Study & Master

Life Sciences

CAPS

Teacher's Guide

Grade 10

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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. The four Knowledge Strands and the order in which they should be studied in Grade 10 are:

1 Molecules to organs (Life at the molecular, cellular and tissue level)
2 Life processes in plants and animals (Processes that sustain life)
3 Environmental Studies (Biosphere to ecosystems)
4 History of life and biodiversity (Diversity, change and continuity)

This is the recommended teaching sequence in Grade 10. 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.

Table 1 shows the concept and content progression of Life Sciences.

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

Strands/grades	Molecules to organs	Life processes in plants and animals	Environmental studies	History of life and biodiversity
10	**1** Chemistry of life – inorganic and organic compounds **2** Cells: the basic 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
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
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 of Life Sciences. These are:

Specific Aim 1: Knowing Life Sciences (theory)

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

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

The relationship between specific aims, skills and assessment of Life Sciences

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

The following cognitive (thinking) skills should be developed in this specific aim:

- Acquire knowledge – action verbs to be used in assessment include: state, name, label, list, define, describe, etc.
- Understand, comprehend, make connections between ideas and concepts to make meaning of Life Sciences – action verbs 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, etc.
- Apply knowledge of Life Sciences in new and unfamiliar contexts – action verbs to be used in assessment include: demonstrate, interpret, predict, compare, differentiate, illustrate, solve, select, etc.
- Analyse, evaluate and synthesise scientific knowledge, concepts and ideas – 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, etc.

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 to every activity equally:
- follow instructions
- handle equipment/apparatus
- make observations in the following ways: do measurements, compare materials before and after treatment, observe results of an experiment/investigation, group materials or examples based on observable similarities and/or differences, counting, etc.
- record information/data in the following ways: as drawings, descriptions, in tables, graphs, etc.
- measure – measure length, volume, temperature, weight, mass, and count accurately
- interpret/translate – convert information from one form into another, e.g. converting a table into an appropriate graph
- design/plan investigations/experiments – Grade 10 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 an hypothesis.
3 Selecting apparatus/equipment/materials.
4 Identifying variables.
5 Suggesting ways of controlling variables.
6 Planning – making all the logistical arrangements.
7 Suggesting ways of recording results.
8 Understanding the need for replication and verification.

Specific Aim 3: Understanding the applications of Life Sciences in everyday life, understanding the history of scientific discoveries and the relationship between indigenous knowledge and science. 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:
- understanding the history and relevance of some scientific discoveries
- relationship of indigenous knowledge to 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
- 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, ecologist, ecotourism, etc.), agricultural fields, education fields.

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

Study and 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 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 concepts 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 this 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 skills), 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

ASSESSMENT

This section contains Formal Assessment Tasks, term practicals and tests.

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

Life Sciences Weighting Grid - Grade 10 PAPER 1

Question number	Cognitive ability levels				Chemistry of Life	Cells: Basic Units of Life	Cell Division: Mitosis	Plant & Animal Tissues	Plant Organs	Support & Transport in Plants	Support Systems in Animals	TOTAL
	A	B	C	D								
Actual marks												
Norm %	40	25	20	15	16	17	12	17	04	17	17	
Marks	60	37,5	30	22,5	23	25	18	29	05	25	25	150

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

Life Sciences Weighting Grid - Grade 10 PAPER 2

Question number	Cognitive ability levels				Transport System in Mammals	Biosphere to Ecosystems	Biodiversity and Classification	History of Life on Earth	TOTAL
	A	B	C	D					
Actual marks									
Norm %	40	25	20	15	20	40	07	33	
Marks	60	37,5	30	22,5	30	60	10	50	150

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

FORMAL ASSESSMENT TASKS

This section contains Formal Assessment Tasks in the Learner's Book.

Other Formal Assessment Tasks and Recommended Practical Tasks can be found in the Learner's Book.

Formal Assessment Tasks and Prescribed Practical Tasks in the Learner's Book

Learner's Book pages 17–122
Duration: 11 weeks

STRAND 1 MOLECULES TO ORGANS

Learner's Book pages 19–45
Duration: 10 hours

Unit 1 The chemistry of life

Term 1, Weeks 1–2,5

Activity number	Title	Learner's Book Page	Teacher's Guide Page
2	Testing for the presence of a carbohydrate (glucose)	26	D1
3	Testing for the presence of starch	27	D1
4	Testing for the presence of fats and oils – the translucent spot test	28	D2
6	Testing for the presence of proteins (Millon's reagent test)	33	D2
11	Investigating the effect of temperature on enzyme activity	38	D3
12	Investigating the effect of pH on enzyme activity	39	D3
15	Designing a simple investigation	41	D4

Learner's Book pages 46–75
Duration: 12 hours

Unit 2 Cells: the basic unit of life

Term 1, Weeks 2,5–5,5

Activity number	Title	Learner's Book Page	Teacher's Guide Page
1	Setting up and using a compound light microscope	49	D5
3	Observing plant cells	53	D6
4	Observing animal cells	54	D6
6	Observing diffusion in liquids	60	D8
7	Observing osmosis using potato tissue	62	D8
FAT 11	Understanding organelles	73	D9

Learner's Book pages 76–89
Duration: 8 hours

Unit 3 Cell division: mitosis

Term 1, Weeks 5,5–8,5

Activity number	Title	Learner's Book Page	Teacher's Guide Page
1	Looking at mitosis	82	D11
4	Project: cancer	87	D12

Learner's Book pages 90–122
Duration: 14 hours

Unit 4 Plant and animal tissues

Term 1, Weeks 8,5–9; Term 2, Weeks 1–2

Activity number	Title	Learner's Book Page	Teacher's Guide Page
2	Plant tissues	95	D13
FAT 3	Permanent tissues	96	D15
7	Investigating biotechnology	118	D18
8	Dicotyledonous leaf	118	D20

Learner's Book pages 123–194
Duration: 9 weeks

STRAND 2 LIFE PROCESSES IN PLANTS AND ANIMALS

Learner's Book pages 126–147
Duration: 12 hours

Unit 1 Support and transport systems in plants

Term 2, Weeks 2,5–5,5

Activity number	Title	Learner's Book Page	Teacher's Guide Page
1	Examining root and stem structure	131	D27
2	Aging trees	133	D27
3	Demonstration of transpiration through leaves	136	D27
4	Investigating the effect of environmental factors on the rate of transpiration	138	D28
FAT 7	An investigation into transpiration	142	D29
8	Demonstrating water uptake by roots and through the xylem of the plant	144	D29

Learner's Book pages 148–171
Duration: 12 hours

Unit 2 Support systems in animals

Term 2, Weeks 5,5–8,5

Activity number	Title	Learner's Book Page	Teacher's Guide Page
2	Identifying bones in the skeleton	152	D31
7	Investigating the structure and function of bones, cartilage, tendons, ligaments and joints	160	D33
FAT 8	The role of joints in locomotion	163	D34
FAT 10	Biceps and triceps	165	D34

Learner's Book pages 172–194
Duration: 12 hours

Unit 3 Transport systems in mammals (humans)

Term 3, Weeks 1–3

Activity number	Title	Learner's Book Page	Teacher's Guide Page
1	Dissection of the heart	172	D36
4	Blood vessels	182	D37
6	Pulse rates	185	D38

Learner's Book pages 195–276
Duration: 6 weeks

STRAND 3 ENVIRONMENTAL STUDIES

Learner's Book pages 197–209
Duration: 6 weeks

Unit 1 Fieldwork

Term 3, Weeks 4–9

Activity	Learner's Book Page	Teacher's Guide Page
In this strand, Unit 1 Fieldwork is the Formal Assessment Task and Prescribed Practical Activity for the Knowledge Strand. This takes place across one or two terms.	199	D52

Learner's Book pages 277–347
Duration: 5 weeks

STRAND 4 HISTORY OF LIFE AND BIODIVERSITY

Learner's Book pages 279–305
Duration: 4 hours

Unit 1 Biodiversity and classification

Term 4, Week 1

Activity number	Title	Learner's Book Page	Teacher's Guide Page
2	Grouping everyday objects	286	D87
3	Using a biological key to identify common invertebrates	287	D89
FAT 6	Exploring animal biodiversity	303	D90

Learner's Book pages 306–347
Duration: 20 hours

Unit 2 History of life on Earth

Term 4, Weeks 2–6

Activity number	Title	Learner's Book Page	Teacher's Guide Page
1	Earth's time line – from earliest times to modern life forms	312	D101
8	The fish-amphibian connection	333	D108
9	*Archaeopteryx* – the "missing link" between dinosaurs and birds	340	D109
FAT 11	Fossil tourism – a source of employment	344	D110

Formal Assessment Task Grade 10

Term 1: 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 for 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 An inorganic constituent of protoplasm is:
- **a** water
- **b** glucose
- **c** amino acids
- **d** vitamins

1.1.2 The most abundant organic compound found in the cell walls of plants is:
- **a** protein
- **b** cellulose
- **c** starch
- **d** lipid

1.1.3 Which of the following determines the differential permeability of a cell?
- **a** cytoplasm
- **b** cell wall
- **c** cytosol
- **d** cell membrane

1.1.4 Which of the following sets of features is common to both plants and animal cells?
- **a** cell membrane, cell wall, nucleus
- **b** cytoplasm, nucleus, cell membrane
- **c** chloroplasts, cell membrane, nucleus
- **d** cell membrane, cell wall, chloroplasts

1.1.5 The centrosome:
- **a** attaches two chromatids together
- **b** plays a role in cell division in plant cells
- **c** controls protein synthesis
- **d** plays a role in cell division in animal cells and lower plants only

(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 The micronutrient that is a component of the hormone thyroxine.
1.2.2 The substance that an enzyme acts on.
1.2.3 The monomers that make up proteins.
1.2.4 An organic nutrient that can serve as an insulating material against cold
1.2.5 The cell organelle concerned with the production of ATP.

