ha)	Total forest cover (ha)	Forest cover (%)	Deforestation rate 1990–2000 (%)
Africa	2 978 394	649 866	21.8	0.8
Asia	3 084 746	547 793	X	0.1
North and Central America	2 136 966	549 304	25.7	0.1
Oceania and Australia	849 096	197 623	23.3	0.2

3.2.1 Which region had the highest rate of deforestation in the ten year period? (1)

3.2.2 Calculate the forest cover (%) of Asia indicated as X. Show all working. (3)

3.2.3 List any TWO reasons for deforestation. (2)

3.2.4 Describe TWO consequences that deforestation has on the ecosystem. (4)

[10]

3.3 Study the passage below and answer the questions that follow.

Hoodia

Hoodia gordonii is a spiny succulent plant (cactus) indigenous to the semi-desert of South Africa, Botswana, Namibia and Angola. It grows in extremely high temperatures, and takes many years to reach maturity. *Hoodia* has been used by indigenous populations in southern Africa for centuries to treat indigestion and minor infections. However, the plant has become well known and is in big demand because of the discovery that indigenous people have always used the flesh of the plant to suppress their appetite while on long hunting trips in the desert. The South African Council for Scientific and Industrial Research has isolated the ingredient responsible for the plant's appetite-suppressant quality and it is now marketed as a slimming tablet.

3.3.1 What is the habitat of *Hoodia*? (1)

3.3.2 Name TWO medical conditions that can be treated with *Hoodia*. (2)

3.3.3 Explain why indigenous people must be compensated for the selling of the slimming tablets mentioned in the passage. (3)

[6]

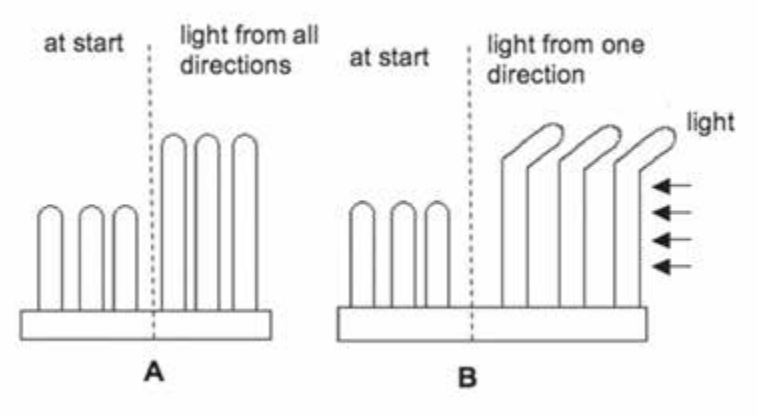
3.4 A group of Grade 12 learners wanted to investigate the effect of light coming from one direction on the growth of shoots. They planted some wheat seeds in two seed trays and allowed it to germinate. When young shoots appeared above the soil level, the shoots were exposed to light from all directions 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 below show the effects of these treatments. Study it and answer the questions that follow.

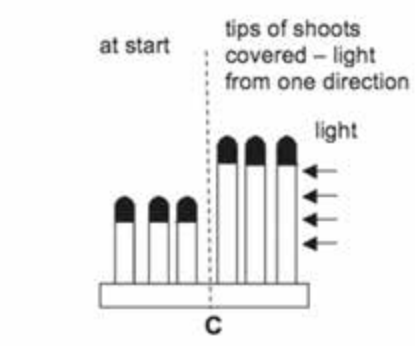


3.4.1 Formulate a hypothesis for the investigation above. (2)

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

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

3.4.4 A third tray (C) was set up in a similar way as 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)

3.4.5 Name ONE use in agriculture of the following:

a auxins (1)

b gibberellins (1)

[10]

3.5 Name the part of the ear that is responsible for balance of the human body due to gravity and describe how this balance is brought about. **[5]**

Total Question 3: [40]

Total Section B: [80]

Section C

Question 4

The nervous and endocrine systems help to protect the human body. Use suitable examples to describe how this is achieved through a reflex action and by the hormone adrenalin.

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

NOTE:NO marks will be awarded for answers in the form of flow charts or diagrams.

Total Section C: [20]

GRAND TOTAL: [150]

Life Sciences Grade 12
Trial Examination: Paper 1
Memorandum of Answers

Marks: 150
Time: 2 hours 30 minutes

Section A
QUESTION 1

1.1

1.1.1 **a**
1.1.2 **d**
1.1.3 **c**
1.1.4 **b**
1.1.5 **c**
1.1.6 **a**
1.1.7 **c**
1.1.8 **d**
1.1.9 **b**
1.1.10 **b** (10 × 2) **[20]**

1.2

1.2.1 Altricial development
1.2.2 Ecological footprint
1.2.3 Dendrites
1.2.4 Negative feedback
1.2.5 Diabetes mellitus
1.2.6 Corpus luteum
1.2.7 Acrosome **[7]**

1.3

1.3.1 B only
1.3.2 B only
1.3.3 A only
1.3.4 B only
1.3.5 A only
1.3.6 A only
1.3.7 A only (7 × 2) **[14]**

1.4

1.4.1 **a** F testis/seminiferous tubules (2)
b C urethra (2)
c D epididymis (2)
1.4.2 testosterone (1)
1.4.3 **a** F (1)
b B (1)
[9]

Total Section A: [50]

Section B
QUESTION 2

2.1

2.1.1 **a** Cerebellum (1)
b Medulla oblongata (1)
2.1.2 **b** (1)
2.1.3 If TSH is not secreted, the thyroid* will not be stimulated to secrete thyroxine* and the level of thyroxine will not be regulated/will decrease; this would lead to the following:
- the basal metabolic rate/rate of respiration will decrease
- the energy levels will decrease
- tissue growth and development will be hindered
- the heart rate will slow down
- hypothyroidism/cretinism/myxodema/any symptom

(*2 compulsory marks + any 2 others) (4)
[7]

2.2

2.2.1
- Size of the needle/needle used
- Thickness of the thread (type of thread)
- Colour of thread
- Size of the eye of the needle
- Time period between attempts
- Starting distance between needle and thread

(Mark first TWO only) (2)

2.2.2 It takes more time to thread a needle with one eye open compared to having both eyes open
OR
It takes less time to thread a needle with both eyes open compared to having one eye open
OR
The more attempts undertaken to thread the needle the less time it takes (any 1 × 2) (2)

2.2.3 To improve the reliability of the results (1)

2.2.4
- The ciliary muscles contract
- Suspensory ligament becomes slack/relaxed
- The lens bulges and becomes more convex/tension on the lens is released
- The sclera pulls forward
- The refractive power of the lens increases
- A clear image is formed on the retina (any 2 × 2) (4)

[9]