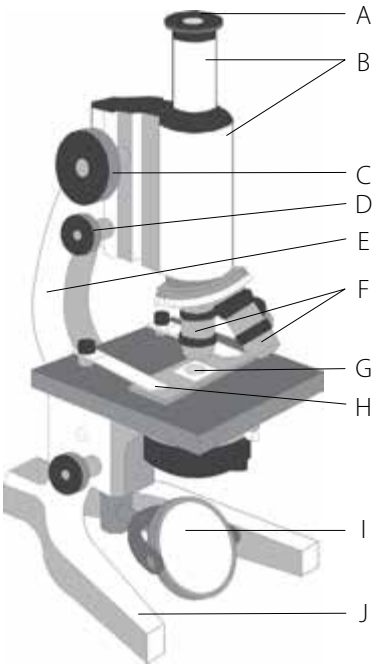
[5]

1.3 Write down the letter of the description in Column 2 that best fits the statement in Column 1.

Column 1	Column 2
1.3.1 Plays a role in the synthesis of chlorophyll	**A** Iodine
1.3.2 Deficiency may cause rickets	**B** Magnesium
1.3.3 Deficiency may cause muscular cramps	**C** Vitamin D
1.3.4 Plays a role in the clotting of blood	**D** Sodium
1.3.5 Deficiency may cause goitre in adults	**E** Nitrogen
	F Vitamin K
	G Sulphur

[5]

1.4 Study the diagram below and then indicate which letter represents each of the following parts:



1.4.1 objective lens
1.4.2 eyepiece
1.4.3 body tube
1.4.4 stage clips
1.4.5 coarse adjustment knob [5]

Total Question1: [25]

Section B

Question 2

2.1 Study the table below, which shows the results of certain tests on **five** different food types, A to E.

Food Type	Name of test and colour change		
	Benedict's/Fehling's test	Iodine test	Biuret/Millon's test
A	Orange	Yellow	Pale blue/white
B	Blue	Black	Pale blue/white
C	Orange	Yellow	Purple/brick-red
D	Blue	Black	Purple/brick-red
E	Orange	Black	Purple/brick-red

2.1.1 Which food type only contains:
- **i** Starch (1)
- **ii** Sugars? (1)

2.1.2 Which food type contains both starch and sugars? (1)

2.1.3 Which food types contain starch, sugars and proteins? (1)

2.1.4 Rice contains starch and proteins, but no sugars.
Which food type is probably rice? (1)

[5]

2.2 Some washing powders are described as having "biological" action because they contain enzymes. These powders are particularly useful for removing stains such as blood, egg, chocolate and gravy. The manufacturers suggest that such washing powders are most effective in lukewarm water, rather than cold or boiling water.

2.2.1 Why are biological washing powders more effective at removing the stains mentioned above than ordinary washing powders? (2)

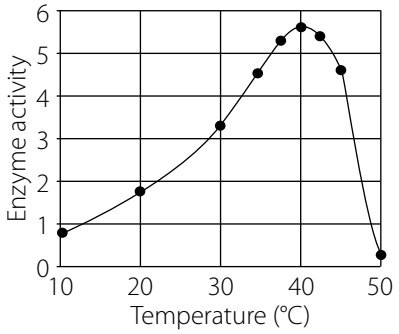
2.2.2 At which temperature in (°C) would you say the lukewarm water must be? Give a reason for your answer. (2)

2.2.3 Why do manufacturers suggest that biological washing powders are less effective at high temperatures? (2)

2.2.4 Suggest two reasons why biological washing powders are more economical than ordinary washing powders to remove stains as mentioned above. (4)

[10]

2.3 The following graph shows the effect of temperature on enzyme activity.



2.2.1 At what temperature does this enzyme act best? (1)

2.2.2
- **i** Why does raising the temperature increase enzyme activity? (2)
- **ii** Why does enzyme activity decrease above 40 °C? (2)

2.2.3 **i** What is the enzyme activity at 20 °C and 30 °C? (1)

ii By approximately how many times does the enzyme activity increase between 20 °C and 30 °C? (2)

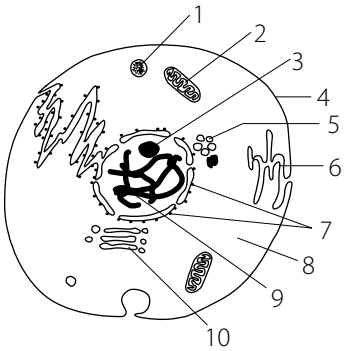
2.2.4 Name a substrate that you could add to the enzyme-substrate mixture in order to stop enzyme activity at 35 °C. Briefly explain. (2)

[10]

Total Question 2: [25]

Question 3

3.1 Study the diagram below and then answer the questions that follow.



3.1.1 Is this a plant cell or animal cell? Give two visible reasons for your answer. (3)

3.1.2 Identify the part labelled 1 and state two functions of it. (3)

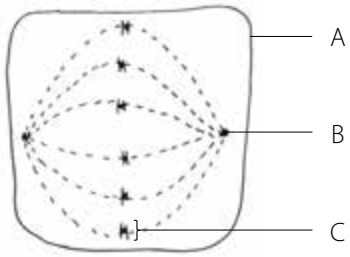
3.1.3 Which number represents a ribosome? (1)

3.1.4 Explain two ways in which part labelled 4 is structurally suited for its function. (4)

3.1.5 Draw and label an enlarged view of organelle 2 to show its structure. (4)

[15]

3.2 Study the picture, which is a diagram of a cell undergoing a phase of mitosis and answer the questions that follow.



3.2.1 Write labels for parts A, B and C. (3)

3.2.2 How many chromosomes are in the cell? (1)

3.2.3 How many chromosomes would be found in each of the daughter cells? (1)

3.2.4 How many chromosomes would be found in each of the daughter cells if this was a body cell from a human? (1)

3.2.5 Explain why two daughter cells are identical to each other and identical to the parent cell from which they were derived. (2)

3.2.6 State ONE difference in telophase between plant cells and animal cells. (2)

[10]

Total Question 3: [25]

Total Section B: [25]

TOTAL: [75]

Formal Assessment Task Grade 10

Term 1: Practical Examination

Marks: 60 **Time : 1 Hour**

1.1 The rate of water loss from the leaves of a potted plant can be measured by determining the mass of the plant at one-hour intervals. An investigation was done to determine the effect of light intensity on the rate of water loss. At each light intensity the apparatus was left for 15 minutes before determining the mass. The loss of water was then determined and recorded in the following table:

Light intensities (kilolux)	Loss of water (g/hour)
0	1
10	15
20	20
30	22
40	22

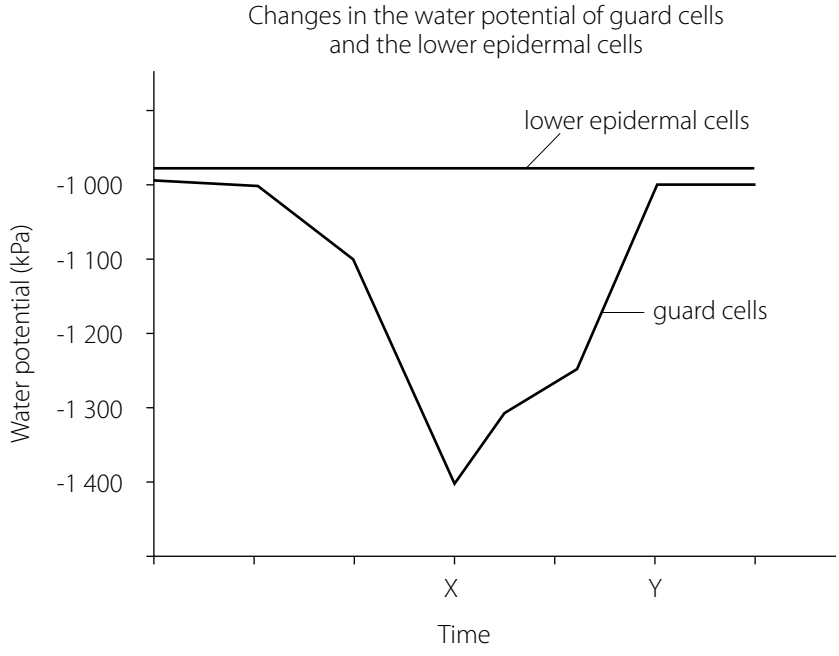
1.1.1 Describe ONE way in which the reliability of the results could be improved at each light intensity. (2)

1.1.2 Draw a line graph showing water loss at different light intensities. (11)

1.1.3 Explain why the water loss at 30 kilolux and 40 kilolux is the same. (3)

[16]

1.2 Study the graph below and answer the questions that follow.



1.2.1 State the main difference between the graphs for the lower epidermal cells and for the guard cells. (2)

1.2.2 What is the water potential of the guard cells at time X? (2)

1.2.3 Will the stomata of the plant be open or closed at time Y? Explain your answer. (3)

[7]

1.3 Study the diagrams below and answer the questions that follow.

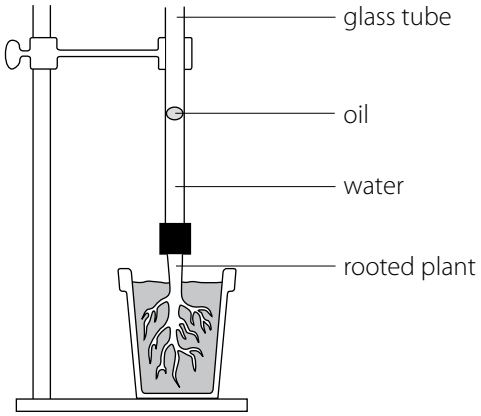


Diagram I

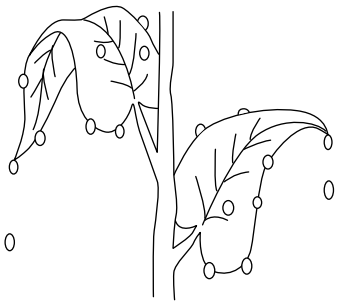


Diagram II

1.3.1 Name the process illustrated in:

i Diagram I (1)

ii Diagram II (1)

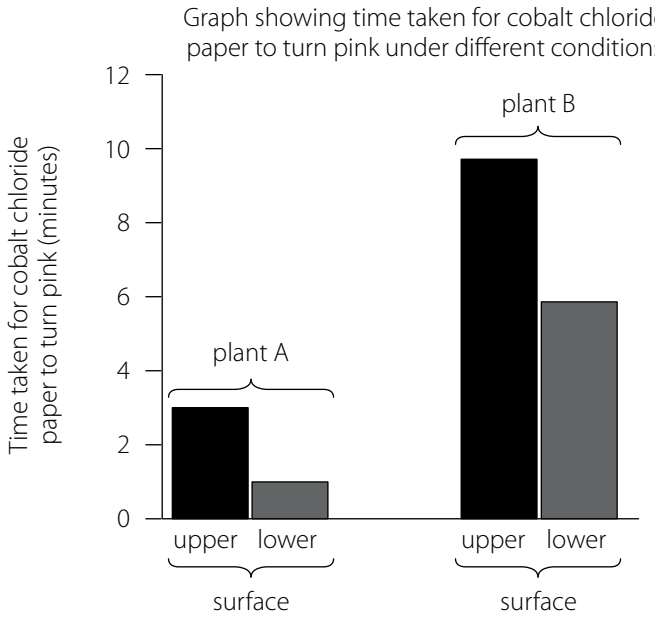
1.3.2 What is the purpose of the oil in Diagram I? (1)

1.3.3 List FOUR environmental factors which will favour the process mentioned in Question **1.3.1 ii**. (4)

1.3.4 Explain the significance of the process in Diagram I for the process in Diagram II. (4)

[11]

1.4 Study the following graph and answer the questions that follow.
Note: Cobalt chloride paper is blue when dry and turns pink when in contact with water.
Both plants, A and B, were exposed to the same environmental conditions.



1.4.1 Give a possible aim for the investigation. (1)

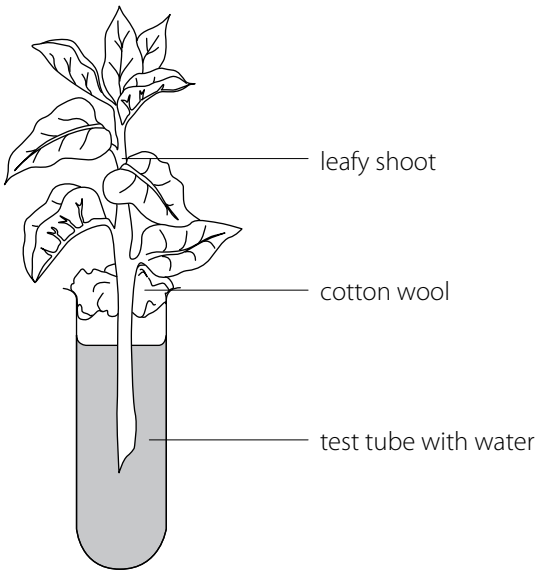
1.4.2 Which plant, A or B, is likely to have xerophytic properties? Explain your answer. (4)

1.4.3 Explain the difference between the results obtained for the upper and the lower surfaces of plant B. (2)

1.4.4 Explain how the internal temperature of plant A will be influenced if the lower surfaces of its leaves are covered with Vaseline. (5)

[12]

1.5 Study the following diagram and answer the questions that follow.
The total mass of the apparatus at the beginning of the investigation was 150 g. The apparatus standing in the classroom was then weighed at 10 minute intervals over the next 50 minutes. After 50 minutes the apparatus was taken outdoors and the weighing continued for another 50 minutes.



Apparatus used to investigate water loss from a leafy shoot

The table below shows the change in mass of the plant over time.

	Inside						Outside				
Time (minutes)	0	10	20	30	40	50	60	70	80	90	100
Change in mass (g)	0	1	3	4	5	9	11	21	24	33	39

1.5.1 Plot a line graph of these results. (10)
1.5.2 List TWO environmental factors that could have caused the greater change in mass after the 50th minute. (2)
1.5.3 Explain ONE way in which the reliability of the results could be improved. (2)
[14]

Total marks: [60]

Grade 10 Practical Examination (Memo)

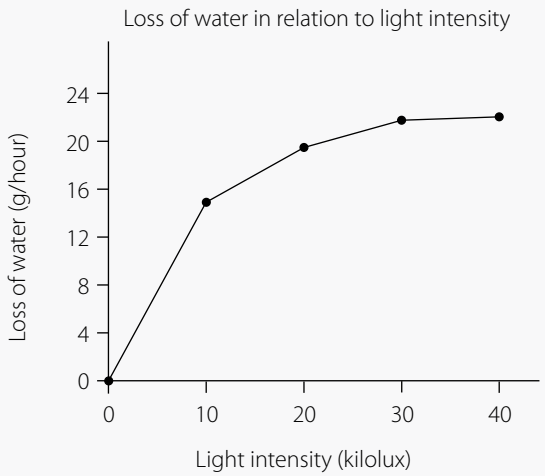
Term 1: Practical Exam

Marks: 60 Time: 1 Hour

1.1

1.1.1 More than one reading could be taken at each light intensity and the average loss calculated (2)

1.1.2



The graph is assessed according to the following criteria

Correct type of graph			**1**
Title of graph			1
Correct choice and label for *x*-axis			1
Correct choice and label for *y*-axis			1
Correct unit for light intensity			1
Correct unit for loss of water			1
Appropriate scale for *x*- axis (constant intervals)			1
Appropriate scale for *y*- axis (constant intervals)			1
Plotting of points	2: plotted all 4 points	1: plotted 2 or 3 points	0: plotted less than 2 points
All plotted points joined			1

(11)

1.1.3
- at a light intensity of 30 kilolux and higher the radius of the stomatal pore is at a maximum
- no further increase in the size of the stomatal pore
- other limiting factors preventing further increase in pore size
- thus no further increase in the rate of transpiration
- thus water loss remains constant

(*any 3*) (3)

[16]

1.2

1.2.1 The water potential of the epidermal cells remains constant and that of the guard cells varies (2)

1.2.2 1 400 kPa (2)

1.2.3 Open (1)
- at Y the water potential of the guard cells is higher
- thus the guard cells are turgid
- thin outer walls of guard cells will bulge out
- thick inner walls of guard cells will be pulled apart

(*any 2*) (2)

[7]

1.3

1.3.1 i Root pressure

ii Guttation (2)

1.3.2 To prevent the loss of water through evaporation (1)

1.3.3
- wet soil
- high humidity
- low temperature
- low light intensity
- wind still/calm conditions

(*any 4*) (4)

1.3.4
- a high root pressure
- will increase/favour guttation
- because of hydrostatic pressure
- building up in the xylem vessels
- water droplets are forced out
- at the edges and margins of the leaves

(*any 4*) (4)

[11]

1.4

1.4.1 To investigate which surface of the leaf transpires most (1)

1.4.2 B
- takes longer time for cobalt chloride paper to turn pink
- which means less water lost per unit time
- which implies the plant has adaptations
- to limit transpiration (4)

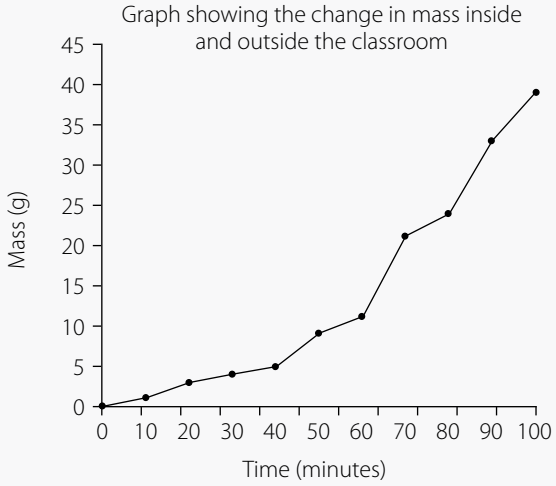
1.4.3
- more water loss through lower surface
- because of the presence of more stomata (2)

1.4.4
- temperature will be higher
- because less stomatal pores available for transpiration
- transpiration rate is lower
- thus less heat lost
- through evaporation of water (5)

[12]

1.5

1.5.1



Rubric for the mark allocation of the graph

Correct type of graph	**1**			
Title of graph	1			
Correct label for *x*-axis including correct units	1			
Correct label for *y*-axis including correct units	1			
Appropriate scale for *x*-axis	1			
Appropriate scale for *y*-axis	1			
Plotting of points for graph	3: plotted all 11 points correctly	2: plotted six or more of the points correctly	1: plotted five or less of the points correctly	0: no points plotted
All plotted points joined	1			

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

(10)

1.5.2 High light intensity
High temperature
Wind
Low humidity (*any 2*) (2)

1.5.3 Repeat the investigation several times
to compensate for human error/unforeseen variables
OR
Replace cotton wool with rubber stopper/oil layer
which is water tight/water vapour cannot
pass through. (2)

[14]

TOTAL: [60]

Formal Assessment Task Grade 10

Term 2: 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 for 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 The upward movement of water in a plant takes place through the:
- **a** xylem
- **b** phloem
- **c** parenchyma
- **d** endodermis

1.1.2 The Casparian strips are found in the:
- **a** stele of the stem
- **b** endodermis of the root
- **c** pericycle of the root
- **d** epidermis of the root

1.1.3 The bark of a tree is produced by:
- **a** primary phloem
- **b** mature bark cells
- **c** vascular cambium
- **d** cork cambium

1.1.4 Study the diagrams below.

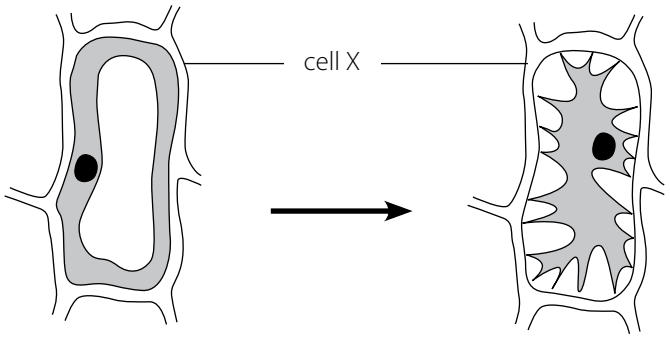


Diagram I Diagram II

Cell X has undergone physical changes from Diagram I to Diagram II.
Which of the following statements are TRUE about cell X in Diagram II?

i Cell X was boiled
ii Cell X was exposed to very hot and dry conditions
iii Cell X was placed in an isotonic solution
iv Exosmosis has taken place in cell X

a **i**, **ii** and **iv**
b **ii** and **iii**
c **i** and **iv**
d **ii** and **iv**

1.1.5 Two statements are provided below.

Statement I	Statement II
Stomata are mainly closed at night.	Water moves as a result of a higher water potential in the guard cells to adjacent cells

Which ONE of the following is correct for Statements I and II?

a Statement I is true, Statement II is false
b Statement I is false, Statement II is true
c Statements I and II are true, but Statement II does not explain Statement I correctly
d Statement I and Statement II are true, and Statement II explains Statement I correctly

(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 A plant supporting tissue composed of living cells with unevenly thickened cell walls.
1.2.2 The inner cavity formed in sclerenchyma fibres after disintegration of the living contents of the cells.
1.2.3 Modified epidermal cells, which control gaseous exchange in leaves.
1.2.4 The movement of water molecules through a differentially permeable membrane.
1.2.5 The loss of water in vapour form from the aerial parts of a plant.