2.3

2.3.1 **a** Umbilical cord (1)
b Cervix/endometrium/uterus wall (1)

2.3.2
- It provides the fluid medium for free movement of foetus
- It acts as a shock absorber
- It protects the foetus against dehydration
- It protects the foetus against temperature changes
- Promotes lung development
- Holds waste

(Mark first ONE only) (1)

2.3.3
- Uterine walls are made up of (strong) muscles – which contract and relax to push the foetus/afterbirth forward
- Cervix has (elastic) muscles – allowing dilation of the opening to let the foetus out (any 1 × 2) (2)

2.3.4
- Respiratory/gaseous exchange system
- Digestive system
- Excretory system (Mark first TWO only) (2)

2.3.5 High levels of progesterone inhibit the secretion of FSH (2)
[9]

2.4
- Heat receptors in the skin are stimulated by high temperature
- Impulses sent to hypothalamus
- Impulses sent to blood vessels
- Vasodilation occurs/arterioles to the skin become wider
- More blood flows to the capillaries
- More heat reaches the skin surface
- More heat is lost to the surroundings
- More blood flows to the sweat glands
- Sweating increases
- More heat is lost through evaporation of sweat

(any 5) **[5]**

2.5

2.5.1 A – Centromere
B – Chromatid
C – Chromosome
D – Homologous chromosomes/bivalent (4)

2.5.2 Crossing over (1)

2.5.3 Prophase I (1)

2.5.4 It ensures that the gametes produced at the end of meiosis are genetically different from each other/ genetic variation (1)

2.5.5
- Random/independent assortment of chromosomes
- Chromosomes/chromatids arrange themselves randomly/independently
- on either side of the equator during metaphase I/II (3)

[10]

Total Question 2: [40]

QUESTION 3

3.1

3.1.1
- Wear rubber gloves when taking the samples so as not to get contaminated with germs
- Samples should be taken by using a container/bottle attached to a string to avoid stepping too close to the river bank/prevent drowning/falling into water/ contamination (2)

3.1.2
- Temperature of the human body at which the bacterium normally lives
- *E. Coli* normally lives in large intestinal of humans
- human body temperature is 37 °C
- to allow bacteria to reproduce

(Mark first TWO only) (2)

3.1.3 River Y (1)

3.1.4
- The chemical indicator changed to a cloudy yellow colour which indicates the presence of *E. coli*
- which is a positive test for *E.coli* (2)

3.1.5
- Lack /absence of proper sewage systems
- poor hygiene/bacteria in water results in faeces getting into water (1 × 2) (2)

[9]

3.2

3.2.1 Africa (1)

3.2.2 $\frac{547\,793}{3\,084\,746} \times \frac{100}{1}$

= 17,8 (accept 17,7–17,8) (3)

3.2.3 Trees used for:
- fuel/fire
- building houses
- space for human settlements/farming/livelihood
- furniture
- medicinal purposes

(Mark first TWO only) (2)

3.2.4
- Loss of habitat results in death of organisms/ extinction of species/migration of species
- The balance of gases/carbon dioxide/oxygen will be disturbed because of the loss of plants for photosynthesis
- Disturb food chains/species migrate/dying out
- Habitat degradation which will result in increased soil erosion reduces fertility of soil

(Mark first TWO only, 2 × 2) (4)

[10]

3.3

3.3.1 Semi-desert (1)

3.3.2 To treat:
- indigestion
- minor infections
- obesity

(Mark first TWO only) (2)

3.3.3 Indigenous people were the first to use the plant for suppressing appetite. Royalty must be paid for their intellectual property. (3)

[6]

3.4

3.4.1 Shoots will grow towards the light
OR
Shoots will grow away from the light
OR
Light has no influence on the shoot (1 × 2) (2)

3.4.2 It is the control – to verify the results of the experiment/ to allow for one variable only. (2)

3.4.3 Shoots grow towards the source of light. (2)

3.4.4 The auxins that make the shoot to grow towards the light is in the tips of the shoots. (2)

3.4.5 **a** Apical dominance (1)

b Tall growth of a plant/stimulate seed germination (1)

[10]

3.5
- The utriculus and sacculus register information about the position of the head
- The walls of the utriculus and sacculus are lined by maculae
- The maculae contain sensory hair cells that are stimulated by otoliths (calcium carbonate crystals)
- Otoliths react to gravitational pull when the head tilts to one side, stimulating the hair cells
- The hair cells release impulses which are transmitted along the vestibular branch of the auditory nerve to the CEREBELLUM, informing the brain of the new position of the head. **[5]**

Total Question 3: [40]

Total Section B: [80]

Section C
QUESTION 4

Mechanism of reflex action

Example: withdrawal of hand after being pricked by a pin/from hot surface/(any other suitable example) (1)

- receptors in the skin
- receive the stimulus
- stimulus is converted into a nerve impulse
- the impulse travels along the sensory neuron
- towards the spinal cord
- along the dorsal root of the spinal nerve
- in the spinal cord, the sensory neuron makes synaptic contact
- with the connector/ interneuron
- and then the impulses are transmitted along the motor neuron
- along the ventral root of the spinal nerve
- to the effector organ/muscle
- which contracts and pulls the hand away
- the reflex action provides a quick response to the stimulus so injury is minimised max. (10)

Action of adrenalin

Example: chased by a ferocious dog/(any other suitable example) (1)

Adrenalin prepares the body to cope with the emergency, danger and stress in the following ways:

- brain becomes aware of danger/emergency situation
- through impulses from the sense organs
- adrenal gland is stimulated to secrete adrenalin
- messages are then sent to various parts of the body (blood vessels, heart)
- blood vessels of the skin/digestive system constrict
- but the blood vessels to the heart muscles and brain (important vital organs during an emergency) dilate
- the heart rate also increases
- rate and depth of breathing increases
- the conversion of glycogen to glucose is promoted in the liver
- vital organs receive more blood/oxygen/glucose
- to raise metabolic activities of cells to release more energy
- muscle tone increases
- pupil dilate
- to allow a rapid response to ensure safety max. (5)

Assessing the presentation of the essay

Marks	Description
3	Well structured – demonstrates insight and understanding of question
2	Minor gaps or irrelevant information in the logic and flow of the answers
1	Attempted but with significant gaps and irrelevant information in the logic and flow of the answers
0	Not attempted/nothing written other than question number/no correct information

Content (17)
Synthesis (3)
[20]

Total Section C: [20]

GRAND TOTAL: [150]

Life Sciences Grade 12

Trial Examination Paper 2

Marks: 150 **Time : 2 hours 30 minutes**

Instructions and information

1. Answer ALL the questions.
2. Write ALL the answers in the ANSWER BOOK.
3. Start each question at the top of a NEW page.
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7. Draw diagrams or flow charts only when asked to do so.
8. The diagrams in this question paper are NOT all drawn to scale.
9. Non-programmable calculators, protractors and compasses may be used.
10. Write neatly and legibly.