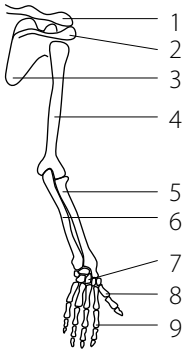
[5]

1.3 Write down the letter of the description in Column 2 that best describes the term in Column 1.

Column I	Column 2
1.3.1 ball-and-socket joint	**A** is fused to the breast-bone
1.3.2 disc of cartilage	**B** is found in the wrist
1.3.3 rib	**C** is found in the shoulder
1.3.4 sacrum	**D** is found in the base of the skull
1.3.5 foramen magnum	**E** separates two free vertebrae
	F consists of fused vertebrae
	G articulates with a transverse process
	H consists entirely of non-living material

[5]

1.4 Study the diagram below and provide labels for the parts numbered: 1, 3, 5, 7 and 9



[5]

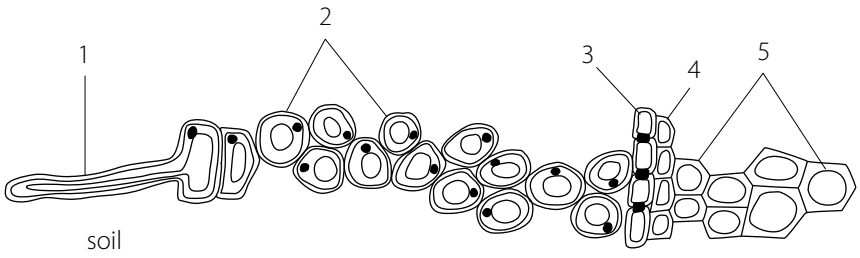
Total Question 1: [25]

Total Section A: [25]

Section B

Question 2

2.1 The diagram below represents part of a cross section through an angiosperm root. Answer the questions based on it.



2.1.1 Identify parts numbered 2, 3, 4 and 5. (4)

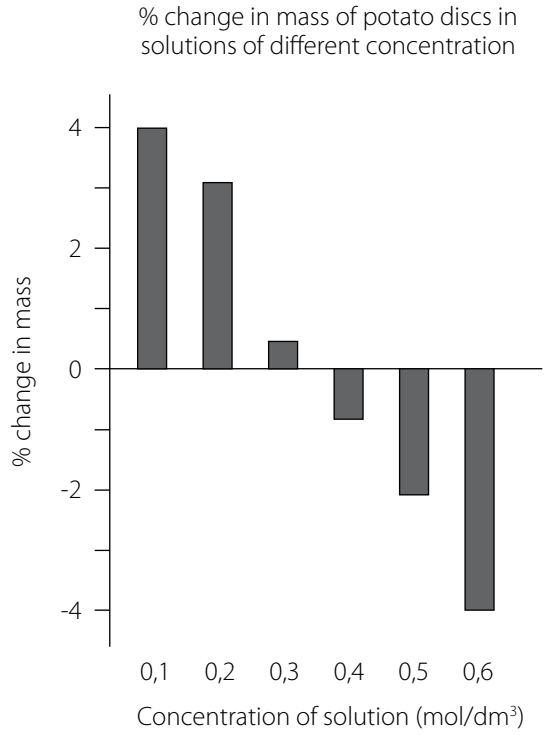
2.1.2 Describe how water enters the structure numbered 1 from the soil. (6)

[10]

2.2 A group of students carried out an investigation on osmosis.
They proceeded as follows:

- Thin discs of potato were cut and separated into batches of ten.
- Each batch (A, B, C, D, E and F) was weighed and placed into six different concentrations of salt solutions.
- Fifteen minutes later the discs of each batch were removed and the surface liquid wiped off. The discs were then weighed again.

The results are shown in the graph below.



2.2.1 Explain each of the following precautionary procedures:

i Drying the surface of the discs before re-weighing (2)

ii The use of batches of 10 discs instead of a single disc (2)

iii Waiting for 15 minutes before weighing the discs again (2)

2.2.2 Explain what has happened to the mass of the discs shown on the graph in batches:

i A, B and C (1)

ii D, E and F (1)

2.2.3 Explain the change mentioned in question **2.2.2 ii**. (3)

2.2.4 Determine from the graph the concentration of salt solution at which there will be no change in the mass of the potato discs. (2)

2.2.5 Explain why the percentage change in mass, and not the actual change in mass, is recorded in the graph. (2)

[15]

Total Question 2: [25]

Question 3

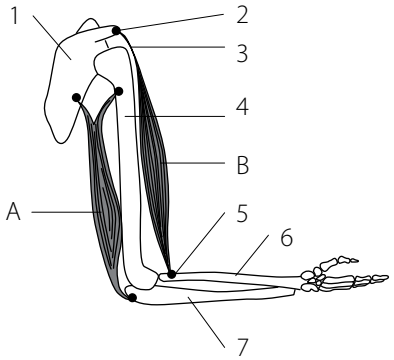
3.1 List five functions of the human skeleton. **[5]**

3.2 Complete the following table by writing the missing information next to the question numbers.

Type of joint	Description of movement	Example/s
3.2.1	Allow back and forth movement, like a door	3.2.2
Gliding	3.2.3	Wrists and ankles
3.2.4	Allow rotational movements	Shoulders and hips
Pivot	3.2.5	Between first two vertebrae of the neck

[5]

3.3 Study the diagram below and then answer the questions that follow.



3.3.1 Name the muscles A and B respectively and the structure 3. (3)

3.3.2 State one reason why it is important for structure 3 to be non-elastic. (2)

3.3.3 When the arm is in a fully straightened position, name the part that can bring it Back to the bent position shown in the diagram. (1)

[6]

3.4 People with osteoporosis have bones that break easily. In osteoporosis the bones start to lose calcium phosphate.

3.4.1 Why do osteoporotic bones break more easily? (2)

3.4.2 Why would a woman with osteoporosis become shorter in height? (2)

3.4.3 Would osteoporotic bones float more easily in water? Explain your answer. (2)

3.4.4 Why would a woman with osteoporosis become hunched as she grows older? (3)

[9]

Total Question 3: [25]

Total Section B: [50]

TOTAL: [75]

Formal Assessment Task Grade 10

Term 2: Practical Examination

The effects of environmental conditions on the rate of transpiration

For this task you are to design and carry out an investigation to see what effect wind, high temperature and high humidity have on the rate at which water is lost from plants.

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 terms of the general principles.

Guidance to learners:

1. Identify and state the problem to be investigated.
2. Identify all variables.
3. State an 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 2 Practical

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)		
Do different environmental factors/ conditions have different effects on the rate of water loss in plants?			**i** Made accurate observations/ measurements /calculations		
1.2 Stating a hypothesis			**ii** Collected consistent data		
Plants lose water at a faster rate under windy conditions and under high temperatures, than under normal conditions and under high humidity (compare with the general scoring sheet on the previous page to see whether this statement of hypothesis satisfies all of the criteria)			**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 variable. See assessment criteria for different types of graphs.		
Aim: To determine the effect of different environmental factors on the rate of water loss in plants			**iv** Provided appropriate title for graph		
i Logical aim stated			**v** Plotted points accurately		
ii Provided step-by-step detailed plan			**vi** Joined points appropriately		
iii Appropriate control/s set up			**2.3** Drawing reasonable conclusion		
iv Recognised that only one independent factor should be variable			**i** Identified tendencies and trends in data		
v Clearly stated precautions			**ii** Conclusion/s is/are relevant to the aim/hypothesis		
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 Indicated the plan for collecting/ recording data – depends on design, e.g could record distance bubble moves, difference in mass, etc.					
ii Recorded data appropriately (e.g. table, drawing, etc.)					
iii Recognised the existence of errors in data					

Formal Assessment Task Grade 10

Term 3: Test 3

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 for 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 The entire section of the Earth's surface that supports life is called the:
- **a** biome
- **b** biosphere
- **c** ecosystem
- **d** community

1.1.2 The following are found in an ecosystem:
- **i** animal population
- **ii** plant population
- **iii** community
- **iv** abiotic environment
- **v** soil

Which of the following pairs make up an ecosystem?
- **a** **i** and **ii**
- **b** **ii** and **iii**
- **c** **iii** and **iv**
- **d** **iv** and **v**

1.1.3 The place in which organisms live is called its:
- **a** habitat
- **b** niche
- **c** ecosystem
- **d** community

1.1.4 Which of the following is a physiographic factor?
- **a** light intensity
- **b** slope of the ecosystem
- **c** pH of the soil
- **d** carbon dioxide concentration in the air

1.1.5 Primary and secondary consumers are usually known as:

a carnivores and omnivores
b herbivores and carnivores
c omnivores and herbivores
d omnivores and decomposers

(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 A group of individuals of the same species.
1.2.2 The specific position and role of an organism in an ecosystem.
1.2.3 Plants that are adapted to live in very dry habitats.
1.2.4 Organisms like bacteria that feed on dead or decaying organisms.
1.2.5 The animal that is caught and eaten by a carnivorous animal.

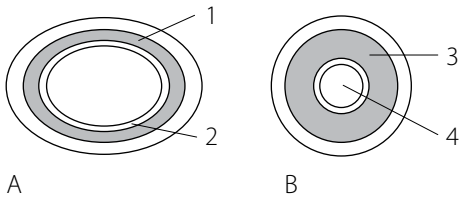
[5]

1.3 Write down the letter of the description in Column 2 that best describes the term in Column 1.

Column 1	Column 2
1.3.1 savannah	**A** twilight active
1.3.2 exothermic	**B** shade loving
1.3.3 deciduous forest	**C** body temperature depends on the environment
1.3.4 tropical rain forest	**D** body temperature is constant irrespective of the environmental temperature
1.3.5 temperate grassland	**E** biome including grass, hyenas, antelopes, zebras and lions
	F coniferous forests and relatively infertile acidic soil
	G exhibits the greatest diversity of plant species
	H the subsoil is permanently frozen
	I agriculture is commonly practiced in a "cut-burn-cultivate-abandon" mode
	J Earth and atmosphere

[5]

1.4 Study the diagrams, which show a cross-section of mammalian blood vessels, and answer the questions that follow.



1.4.1 Identify parts 1 and 4. (2)
1.4.2 Which vessel (A or B) represents an artery? Give a reason for your answer. (2)
1.4.3 Which vessel carries blood at low pressure? (1)

[5]

Total Question 1: [25]

Total Section A: [25]

Section B

Question 2

2.1 In an investigation on soils to determine the water content, permeability to water and humus content, three samples, A, B, and C of soil were taken from different places on a school ground and analysed. The results are indicated in the table below.