Section A

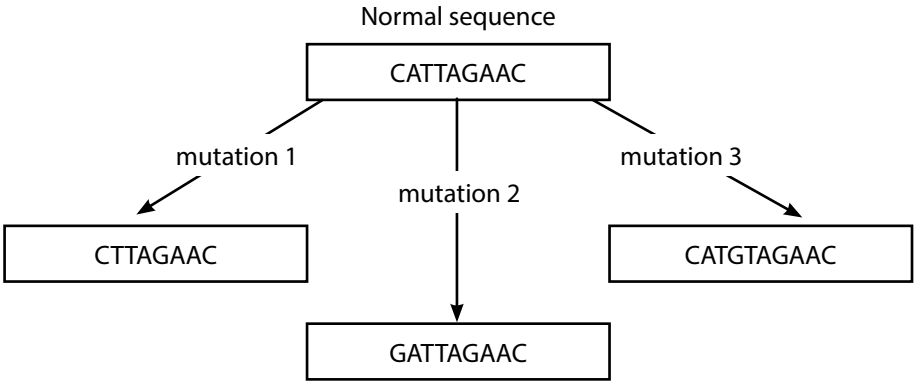
Question 1

1.1 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 **1.1.5**) in your ANSWER BOOK, for example **1.1.6 d**.

1.1.1 Deoxyribonucleic acid does not have . . .

a thymine
b nucleotides
c hydrogen bonds
d uracil

1.1.2 The diagram below shows a normal gene sequence and three mutated sequences of the same gene. Which row in the table below correctly identifies the cause of each type of mutation?



Row	Mutation 1	Mutation 2	Mutation 3
a	deletion	substitution	insertion
b	insertion	substitution	deletion
c	insertion	deletion	substitution
d	deletion	insertion	substitution

1.1.3 Which one of the following is a sex linked genetic disorder?

a haemophilia
b Down's syndrome
c sickle cell anaemia
d albinism

1.1.4 A woman who is homozygous for curly hair marries a man who is homozygous for straight hair. What is the probability of them producing a child with wavy hair? (Note: curly hair is dominant.)

a 25%
b 50%
c 100%
d 75%

1.1.5 A mother has blood group AB and a father blood group B. They have three children and an adopted child. The blood groups of the children are represented in the table below.

Children	Blood Groups
Simanele	AO
Thusini	BO
Philani	AB
Ncube	OO

Which child is adopted?

a Simanele
b Philani
c Ncube
d Thusini

(5 × 2) [10]

1.2 Give the correct **biological term** for each of the following descriptions. Write only the term next to the question number (**1.2.1** to **1.2.6**) in your ANSWER BOOK.

1.2.1 The formation of a new species from a population of a particular species that may become separated by factors other than a geographical barrier
1.2.2 The opening at the base of the human skull
1.2.3 The process during which the mRNA is decoded in the cytoplasm
1.2.4 Different expressions of a gene found on the same locus on homologous chromosomes
1.2.5 A long period of stasis in which rapid speciation occurs that results in the lack of transitional fossil formation
1.2.6 The mechanism responsible for evolution

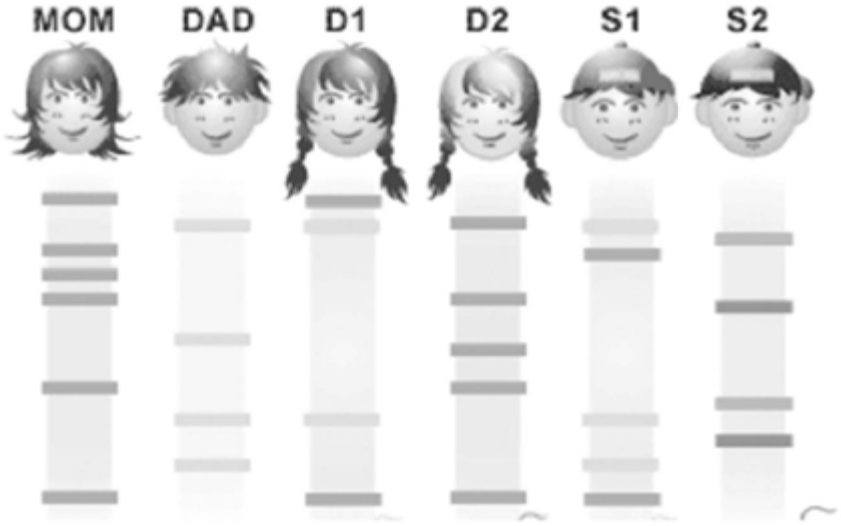
[6]

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. Write A only, B only, both A and B, or none next to the question number (**1.3.1** to **1.3.6**) in the ANSWER BOOK.

Column I		Column II
1.3.1	The study of the past and present distribution of individual species as evidence for evolution	A: Comparative embryology B: Paleontology
1.3.2	A condition in which there is an extra chromosome in pair 21	A: Down's syndrome B: Non disjunction
1.3.3	Fossil evidence found in Ethiopia	A: *Australopithecus boisei* B: *Ardipithecus* spp.
1.3.4	Organisms have an inherent/internal drive to change	A: Wallace B: Lamarck
1.3.5	A sudden change in the sequence of nitrogen bases in DNA	A: cloning B: mutation
1.3.6	First *Homo* species to have migrated out of Africa	A: *Homo sapiens* B: *Homo erectus*

(6 × 2) [12]

1.4 Study the DNA fingerprints of a married couple and their two daughters and two sons.



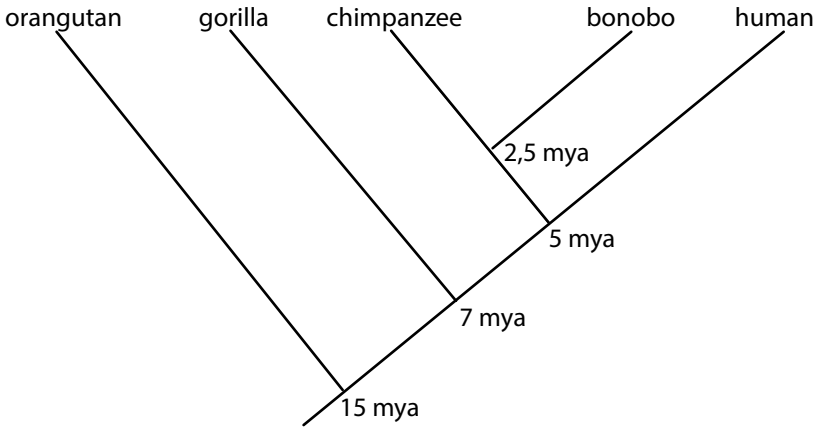
1.4.1 Which is the couple's biological daughter (D1 or D2)? (2)
1.4.2 Which son (S1 or S2) has been adopted by the couple? (2)
1.4.3 Name the procedure used above to determine the siblings. (2)
1.4.4 Would the husband be justified in his claim that daughter 2 is not his biological child? Explain your answer. (2)
[8]

1.5 A group of Grade 12 learners did a survey about the frequency of genetic disorders in a rural area with a sample size of 500. The results are shown in the table below.

Genetic Disorder	Frequency in population (%)
Haemophilia	2
Down's syndrome	3
Sickle cell anaemia	15
Absence of any disorder	80

1.5.1 List THREE steps in the planning of the investigation. (3)
1.5.2. Calculate the number of participants suffering with sickle cell anaemia. Show your calculation. (3)
1.5.3 State TWO ways in which the reliability of the investigation results could be improved (2)
[8]

1.6 By analysing the DNA of humans and living apes, scientists have produced the phylogenetic tree below. Study the evolutionary relationship below and then answer the questions.



1.6.1 How long ago did gorillas start evolving? (2)
1.6.2 When did the human line branch off from the chimpanzee? (2)
1.6.3 Which two organisms are the most closely related? (2)
[6]

Total Section A: [50]

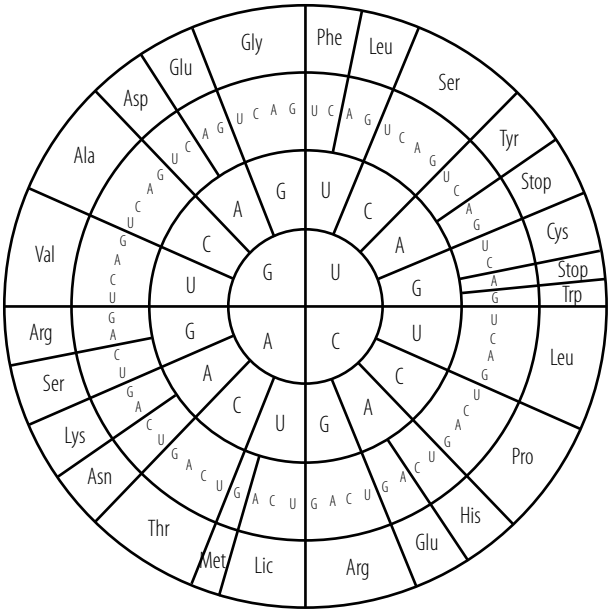
Section B

Question 2

2.1 Study the information below, which shows a part of a molecule that is the blueprint and the anticodons responsible for the building blocks of proteins, to answer the questions.

G A T C A C G A T A G C
Blueprint molecule

Key: works from the inside going out
Innermost ring = first letter of anti-codon
Second ring = second letter of anti-codon
Third ring = third letter of anti-codon
Outermost ring = amino acid



2.1.1 Identify the blueprint molecule. State a reason for your answer. (2)
2.1.2 List the sequence of nucleotides of the last two codons on the mRNA formed from the molecule identified in Question **2.1.1** above. (2)
2.1.3 Name the amino acids that would join to form the peptide chain at this juncture mentioned in Question **2.1.1** above. (2)
2.1.4 How many anticodons can possibly code for the amino acid serine (Ser)? (2)
2.1.5 State the type of mutation that would occur if the third nucleotide on the mRNA molecule was replaced with cytosine, and explain its effect. (2)
[10]

2.2 Study the diagrams below which show different phases in cell division occurring in the ovaries of a frog and then answer the questions.

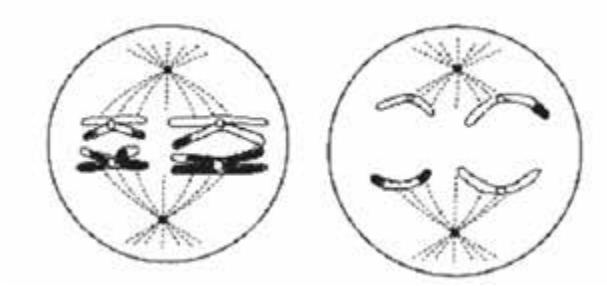


Diagram I Diagram II

2.2.1 Identify the phases that are illustrated above. Give reasons for your answer. (4)

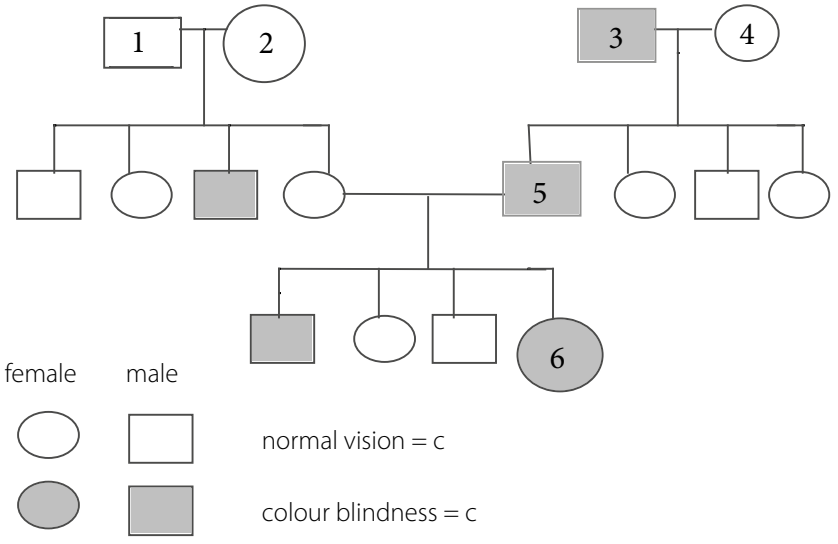
2.2.2 State two mechanisms that are responsible for the formation of genetically different sperm. (2)

2.2.3 How many chromosomes would be present in each of the eggs resulting from diagram II? (1)

2.2.4 Tabulate two differences between the phase shown in diagram I above and mitosis. (5)

[12]

2.3 Study the pedigree diagram of a family where some individuals display colour blindness. Colour blindness is a sex linked disorder. Use C to represent normal vision and c for the colour blindness trait.



2.3.1 State the genotypes of persons represented by numbers 2, 3 and 6. (6)

2.3.2 Account for the relationship between gender and the incidence of colour blindness. (2)

[8]

Total Question 2: [30]

Question 3

3.1 Study the Punnet square below which shows the results of plants with round and yellow seeds having been cross pollinated with green wrinkled seeds.