	A	B	C
Water content (%)	25	10	50
Permeability to water (ml of water passing through 100 g soil in 1 minute)	20	45	5
Humus content (%)	15	5	10

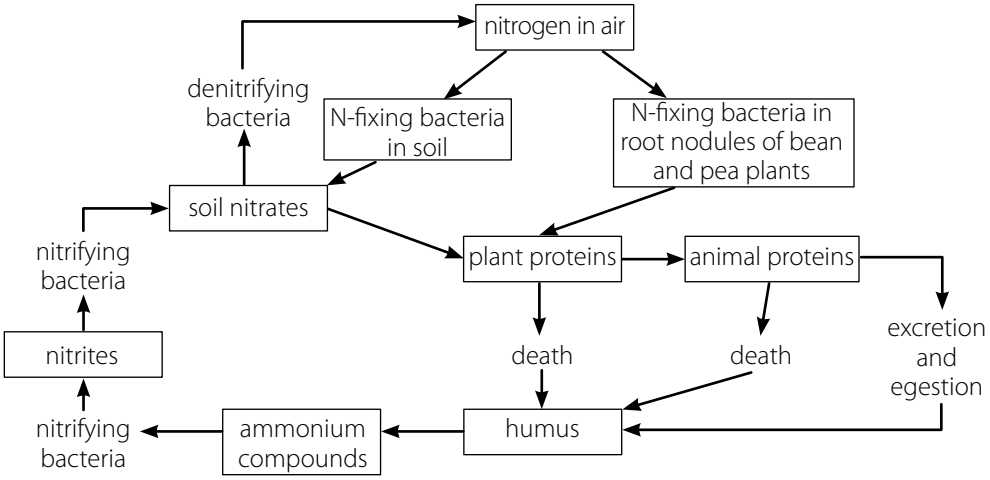
2.1.1 Which soil sample would you consider to be the best for plant growth? Suggest ONE reason for your answer. (2)

2.1.2 Which soil would most easily become waterlogged? Suggest ONE reason for your answer. (2)

2.1.3 In which of the soils will plants wither the quickest? Suggest ONE reason for your answer (2)

[6]

2.2 The flow diagram below represents the nitrogen cycle. Answer the questions based on it.



2.2.1 Why do plants require nitrates? (1)

2.2.2 How do plants obtain nitrates from the soil? (1)

2.2.3 If soils lack nitrates, farmers may try to improve such soils by adding artificial fertiliser containing ammonium salts. Suggest how this would improve the soil. (2)

2.2.4 Suggest another method farmers could use to achieve the same results as using artificial fertiliser. (2)

2.2.5 Explain why denitrifying bacteria are regarded as a nuisance to the farmer. (2)

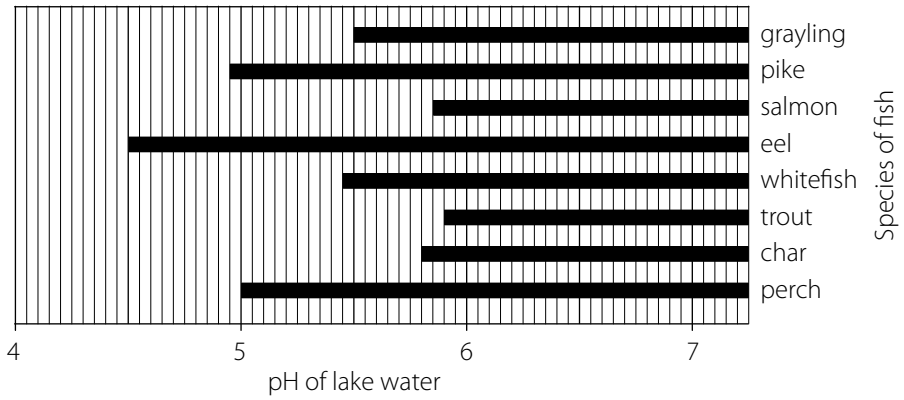
2.2.6 In a natural habitat the amount of nitrate available in the soil for the plants to use would be approximately the same every growing season. Suggest how this would change if the natural area was ploughed and used to grow maize for many years. (2)

2.2.7 Some farmers grow leguminous plants such as peas and beans as an alternative to maize some years. Suggest TWO ways in which the leguminous plants can be useful to the farmer. (2)

2.2.8 Explain why nitrate levels are often low in waterlogged soils. (2)

[14]

2.3 The graph below shows the effect of pH on the biodiversity of fish species in a freshwater habitat. Answer the questions based on it.



2.3.1 Identify the species that favours:

i the lowest pH (1)

ii the highest pH (1)

2.3.2 At which pH are the following species found?

i pike (1)

ii perch (1)

iii trout (1)

[5]

Total Question 2: [25]

Question 3

3.1 Read the following extract and then answer the questions which follow.

The Namib Desert stretches for 300 km along the Atlantic Ocean coast of Namibia. Very little rain falls in the Namib Desert. Most of the moisture needed by the organisms that live here is blown in over the desert as a thick mist from the sea.

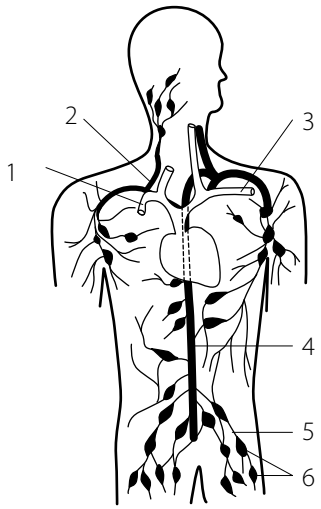
Many organisms live on the sand dunes and in the valleys between the dunes, forming a desert community. Ants, crickets, beetles, beetle larvae and termites all feed off seeds and bits of organic matter, which the wind carries inland from the coast. The ants are eaten by ant lion larvae, which hide in the sand. Spiders feed on the termites. Scorpions eat beetle larvae and spiders. Sun spiders, which are not true spiders, devour the scorpions as well as the beetles and beetle larvae. Lizards eat spiders, beetles and sun spiders. The side-winder feeds on the lizards.

3.1.1 Use the organisms mentioned in the passage to draw a food pyramid with seven levels. (7)

3.1.2 Explain what would happen to the ecosystem if the number of organisms in the third trophic level increased drastically. (3)

[10]

3.2 Study the diagram of the lymphatic system and answer the questions that follow.



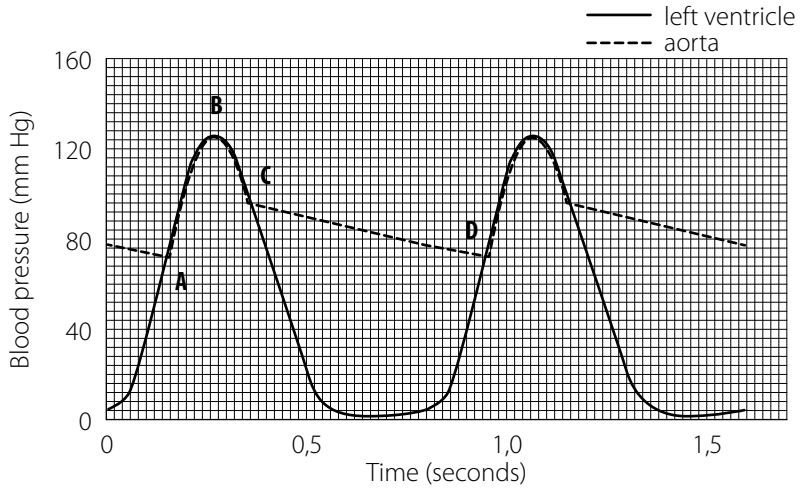
3.2.1 Identify the ducts numbered 2 and 4 (2)

3.2.2 Identify the structures numbered 6 and state their functions. (2)

3.2.3 How would the composition of the lymph in duct 4 differ from that in duct 2? Suggest a reason for your answer. (2)

[6]

3.3 The graph below shows the blood pressure in the left ventricle and aorta during two consecutive heartbeats. Study the graph and answer the questions that follow.



3.3.1 How long does:

i one complete heartbeat, and (1)

ii ventricular diastole last? (1)

3.3.2 For how long during each heartbeat is the semi-lunar valve closed? Explain your answer. (3)

3.3.3 Briefly explain how blood pressure is generated in the left ventricle. (4)

[9]

Total Question 3: [25]

Total Section B: [50]

TOTAL: [75]

Formal Assessment Task Grade 10

Term 3: Practical Examination

Dissection of sheep/cow/pig heart

Instructions

You will need the following:

- a fresh sheep/cow/pig heart from the local butcher
- a scalpel or knife
- dissecting needles
- label flags
- dissecting board to cut on
- a pair of sharp scissors
- forceps or tweezers
- pins
- newspaper

- Collect a dissecting board, newspaper, sharp scalpel/knife, forceps, dissecting needles, scissors, pins and label flags from your teacher
- Fetch a heart and place it on the board or newspaper

1 External structure of the heart

1.1 Look for the large rubbery white blood vessel and a slightly narrower (smaller) vessel at one end of the heart. This end is the upper end.
Now place the heart on the board with the upper end towards you.
Examine the heart closely and describe the outer covering. (2)

1.2 Describe what the entire heart feels like. (2)

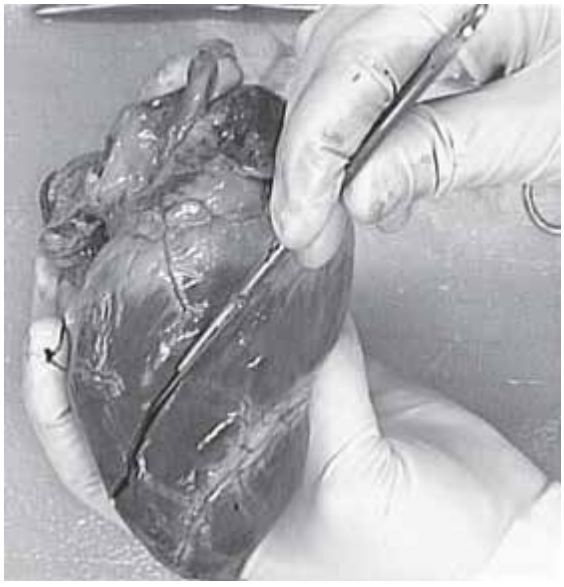
1.3 Now compare what the upper end and the lower end feels like. (2)

1.4 Draw and label the external view of the heart. (10)
Marks will be awarded for the following: proportion; position of parts; shape; caption and labels

[16]

2 Internal structure of the heart

2.1 Cut open the heart as indicated in the photograph below.



2.2 Now separate the cut portion from that on the board and pin it to the board. Describe what you observe. (4)

2.3 Prepare your label flags with the following labels: septum, right atrium, left atrium, right ventricle, left ventricle

Now identify these parts on the heart and place the label flags on it. (5)

Do not remove the labels until your teacher has seen it.

2.4 Which chambers have a larger volume? (1)

2.5 Which chambers are more muscular (upper or lower)? (1)

2.6 Suggest a reason for your answer in **2.5** (2)

2.7 Use the blunt end of the dissecting needle and insert it into one of the two vessels at the top end of the heart. Into which chamber does it enter? (1)

2.8 Now identify this vessel (1)

2.9 Use the blunt end of the dissecting needle and insert it into the other vessel at the top end of the heart. Into which chamber does it enter? (1)

2.10 Now identify this vessel (1)

2.11 To observe how the valves work pour some water into each of the above vessels (one at a time) and describe what you observe. (2)

2.12 **Accuracy will be judged by teacher and marks recorded in the scoring sheet for dissection. Teacher must also make a judgement on the quality of dissection and record this in the scoring sheet.** (5)

[24]

TOTAL: [40]

Criteria for assessing heart dissection

Grade: __________________ Teacher: ____

Names of learners	Quality of dissection			Identification of parts					Other aspects of worksheet	Total
	Very neat, chambers clearly demarcated, no distortion	2- 3 chambers clearly demarcated, with a little distortion	Poorly performed – great deal of distortion	Septum	Right atrium	Left atrium	Right ventricle	Left ventricle		
Marks	5	3	1	1	1	1	1	1	30	40

Formal Assessment Task Grade 10

Term 4: Test 4

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 for 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 Classification systems can be:
- **a** artificial, e.g. grouping plants according to the colour of their flowers
- **b** natural, e.g. the phylogenetic groupings of insects into various classes
- **c** used on plants, animals, bacteria, fungi and protists
- **d** all of the above

1.1.2 Which one of the following rules does not apply to binomial nomenclature?
- **a** both names are always printed in italics
- **b** both names are always underlined when hand written
- **c** both names are usually in Latin or in another ancient language
- **d** the species name is always written first, followed by the generic name

1.1.3 An outstanding characteristic of bacteria is that they:
- **a** usually contain chlorophyll
- **b** possess no nuclear material
- **c** need light for growth
- **d** possess a cellulose cell wall

1.1.4 Which statement about global diversity is not true?
- **a** to date every living organism on Earth has been fully classified
- **b** International Biodiversity Day is celebrated every year on 22 May
- **c** the diversity of frog species is rapidly declining, leading them towards extinction
- **d** South Africa has very high biodiversity

1.1.5 A characteristic common to protozoa is that all of them:
- **a** form pseudopodia
- **b** are unicellular
- **c** live parasitically
- **d** have contractile vacuoles

(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 A branched diagram that shows the linear evolutionary history of descendents from an ancestral species.