Gametes	RY	Ry	rY	ry
RY	RYRY	RRYy	RrYY	RrYy
Ry	RRyY	RRyy	RrYy	Rryy
rY	rRYY	rRYy	rrYY	rrYy
ry	rRYy	rRyy	rryY	rryy

3.1.1 State the genotype/s of the gametes that are dominant for seed shape. (2)

3.1.2 State the genotype of the parents of the offspring shown in the Punnett square. Indicate whether they are homozygous or heterozygous for the traits. (2)

3.1.3 What percentage of the F_1 offspring were recessive for both traits? (2)

3.1.4 State the phenotypic ratio of the offspring represented in the table. (4)

[10]

3.2 A farmer selectively interbreeds a heterozygous dominant brown haired cow with a white recessive bull.

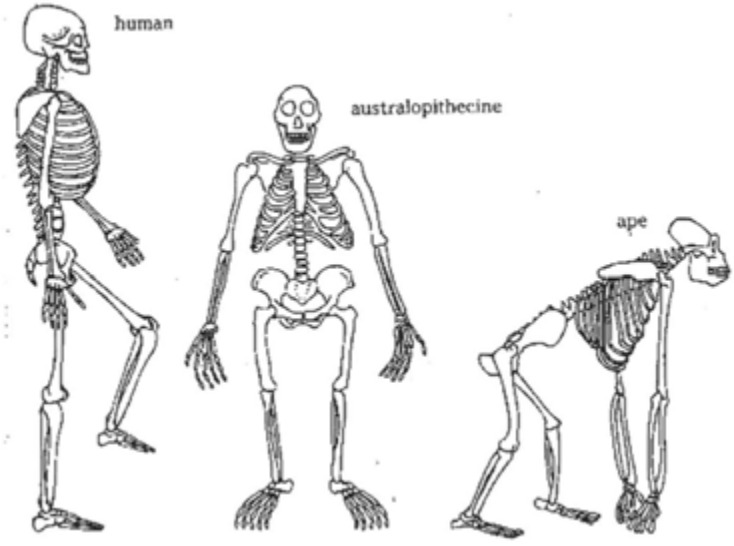
3.2.1 Draw a diagram of the cross to show the ratio of the offspring of the F1 generation. (6)

3.2.2 If the farmer produced in total 26 calves, how many would be white? (3)

3.2.3 If the brown offspring were interbred, what is the probability of them producing white calves? Explain your answer. (4)

[13]

3.3 Study the diagrams of *Homo* sp., *Australopithecus* sp. and *Pan* below and then answer the question.



3.3.1 Identify THREE features of the australopithecine with respect to the cranium, pelvic girdle and feet that show it is an intermediate (missing link) form between human and apes. Tabulate your answer. [7]

Total Question 3: [30]

Total Section B: [60]

Section C

Question 4

4.1 Study the data below which shows the proportion of female *Anopheles* mosquitoes in a region in SA that were resistant to the insecticide, DDT. In 2005 there was a maximum number of resistant mosquitoes.

Year	2001	2002	2003	2004	2005
Resistant mosquitoes	5%	20%	50%	80%	Total resistance
Death from malaria	50	200	500	800	1 000

4.1.1 State TWO generalisations from the information in the table above. (4)

4.1.2 Initially, only 5% of the mosquitoes had genetic resistance to the insecticide. Explain how the number of mosquitoes resistant to the insecticide increased annually. Use a theory to explain this. (6)

4.1.3 Name an insecticide that may be used to kill the mosquitoes. (1)

4.1.4 Calculate the increase in the number of people that died from malaria from 2001 to 2003. (3)

4.1.5 Draw a graph to show the trend in the death rate from malaria in the first three years of spraying the insecticide. Show all working. (6)

[20]

4.2 Modern humans that exist in a particular region of the Earth look very similar to each other. However fossil evidence found in South Africa and East Africa have revealed that *Homo sapiens* evolved in Africa. Discuss the Out of Africa hypothesis that is postulated as an explanation for the migration, providing the two lines of genetic evidence to support this hypothesis and an explanation for the similarities that exist among the people of a particular region.

Content (17)
Integration (3)
[20]

NOTE: NO marks will be awarded for answers in the form of flow charts or diagrams.

Total Section C: [40]

GRAND TOTAL: [150]

Life Sciences Grade 12
Trial Examination: Paper 2
Memorandum of Answers

Marks: 150
Time: 2 hours 30 minutes

Section A

QUESTION 1

1.1.1 **d**
1.1.2 **d**
1.1.3 **a**
1.1.4 **c**
1.1.5 **c** (5 × 2) **[10]**

1.2.1 allopatric speciation
1.2.2 foramen magnum
1.2.3 translation
1.2.4 heterozygous
1.2.5 punctuated equilibrium
1.2.6 natural selection **[6]**

1.3.1 B only
1.3.2 A only
1.3.3 B only
1.3.4 A only
1.3.5 B only
1.3.6 B only (6 x 2) **[12]**

1.4.1 daughter 1 (2)
1.4.2 son 2 (2)
1.4.3 gel electrophoresis/PCR (2)
1.4.4 yes – daughter 2 does not have any horizontal bars that match with that of the father (2)
[8]

1.5.1
- Decide the sample size
- Decide the context/population group of the sample
- Instruments used in the collection of data
- Recording of data (any 3) (3)

1.5.2 Number suffering with sickle cell anaemia

$= \frac{15}{100} \times 500 = 75$ (3)

1.5.3 Survey a large group/repeat the survey in a different area/number of areas (2)
[8]

1.6
1.6.1 7 mya (2)
1.6.2 5 mya (2)
1.6.3 chimpanzee and bonobos (2)
[6]

Total Section A: [50]

QUESTION 2

2.1
2.1.1 DNA – presence of tyrosine (2)
2.1.2 CUA UCG (2)
2.1.3 Asp – Ser (2)
2.1.4 6 (2)
2.15
- Substitution/point/gene mutation
- The same amino acid would occur in that position therefore the sequence would not be changed, hence the protein would not be altered. (2)

[10]

2.2
2.2.1 I metaphase 1 of meiosis
– double row of chromosomes at equator
II anaphase 2 of meiosis
– daughter chromosomes being pulled to respective poles (4)

2.2.2
- Crossing over
- Random/independent assortment of chromosomes (2)

2.3.3 two (1)

2.3.4

Metaphase 1	Mitosis
Double row of chromosomes	Single row of chromosomes
Variation	No variation

(2 × 2 + 1 for table) (5)
[12]

2.3
2.3.1 2 – X^C X^C
3 – X^c Y
6 – X^c X^c (6)

2.3.2 Incidence of colour blindness is lower in females than in males . (2)
[8]

Total Question 2: [30]

QUESTION 3

3.1
3.1.1 RY, Ry (2)
3.1.2 RrYy – heterozygous (2)
3.1.3 6,25% (2)
3.1.4 9 round, yellow
3 round, green
3 wrinkled , yellow
1 wrinkled, green (4)
[10]

3.2.1
P_1 phenotype Brown × white {1}
genotype Bb × bb {1}
Meiosis
Gametes B b × b b {1}
Fertilisation
F_2 genotype Bb : bb {1}
phenotype 1 Brown : 1 White {1}
Parents and offspring/P_2 and F_2 {1}
Meiosis and fertilisation {1} (any 6) (6)

3.2.2 number of white calves is 50% of 26 = 13 (3)

3.2.3 There is a 25% probability of producing white calves, since the brown offspring are heterozygous for the condition which means that some F_2 offspring are likely to inherit both recessive alleles coding for white, resulting in there being white calves. (4)
[13]

3.3.1

	Similarity of australopithecine with...	
	Ape	Human
Cranium	Small brain	Foramen magnum centrally located
Pelvic girdle	Not long and narrow	Bowl shaped
Feet	Divergent big toe/long toes	No short toes/parallel toes

(3 × 2 + 1 for table) [7]

Total Question 3: [30]
Total Section B: [60]

Section C
QUESTION 4

4.1

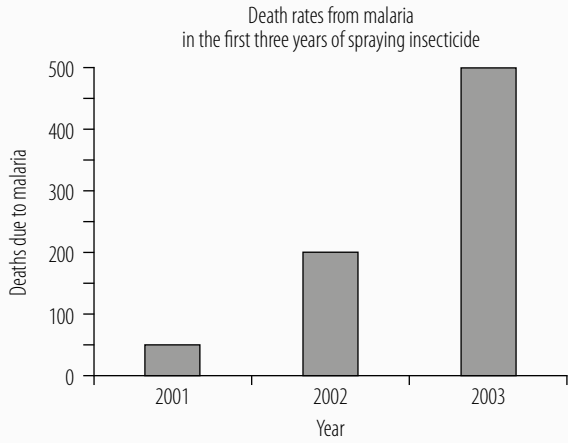
4.1.1 With time (annually) there was an increase in the percentage of mosquitoes that were resistant to pesticides, until 2005, when all were resistant. There is a progressive increase in the number of deaths from malaria. max. (4)

4.1.2 Due to random mutations, there existed variation in the population of mosquitoes. Those mosquitoes that were not resistant died when sprayed with DDT while some were resistant to DDT and survived. Those with the favourable characteristic passed it on to their offspring and over many years through natural selection, increased the number of resistant mosquitoes. max. (6)

4.1.3 DDT (1)

4.1.4 500 – 50= 450 or 45% × 1 000= 450 (3)

4.1.5



Rubric for the mark allocation of the graph (6)

Correct type of graph	1
Title of graph	1
Correct label and units for *x*-axis	1
Correct label for and units for *y*-axis	
Appropriate scale for axes	1
Drawing of the bars/plotting	1: 1–2 bars plotted correctly 2: All 3 bars plotted correctly

[20]

4.2 **Essay**

Out of Africa hypothesis

Homo sapiens arose in Africa and migrated out of the continent around 50 000 to 100 000 years ago. *Homo sapiens* replaced populations of *Homo erectus* in Asia and *Homo neanderthalensis* in Europe. Migration of *Homo erectus* from Africa into the rest of the world.

Ice age – climate changed resulting in vegetation change, competition among animals for resources. Animals migrated in search of food. Humans followed.

max. (5)

Genetic evidence (Y chromosome and mtDNA – individual ancestry)

DNA from Y chromosomes and mitochondrial DNA are used to determine individuals' ancestry.

Using DNA from Y chromosomes

Male sex chromosomes are XY and female sex chromosomes are XX. During meiosis there is no crossing over between the X-chromosome and the Y-chromosome in male sex chromosomes. DNA in the Y-chromosome is passed from father to son without any DNA from the mother. DNA from the Y-chromosome is used to trace the male ancestry. Analysis of Y-chromosome of modern humans led to a common male ancestor who lived in Africa around 50 000 years ago.

Conclusion:

- all humans alive today are genetically very similar and can interbreed.
- there are small genetic differences between modern humans as a result of adapting to their local environment. max. (4)

Mitochondrial DNA

Cells contain mitochondria – cellular respiration – ATP. Mitochondria contain DNA = mitochondrial DNA (mtDNA). Egg and sperm cells contain mtDNA in the same way as all cells. Fertilisation: mtDNA of sperm cell does not enter the egg cell because the head of the sperm penetrates the egg cell. Zygote (male or female) have mtDNA of the mother. mtDNA is used when one traces the female ancestry. Analysis of modern human using 133 types of mtDNA. All modern humans descended from a common ancestor, a woman from Africa = Mitochondrial Eve and she lived around 150 000 years ago. max. (4)

Similarities

As some populations migrated out of Africa, they carried only part of the population gene pool, which resulted in reduced variation. As each sub-group continued to migrate, they then carried even less of the previous gene pool – resulting in an even smaller gene pool, hence less genetic variation.

max. (4)

Assessing the presentation of the essay

Marks	Description
3	Well structured – demonstrates insight and understanding of question
2	Minor gaps or irrelevant information in the logic and flow of the answers
1	Attempted but with significant gaps and irrelevant information in the logic and flow of the answers
0	Not attempted/nothing written other than question number/no correct information

Content (17)
Synthesis (3)
[20]

Total Section C: [40]

GRAND TOTAL: [150]

Life Sciences Weighting Grid – Grade 12 PAPER 1

Question number	Cognitive ability levels				Meiosis	Reproduction in vertebrates	Human reproduction	Responding to the environment (humans)	Human endocrine system	Homeostasis in humans	Responding to the environment (plants)	Human impact on the environment (Gr 11)	TOTAL
	A	B	C	D									
Q1													
1.1.1		2					2						
1.1.2			2				2						
1.1.3	2						2						
1.1.4	2							2					
1.1.5	2							2					
1.1.6				2							2		
1.1.7				2							2		
1.1.8	2					2							
1.1.9	2								2				
1.1.10			*2*					2					
11	7					1	2	1	2			1	
1.3.1		2				2							
1.3.2		2							2				
1.3..3		2										2	
1.3.4		2				2							
1.3.5		2					2						
1.3.6		2						2					
1.3.7		2						2					
1.4.1 a		2					2						
1.4.1 b		2					2						
1.4.1 c		2					2						
1.4.2	1						1						
1.4.3 a	1						1						
1.4.3 b	1						1						
Q1 Total	**20**	**22**	**4**	**4**		**7**	**19**	**11**	**6**		**4**	**3**	**50**