1.2.2 A term used to describe an underdeveloped organ, such as wisdom teeth and the appendix of humans.

1.2.3 The occurrence of plant and animal species in only one locality, usually a small area, and nowhere else.

1.2.4 A practical device used by biologists to unlock the correct name of an unknown organism, using features and characteristics of that organism.

1.2.5 The science of classification.

[5]

1.3 Write down the letter of the term in column II that best fits the description in column I.

Column I	Column II
1.3.1 The lowest level in a classification hierarchy	A Kingdom B Genus C Species D Chordata E Class F Venn diagram G Family H Taxonomy
1.3.2 Phylum that includes vertebrates	
1.3.3 Moths, ants, and ant-lions belong to the same	
1.3.4 Mosses, ferns, and grasses belong to the same	
1.3.5 Group name for the most closely related species	

[5]

1.4 Complete the table below by indicating the missing information next to the relevant number.

Common name of fossils	Species	Where found	Discovered by
Tuang Child	*Australopithecus africanus*	1.4.1	1.4.2
Mrs Ples	1.4.3	Sterkfontein caves	Robert Broom
1.4.4	*Australopithecus africanus*	1.4.5	Ron Clark

[5]

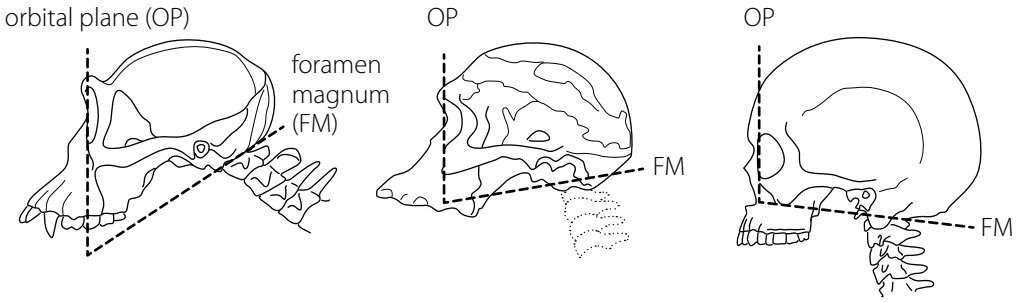
Total Question 1: [25]

Total Section A: [25]

Section B

Question 2

2.1 Study the structural differences in the three skulls shown below.



2.1.1 Describe the changes to the position of the foramen magnum (the opening at the base of the skull where the spinal column passes through) from the chimpanzee to *Homo sapiens*. (3)

2.1.2 Explain how these changes may have contributed to bipedalism in hominins. (5)

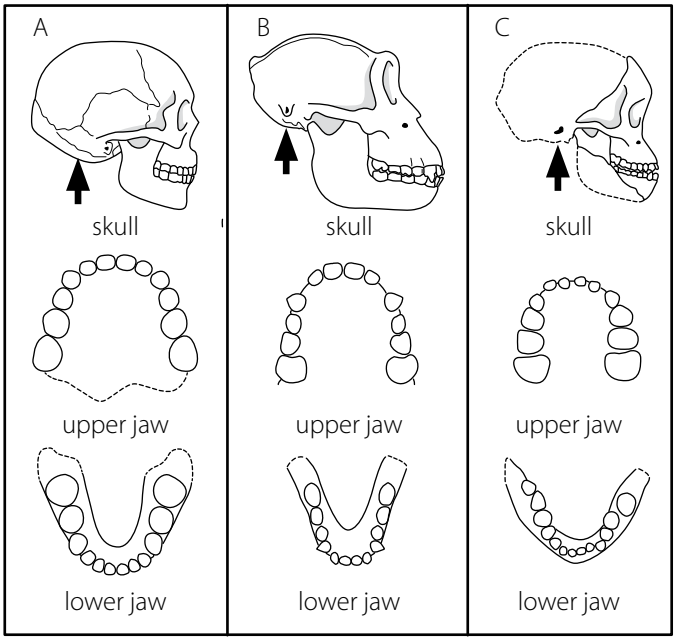
2.1.3 Chimpanzees have opposable thumbs and also opposable big toes. This means that there is a wide cleft between the thumb/toe and the remaining four digits. However, in hominins, the toes are all parallel to one another.

i What may be the possible evolutionary benefits to hominins of developing non-opposable toes? (4)

ii What may be the evolutionary benefits to humans of retaining the opposable thumb? (3)

[15]

2.2 The following diagrams represent the skull, the upper jaw and the lower jaw of the Taung child (*Australopithecus africanus*), a modern human (*Homo sapiens*) and a chimpanzee (*Pan troglodytes*). The arrow indicates the position of the foramen magnum. Study the diagrams and answer the questions that follow.



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

2.2.2 Assuming that the diagrams were drawn to scale, list TWO observable differences between the skulls of organisms A and B. (2)

2.2.3 Which of A, B or C represents a carnivore? (1)

2.2.4 Explain your answer in **2.2.3** using the features visible in the diagram. (2)

2.2.5 By looking at the position of the foramen magnum (indicated by the arrow) state which TWO organisms are best adapted for walking on two legs rather than four. (2)

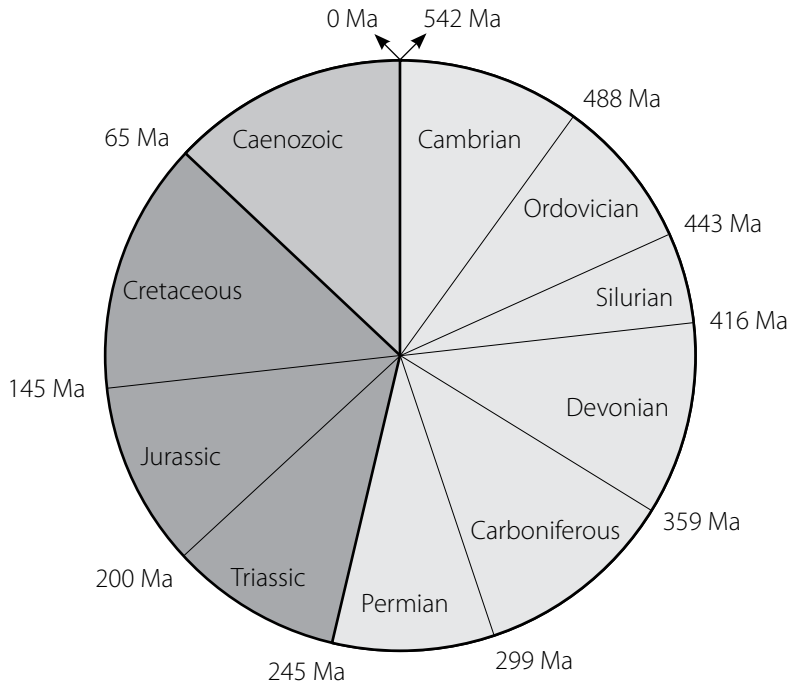
[10]

Total Question 2: [25]

Question 3

3.1 Study the pie chart below which shows some geological periods of the three eras and answer the questions that follow.

Some geological periods of the three eras



3.1.1 Which of the three eras had the longest duration? (1)

3.1.2 The biggest mass-extinction took place 250 million years ago.

i State in which era this occurred. (1)

ii State in which period this occurred. (1)

3.1.3 In which era did modern humans first appear on Earth? (1)

3.1.4 Scientists think that "something large" from outer space struck the Earth when the Cretaceous period ended

i How many years ago did this "something large" strike the Earth? (1)

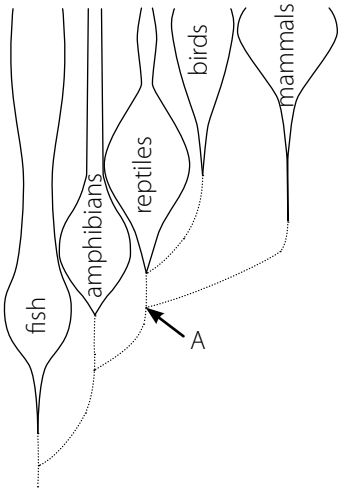
ii Name a possible structure that hit the Earth at the end of the Cretaceous period. (1)

iii Describe how this structure named in Question **3.1.4 ii** could have caused the mass extinction of many species. (4)

3.1.5 The half-life of C^{14} is 5 730 years and the half-life of uranium is 700 million years. Explain which of C^{14} or uranium should be used to calculate the age of dinosaur fossils. (3)

[13]

3.2 Study the diagram below, which shows the relative number of species in the five vertebrate classes (fish, amphibians, reptiles, birds and mammals). The distance between the two lines in each class gives an indication of the number of species.

ERA	Period	Time (million years ago)	Vertebrate fossils
CENOZOIC	Quaternary	100	
	Tertiary		
MESOZOIC	Cretaceous	200	
	Jurassic		
	Triassic	300	
PALAEOZOIC	Permian		
	Carboniferous		
	Devonian	400	
	Silurian		
	Ordovician	500	
	Cambrian		
	Pre-Cambrian	600	

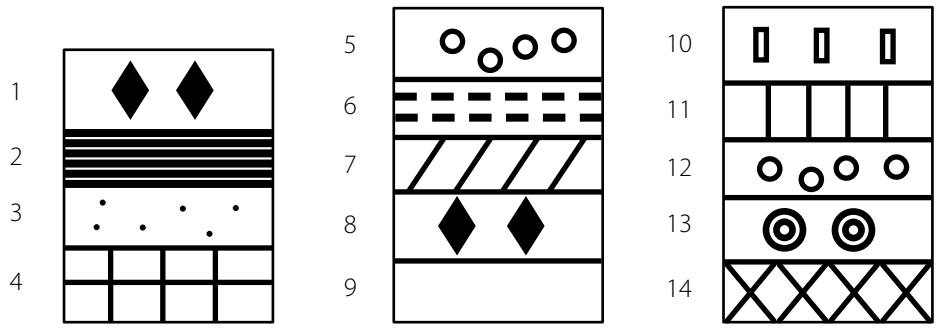
3.2.1 During which geological period were the most species of amphibians present? (1)

3.2.2 Describe the changes in the number of reptiles and mammals during the Cretaceous period. (4)

[5]

3.3 Some fossils are typical of a particular period of the Earth's history. Certain fossil organisms have lived only in that period and it is then possible to tell the age of the rock in which they are found. Such fossils are called index fossils. A typical index fossil is the trilobite that lived in the oceans during the Palaeozoic era. At the end of this era they became extinct. If rock contains trilobites, we can conclude that the rock was formed during that era.