A = knowing science B = understanding science C = applying scientific knowledge D = evaluating, analysing, synthesising

Life Sciences Weighting Grid – Grade 12 PAPER 1

Question number	Cognitive ability levels				Meiosis	Reproduction in vertebrates	Human reproduction	Responding to the environment (humans)	Human endocrine system	Homeostasis in humans	Responding to the environment (plants)	Human impact on the environment (Gr 11)	TOTAL
	A	B	C	D									
Q2													
2.1.1 a	1							1					
2.1.1 b	1							1					
2.1.2		1						1					
2.1.3				4					4				
2.2.1			2					2					
2.2.2			2					2					
2.2.3			1					1					
2.24			4					4					
2.3.1 a	1						1						
2.3.1 b	1						1						
2.3.2	1						1						
2.3.3		2					2						
2.3.4			2				2						
2.3.5				2			2						
2.4	5									5			
2.5.1	4				4								
2.5.2	1				1								
2.5.3	1				1								
2.5.4		1			1								
2.5.5			3		3								
Q 2 Total	**16**	**4**	**14**	**6**	**10**		**9**	**12**	**4**	**5**			**40**

A = knowing science B = understanding science C = applying scientific knowledge D = evaluating, analysing, synthesising

Life Sciences Weighting Grid – Grade 12 PAPER 1

Question number	Cognitive ability levels				Meiosis	Reproduction in vertebrates	Human reproduction	Responding to the environment (humans)	Human endocrine system	Homeostasis in humans	Responding to the environment (plants)	Human impact on the environment (Gr 11)	TOTAL
	A	B	C	D									
Q3													
3.1.1			2									2	
3.1.2				2								2	
3.1.3				1								1	
3.1.4				2								2	
3.1.5			2									2	
3.2.1		1										1	
3.2.2		3										3	
3.2.3		2										2	
3.2.4				4								4	
3.3.1	1											1	
3.3.2	2											2	
3.3.3				3								3	
3.4.1			2										
3.4.2			2								2		
3.4.3			2								2		
3.4.4			2								2		
3.4.5 a	1										2		
3.4.5 b	1							5			1		
3.5		5									1		
Q3 Total	**5**	**11**	**12**	**12**				**5**			**10**	**25**	**40**

A = knowing science B = understanding science C = applying scientific knowledge D = evaluating, analysing, synthesising

Life Sciences Weighting Grid – Grade 12 PAPER 1

Question number	Cognitive ability levels				Meiosis	Reproduction on in vertebrates	Human reproduction	Responding to the environment (humans)	Human endocrine system	Homeostasis in humans	Responding to the environment (plants)	Human impact on the environment (Gr 11)	TOTAL
	A	B	C	D									
Q4	15	2		3				12	8				20
Q1 total	20	22	4	2		7	19	11	6		4	3	50
Q2 total	16	4	14	6	10		9	12	4	5			40
Q3 total	5	11	12	12				5			10	25	40
Q4 total	15	2		3				12	8				20
Actual marks	56	39	30	25	10	7	28	40	18	5	14	29	150
Norm %	40	25	20	15	7	4	21	27	10	7	7	17	100%
Marks	60	37,5	30	22,5	11	6	31	40	15	11	11	25	150

A = knowing science B = understanding science C = applying scientific knowledge D = evaluating, analysing, synthesising

Life Sciences Weighting Grid – Grade 12 PAPER 2

Question number	Cognitive ability levels				DNA: Code of life	Meiosis	Genetics and inheritance	Evolution through natural selection	Human evolution	Total
	A	B	C	D						
1.1.1	2				2					2
1.1.2			2		2					2
1.1.3	2						2			2
1.1.4		2					2			2
1.1.5			2				2			2
1.2										
1.2.1	1							1		1
1.2.2	1									1
1.2.3	1				1				1	1
1.2.4	1						1			1
1.2.5	1							1		1
1.2.6	1							1		1
1.3										
1.3.1		2						2		2
1.3.2		2					2			2
1.3.3		2							2	2
1.3.4		2						2		2
1.3.5		2			2					2
1.3.6		2							2	2
Actual Marks	**10**	**14**	**4**		**7**		**9**	**7**	**5**	**28**

A = knowing science B = understanding science C = applying scientific knowledge D = evaluating, analysing, synthesising

Life Sciences Weighting Grid – Grade 12 PAPER 2

Question number	Cognitive ability levels				DNA: Code of life	Meiosis	Genetics and inheritance	Evolution through natural selection	Human evolution	Total
	A	B	C	D						
1.4.1			2							
1.4.2			2							
1.4.3	1				8					8
1.4.4				3						
1.5										
1.5.1	3									
1.5.2		3					8			8
1.5.4			2							
1.6										
1.6.1		2								
1.6.2		2							6	6
1.6.3			2							
Actual Marks	**4**	**7**	**8**	**3**	**8**		**8**		**6**	**22**

A = knowing science B = understanding science C = applying scientific knowledge D = evaluating, analysing, synthesising

Life Sciences Weighting Grid – Grade 12 PAPER 2

Question number	Cognitive ability levels				DNA: Code of life	Meiosis	Genetics and inheritance	Evolution through natural selection	Human evolution	Total
	A	B	C	D						
2.1										
2.1.1	1	1								
2.1.2				2						
2.1.3				2	10					10
2.1.4				2						
2.1.5	2									
2.2										
2.2.1	2	2								
2.2.2	2									
2.2.3	1					12				12
2.2.4	5									
2.3										6
2.3.1			6				6			2
2.3.2				2			2			
3.1										
3.1.1			2							
3.1.2			2				10			10
3.1.3		2								
3.1.4	4									
Actual Marks	**17**	**5**	**10**	**8**	**10**	**12**	**18**			**40**

A = knowing science B = understanding science C = applying scientific knowledge D = evaluating, analysing, synthesising

Life Sciences Weighting Grid – Grade 12 PAPER 2

Question number	Cognitive ability levels				DNA: Code of life	Meiosis	Genetics and inheritance	Evolution through natural selection	Human evolution	Total
	A	B	C	D						
3.2										
3.2.1		4	2							
3.2.2	3						13			13
3.2.3			2	2						
3.3	1		6						7	7
4.1										
4.1.1				4						
4.1.2								20		20
4.1.3	1									
4.1.4		7								
4.2	10	7		3					20	
Actual Marks	**15**	**18**	**18**	**9**			**13**	**20**	**27**	**40**
Q1	14	21	12	3	15		17	7	11	50
Q2	13	3	6	8	10	12	8			30
Q3	8	6	14	2			23		7	30
Q4	11	14	8	7				20	20	40
Totals	**46**	**44**	**40**	**20**	**25**	**12**	**48**	**27**	**38**	**150**
Norm %	40	25	20	15						
Marks	60	37,5	30	22,5						

A = knowing science B = understanding science C = applying scientific knowledge D = evaluating, analysing, synthesising

SECTION E

PHOTOCOPIABLE SHEETS

The assessment grids on the following pages may be photocopied for use with the Life Sciences Grade 12 Learner's Book.

Teacher assessment

Diagnostic assessment

Name: _____ Date: _____

Specific aim(s)/ criteria	Skills successfully achieved	Skills needing attention	Follow-up comments

Teacher assessment

Summative assessment

Name: _____

Activity: _____ Date: _____

(Please tick ✓ the appropriate column)

Specific aim(s)/ criteria	Exceptional competence	Progress is fast	Progress is consistent	Progress is slow	Unable to do task

Teacher assessment

Summative/formative assessment

Name: _____

Date	Activity	Criteria	Observations and comments

Teacher assessment (class list)

Summative assessment

Activity: _____ Date: _____

Specific aim(s): _____

(Please tick ✓ the appropriate column)

Learner's name	Exceptional competence	Progress is fast	Progress is consistent	Progress is slow	Unable to do task

Teacher assessment

Baseline assessment

Name: ______________________________ Date: ______________________

Specific aim(s)/ criteria	Exceptionally well	More than adequate	Adequate	Needs assistance	Struggles with this	Not dealt with yet

Teacher assessment

Formative assessment

Learner's name: _____

Date: _____

Key
4 *exceeded* the requirements
3 *satisfied* the requirements
2 *partially satisfied* the requirements
1 *not satisfied* the requirements

Research-based assessment	Assignment-based assessment	Project-based assessment	Case study-based assessment	Test-based assessment

Specific aim(s)/criteria	4	3	2	1	Comments

Self assessment

Name: _____

Activity: _____ Date: _____

(Please tick ✓ the column that describes how you worked)

Criteria	Yes	No	Reasons

Teacher's assessment of the individual in a group

Learner's name: _____

Activity: _____ Date: _____

Task skills	**Yes**	**No**	**Comments**
Stays focused on task			
Understands instructions			
Can organise information			
Suggests good ideas			
Communication skills	**Yes**	**No**	**Comments**
Speaks in turn			
Listens to others			
Uses appropriate vocabulary			
Social skills	**Yes**	**No**	**Comments**
Explains or shares ideas			
Encourages others			
Participates actively			

Self assessment/Peer assessment/ Group assessment

Name: _____

Activity: _____ Date: _____

Remember this is an opportunity for you to:

- be honest about what you know
- think about what you need help with
- watch and record your progress
- feel confident about your learning.

Key
4 *exceeded* the requirements
3 *satisfied* the requirements
2 *partially satisfied* the requirements
1 *not satisfied* the requirements

Criteria	4	3	2	1	What I think

Self assessment

My name: _____

Activity: _____ Date: _____

I could do this:	
I found this difficult:	

Self assessment on group work

My name: _____

Activity: _____

Date: _____

Key
4 *exceeded* the requirements
3 *satisfied* the requirements
2 *partially satisfied* the requirements
1 *not satisfied* the requirements

(Please tick ✓ the column that describes how well you worked in your group)

Criteria	4	3	2	1	Comments
I worked well in my group					
I listened to the other group members					
I contributed some of my own ideas					
I thought about solutions to the problem					
I asked questions					
I learnt from the other group members					

Peer assessment

First discuss what criteria you are going to assess with your teacher and your partner.

Name: _____

Activity: _____ Date: _____

What my partner did well:
What my partner could do better:

Peer and self assessment

My name: _____

My partner's name: _____

Activity: _____ Date: _____

(Please tick ✓ the appropriate column)

		Yes	No
Did I complete the task?			
Did my partner complete the task?			
What I could do well:			
What my partner could do well:			
What I need to practise:			
What my partner needs to practise:			

Group assessment

Names of group members: _____

Activity: _____ Date: _____

(Please tick ✓ the appropriate column)

	Yes	No
We worked well together		
We helped each other		
We took turns		
We completed the activity		
We enjoyed the activity, because:		
We did not enjoy the activity, because:		

Parent/Guardian assessment

I am assessing the work of: _____ Date: _____

(Please tick ✓ the appropriate column)

	Good	Fair	Needs attention
Understanding of the work			
Presentation of the work			
Accuracy			
Attitude towards the work			
Other comments:			
Signature: _____			

School closing date: _____

School opening date: _____

Principal's signature: _____ Date: _____

Teacher's signature: _____ Date: _____

Parent's/ Guardian's signature: _____ Date: _____

[School stamp]

Report card

[Name of school]

Name: _____

Grade: _____

Date of birth: _____

Year: _____ Term: _____

Attendance: _____ out of _____school days

Subject	Learning achieved (code)	Learner's competencies/strengths (description)	Support needed (description)
Languages: Home language			
Languages: First Additional Language			
Languages: (Optional) Second Additional Language			
Mathematics			
Life Orientation			
Group B Subject 1:			
Group B Subject 2:			
Group B Subject 3:			

General comments: _____

_____

_____

_____

Description of national codes

7 Outstanding	6 Meritorious	5 Substantial	4 Adequate
3 Moderate	2 Elementary	1 Not achieved	

SECTION F

DOCUMENTS

You may add any other documents you receive in this section and list them for easy reference.

Grade 12

Study & Master

Life Sciences

Study & Master Life Sciences Grade 12 has been especially developed by an experienced author team for the Curriculum and Assessment Policy Statement (CAPS). This easy-to-use course helps learners to master essential content and skills in Life Sciences.

The comprehensive Learner's Book includes:

- an expanded contents page indicating the CAPS coverage required for each strand
- a mind map at the beginning of each module that gives an overview of the contents of that module
- activities that help develop learners' science knowledge and skills as well as Formal Assessment tasks to test their learning
- a review at the end of each unit that provides for consolidation of learning
- case studies that link science to real-life situations and present balanced views on sensitive issues
- 'Information' boxes providing interesting additional information and 'Note' boxes that bring important information to the learner's attention.

The innovative Teacher's Guide includes:

- guidance on the teaching of each lesson for the year
- answers to all activities in the Learner's Book
- assessment guidelines
- photocopiable templates and resources for the teacher.

Annemarie Gebhardt retired as a Life Sciences Curriculum Advisor after having taught in KZN and the Western Cape where she served in national and provincial subject committees. **Peter Preethlall**, Senior Curriculum Advisor in KZN, has been a member of different curriculum development working groups and is now First National Chief Examiner as well as a National External (Umalusi) Moderator. **Sagie Pillay's** experiences as teacher, lecturer, subject advisor and Chief Examiner for Life Sciences makes him eminently suitable to be a member of the national team for training Life Sciences subject advisors.

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