Three different strata (different layers of soil/rock) from three places in a particular area are illustrated below.



Different layers of soil/rock in three different places

The symbols below are used to indicate the four different index fossils found in the different strata in places A, B and C.

3.3.1 Explain why layers 1 and 8 are of the same geological age. (2)

3.3.2 Indicate TWO layers, other than layers 1 and 8, that have the same geological age. (2)

3.3.3 Name a method used to determine the age of a fossil. (1)

3.3.4 State TWO reasons why there are gaps or missing information in the fossil record. (2)

[70

Total Question 3: [25]

Total Section B: [50]

TOTAL: [75]

Formal Assessment Task Grade 10 (Memo)

Term 1: Test 1

Marks: 75 Time: 1 Hour

Section A
QUESTION 1
1.1
1.1.1 **a**
1.1.2 **b**
1.1.3 **b**
1.1.4 **b**
1.1.5 **d**

(5 × 2) **[10]**

1.2
1.2.1 iodine
1.2.2 substrate
1.2.3 amino acids
1.2.4 lipid
1.2.5 mitochondrion **[5]**

1.3
1.3.1 **E**
1.3.2 **C**
1.3.3 **B**
1.3.4 **F**
1.3.5 **A** **[5]**

1.4
1.4.1 **F**
1.4.2 **A**
1.4.3 **B**
1.4.4 **H**
1.4.5 **C** **[5]**

Total Question 1: [25]

Section B
QUESTION 2
2.1
2.1.1 i **B** (1)
ii **A** (1)
2.1.2 **E** (1)
2.1.3 **E** (1)
2.1.4 **D** (1)
[5]

2.2
2.2.1 Stains contain organic compound such as carbohydrates, lipids and proteins. Biological washing powder easily reacts with these compounds. (2)
2.2.2 Approximately 37 °C – that is the optimum temperature for enzyme action. (2)
2.2.3 High temperatures alter the shape of the enzyme molecules. The enzyme is denatured and loses its shape and function. (2)
2.2.4 Less washing powder is needed and lukewarm water requires less energy to heat up. (4)
[10]

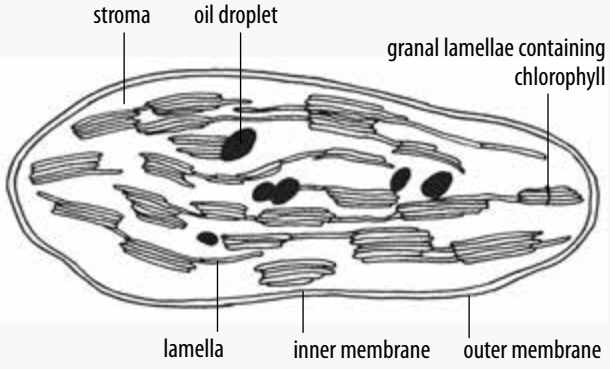
2.3
2.3.1 40 °C (1)
2.3.2 i The rate of movement of substrate molecules increases. The substrate molecules collides with enzyme molecules more often. (2)
ii The enzyme becomes denatured. It loses its shape and catalytic function stops. (2)
2.3.3 i At 20 °C: 1,7 and at 30 °C: 3,3 (1)
ii 2 times (2)
2.3.4 An acid, because the enzyme involved functions in an alkaline medium; acid lowers the pH of the medium and at low pH the enzyme becomes denatured. (2)
[10]

Total Question 2: [25]

QUESTION 3
3.1
3.1.1 Plant cell • possesses cell wall
• and chloroplasts (3)
3.1.2 Cell wall • protects the living contents against damage
• gives rigidity
• gives strength
• supports the cell *max* (3)
3.1.3 5 (1)
3.1.4 4 is the mitochondrion
- it consists of a double membrane with the inner one folded into cristae
- the cristae increases the surface area for enzyme activity, hence making the process of cellular respiration more efficient
- enzymes are present between the membranes as well as in the matrix
- making the process of cellular respiration more efficient

(4)

3.1.5



(4)
[15]

3.2
3.2.1 A: cell membrane B: centriole C: chromosome (3)
3.2.2 6 (1)
3.2.3 6 (1)
3.2.4 46 (1)
3.2.5 One daughter cell has one half of a chromosome (one chromatid) that has an identical half (one chromatid) in the other daughter cell. (2)
3.2.6 During telophase – cytokinesis takes place. In plant cells cytokinesis occurs through vesicles which fuse to form a cell plate between the daughter cells. In animal cells, cytokinesis occurs through a furrowing process. (2)
[10]

Total Question 3: [25]
TOTAL: [75]

Formal Assessment Task Grade 10 (Memo)

Term 2: Test 2

Marks: 75 Time: 1 Hour

Section A
QUESTION 1
1.1
1.1.1 **a**
1.1.2 **b**
1.1.3 **d**
1.1.4 **d**
1.1.5 **d**
(5 × 2) **[10]**

1.2
1.2.1 collenchyma
1.2.2 lumen
1.2.3 guard cells
1.2.4 osmosis
1.2.5 transpiration **[5]**

1.3
1.3.1 **C**
1.3.2 **E**
1.3.3 **G**
1.3.4 **F**
1.3.5 **D** **[5]**

1.4 1 clavicle 3 scapula 5 radius 7 carpals 9 phalanges **[5]**
Total Question 1: [25]

Section B
QUESTION 2
2.1
2.1.1 2 – cortex/parenchyma cells 3 – endodermis
4 – pericycle 5 – xylem (4)
2.1.2
- the water potential of the soil solution is higher than that of the cell sap of the root hair
- water diffuses along a water potential gradient from the soil solution by osmosis
- through the permeable cell wall and differentially permeable cell membrane and cytoplasm
- through the tonoplast
- into the vacuole of the root hair
- with lower water potential
- intake of water through the root hairs is by passive absorption
- as water enters, the water potential of cell sap increases

(6)
[10]

2.2
2.2.1 i To remove any water adhering to the potato discs to ensure a more accurate measurement of the mass (2)
ii Using 10 discs would increase the reliability of the results rather than using a single one (2)
iii Allowing enough time for osmosis to take place (2)
2.2.2 i It increased (1)
ii It decreased (1)
2.2.3
- The potato discs were placed in a solution that was hypertonic/the solution had a lower water potential than that of the cells.
- Water moved out of the potato cells through exosmosis
- The loss of water led to a decrease in the mass of the potato discs

(3)
2.2.4 Between 0,3–0,4 mol/dm^3 (2)
2.2.5 To provide more accurate results (2)
[15]
Total Question 2: [25]

QUESTION 3
3.1 movement/locomotion; protection; support; hearing; storage of minerals; haemopoiesis (production of blood cells by red bone marrow) **[5]**

3.2
3.2.1 hinge (1)
3.2.2 elbows, knee, fingers and toes (1)
3.2.3 allows bones to slide over each other (1)
3.2.4 ball and socket (1)
3.2.5 allows bones to twist against each other (1)
[5]

3.3
3.3.1 A – triceps, B – biceps, 3 – tendon joining biceps to the scapula (3)
3.3.2 so that the biceps muscle does not pull away from the scapula when the shoulder joint is moving and to hold the ball of humerus in the socket of the scapula (2)
3.3.3 biceps muscle (1)
[6]

3.4
3.4.1 Osteoporotic bones are brittle because the structure of the bone is damaged (2)
3.4.2 Because her vertebrae start to collapse and become narrower (2)
3.4.3 Yes. Because they are lighter than normal bone (2)
3.4.4 It is likely that her vertebrae have collapsed and become narrower, so her back would become hunched (3)
[9]
Total Question 3: [25]
TOTAL: [75]

Formal Assessment Task Grade 10 (Memo)

Term 3: Test 3

Marks: 75 Time: 1 Hour

Section A
QUESTION 1
1.1
1.1.1 **b**
1.1.2 **c**
1.1.3 **a**
1.1.4 **b**
1.1.5 **b** (5 × 2) **[10]**

1.2
1.2.1 population
1.2.2 niche
1.2.3 xerophytes
1.2.4 decomposers
1.2.5 prey **[5]**

1.3
1.3.1 **E**
1.3.2 **C**
1.3.3 **F**
1.3.4 **G**
1.3.5 **I** **[5]**

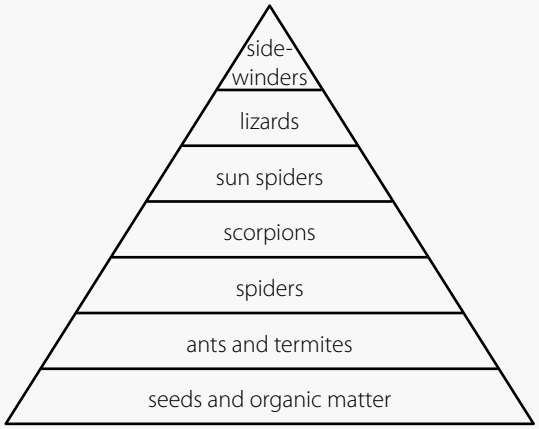
1.4
1.4.1 1 – connective tissue 4 – lumen (2)
1.4.2 B – has thick muscular wall to withstand pressure exerted by pumping action of heart
lumen is narrow which facilitates faster movement of blood (2)
1.4.3 A – muscular wall is thin (1)
[5]
Total Question 1 : [25]

Section B
QUESTION 2
2.1
2.1.1 A • contains adequate water
• high humus content (2)
2.1.2 C • high water content
• permeability to water is very low (2)
2.1.3 B • its water holding capacity is very low
• water drains very easily through the soil and it dries quickly
• its humus content is low (2)
[6]

2.2
2.2.1 for production of proteins (1)
2.2.2 in a dissolved form through their roots (1)
2.2.3 the ammonium salts will be changed by nitrifying bacteria into nitrates (2)
2.2.4 by adding compost/manure (2)
2.2. they destroy nitrates and so decrease the levels of nitrate in the soil (2)
2.2.6 nitrate levels would drop (2)
2.2.7 Any two of: seeds for the crop may form human or livestock feed, root nodules with nitrogen fixing bacteria, which increase nitrate levels instead of reducing them (2)
2.2.8 Waterlogged soils contain little air, nitrifying bacteria are inactive and release of nitrates is reduced. But denitrifying bacteria are still active and so nitrates are still destroyed. (2)
[14]

2.3
2.3.1 i eel (1)
ii trout (1)
2.3.2 i pike – 4,95 (1)
ii perch – 5 (1)
iii trout – 5,90 (1)
[5]
Total Question 2 : [25]

QUESTION 3
3.1
3.1.1



(7)
3.1.2 The third level consists of spiders.
• an increase in spiders will result in a corresponding decrease in ants and termites
• due to the increase in predators that will require more food
• In addition the scorpion population will also increase
• Because more spiders are available as food (3)
[10]

3.2
3.2.1 2 – right lymphatic duct 4 – thoracic duct (2)
3.2.2 6 – lymph nodes – filter and remove foreign particles from the lymph and prevent them from spreading throughout the body (2)
3.2.3 The lymph in 4 contains a higher concentration of fats and glucose than the lymph in 1. Fats and glucose are derived from the villi of the small intestine and are transported by the thoracic duct. (2)
[6]

3.3
3.3.1 i 0,8 sec (1)
ii 0,35 sec (1)
3.3.2 0,6 sec. The valve is closed when the ventricular pressure drops below the aortic pressure. The length of this period is shown by CD on the graph. (3)
3.3.3 • during ventricular systole the cardiac muscles in the wall of the left ventricle contract
• the wall moves inwards against the blood inside and the volume of ventricle is reduced
• the mitral valve is closed and ventricular pressure increases (4)
[9]
Total Question 3: [25]
TOTAL: [75]

Formal Assessment Task Grade 10 (Memo)

Term 4: Test 4

Marks: 75 Time: 1 Hour

Section A
QUESTION 1
1.1
1.1.1 **d**
1.1.2 **d**
1.1.3 **d**
1.1.4 **a**
1.1.5 **b** (5 × 2) **[10]**
1.2
1.2.1 phylogenetic/family tree
1.2.2 vestigial
1.2.3 endemic
1.2.4 biological key
1.2.5 taxonomy **[5]**

1.3
1.3.1 **C**
1.3.2 **D**
1.3.3 **E**
1.3.4 **A**
1.3.5 **B** **[5]**

1.4
1.4.1 North West Province
1.4.2 Raymond Dart
1.4.3 *Australopithecus africanus*
1.4.4 Little Foot
1.4.5 Sterkfontein caves **[5]**
Total Question 1: [25]

Section B
QUESTION 2
2.1
2.1.1 In chimpanzees the foramen magnum position is posterior (towards the back) to the skull. In *Australopithecus africanus* there is a major shift of the foramen magnum towards the front of the skull. In *Homo sapiens* the foramen magnum is also towards the front of the skull. Thus, the angle between the orbital plane and the foramen magnum is much larger in hominins than in apes. (3)

2.1.2 Bipedal locomotion requires an upright body stance. To accomplish this, the vertebral column had to shift from the posterior quadrupedal position to a ventral (towards the front) position, so that the centre of gravity is in line with the head and the legs, both along the same axis. (5)

2.1.3 i Parallel toes, facing forwards, help bipedal walking and running by offering extra leverage to the feet. This makes the surface area of the foot that is in contact with the ground more compact and so less energy is needed for walking and running. (4)

ii A bipedal life-style frees the hands from locomotion and the hands can now be used for other functions, such as carrying food and other objects and making tools. In humans, the opposable thumb allows skilful manipulation of different objects. (3)
[15]

2.2
2.2.1 A – modern human (*Homo sapiens*); B – chimpanzee (*Pan troglodytes*); C – Taung child (*Australopithecus africanus*) (3)

2.2.2 any two of: (2)

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

2.2.3 B (1)
2.2.4 B has the most developed canines. (2)
2.2.5 A and C. (2)
[10]
Total Question 2: [25]

QUESTION 3
3.1
3.1.1 Paleozoic Era (1)
3.1.2 i Paleozoic Era (1)
ii Permian (1)
3.1.3 Cenozoic (1)
3.1.4 i 65 Ma (1)
ii Comet/star/meteorite/asteroid (1)
iii Extraterrestrial object hit the earth, climate change occurred:
- due to dust clouds
- sunlight was blocked
- ice age occurred
- reduction of CO_2 in the atmosphere
- photosynthesis decreased
- many plants died
- many animals died/dinosaurs become extinct *max* (4)

3.1.5 Uranium will be used, because dinosaurs lived approximately 65 million years ago and ^{14}C can only measure up to 5 730 years ago (3)
[13]

3.2
3.2.1 Permian period (1)
3.2.2 The number of reptile species decreased. The number of mammal species increased.
OR
In the beginning of the Cretaceous period the number of reptile species was large but towards the end of the Cretaceous period the number of reptile species decreased. In the beginning of the Cretaceous period the number of mammal species was very small but towards the end of the Cretaceous period the number of mammal species started to increase. (4)
[5]

3.3
3.3.1 They have the same index fossils (2)
3.3.2 5 and 12 (2)
3.3.3 Radiometric dating/relative dating/absolute dating/carbon dating/isotope (carbon/uranium/potassium) dating/radioactive dating (1)
3.3.4 Conditions for fossilisation to take place were not always favourable:
All fossils NOT found yet.
All organisms are not fossilised/some are eaten by predators/some decay quickly.
Incomplete fossils.
Problems in identifying fossil. *max* (2)
[7]
Total Question 3: [25]
TOTAL: [75]

Life Sciences Examination: Exemplar Paper 1

Marks: 150 **Time: 2½ hours**

This question paper consists of 7 pages.

Instructions and information

1. Read the following instructions carefully before answering the questions.
2. Answer ALL the questions.
3. Write ALL the answers in your ANSWER BOOK.
4. Start the answers to each question at the top of a NEW page.
5. Number the answers correctly according to the numbering system used in this question paper.
6. Present your answers according to the instructions of each question.
7. Do ALL drawings in pencil and label them in blue or black ink.
8. Draw diagrams or flow charts only when asked to do so.
9. The diagrams in this question paper are NOT necessarily drawn to scale.
10. Do NOT use graph paper.
11. You may use a non-programmable calculator, protractor and a compass.
12. 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 Which of the following serves as a macronutrient for plants and animals?
- **a** iron
- **b** phosphorus
- **c** iodine
- **d** sodium

1.1.2 The micronutrient that occurs in thyroxin and causes goitre when deficient is:
- **a** magnesium
- **b** iodine
- **c** iron
- **d** sodium

1.1.3 Calcium is required by humans to:
- **a** assist in the clotting of blood
- **b** control the water balance in blood
- **c** prevent muscular cramps
- **d** produce the hormone thyroxin

1.1.4 Proteins differ from carbohydrates in that:
- **a** they all function as enzymes
- **b** some are hormones
- **c** they all supply the main source of food for energy
- **d** they all react negatively with Millon's reagent

1.1.5 The vitamin that prevents scurvy is found in:
- **a** butter, plant oils and milk
- **b** milk, fish liver oil and cheese
- **c** citrus fruit, tomatoes and spinach
- **d** meat, liver and whole-grain bread

1.1.6 All enzymes are:

a proteins
b inorganic compounds
c vitamins
d hormones

(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** to **1.2.7**) in your ANSWER BOOK.

1.2.1 The most important inorganic solvent in nature.
1.2.2 An organic nutrient that can serve as an insulating material against cold.
1.2.3 A scale of 1 to 14 that indicates the level of acidity or alkalinity of a solution.
1.2.4 The monomers that make up proteins.
1.2.5 The cell organelle that is concerned with the production of ATP.
1.2.6 An organelle in plant cells that store starch.
1.2.7 The organic compound that forms the main constituent of the cell walls in flowering plants.
1.2.8 An organelle in the cytoplasm of plant cells that is responsible for the bright colour in many flowers.
1.2.9 Cells in phloem, which, in addition to companion cells are responsible for the translocation of dissolved food.
1.2.10 The mutually attractive force that develops between water molecules in the xylem.

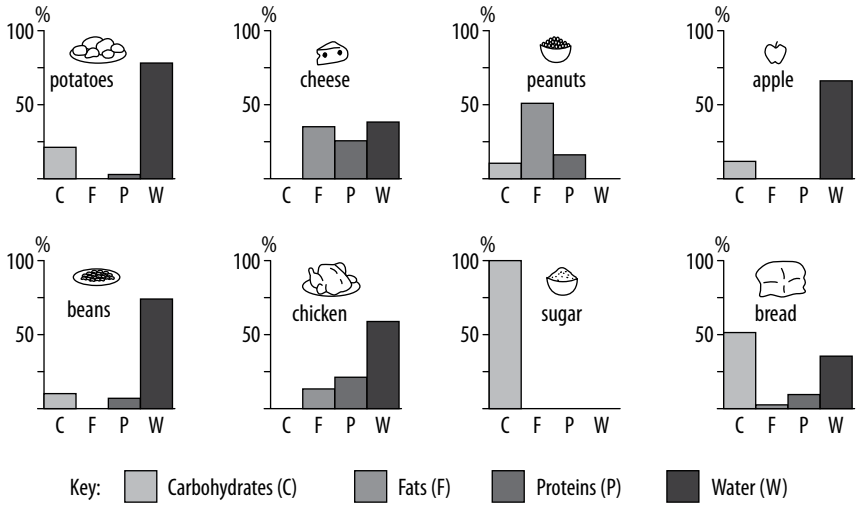
[10]

1.3 Indicate whether each of the statements in Column 1 applies to **a** ONLY, **b** ONLY, BOTH **a** AND **b**, or NONE of the items in Column 2. Write **a** only, **b** only, both **a** and **b**, or none next to the question number (**1.3.1**–**1.3.8**) in your ANSWER BOOK.

Column 1	Column 2
1.3.1 Deficiency may cause rickets	**a** Calcium **b** Vitamin D
1.3.2 Process(es) in which enzymes are involved	**a** Anabolic **b** Catabolic
1.3.3 Essential in hydrolytic reactions	**a** Carbon dioxide **b** Water
1.3.4 Used to test for the presence of starch	**a** Fehling's solution **b** Benedict's solution
1.3.5 Ratio of hydrogen to oxygen is less than 2:1	**a** Carbohydrates **b** Lipids
1.3.6 Plays a role in the synthesis of chlorophyll	**a** Iron **b** Magnesium
1.3.7 Deficiency may cause muscular cramps	**a** Sodium **b** Calcium
1.3.8 Plays a role in the clotting of blood	**a** Vitamin K **b** Calcium

[8]

1.4 The histograms below show the percentages of carbohydrates, fats, proteins and water in eight types of food.



From the histograms name TWO types of food that:

1.4.1 Contain more than 25% of a nutrient that is involved in the formation of an insulating layer. (2)

1.4.2 Would best help to prevent kwashiorkor (protein – energy malnutrition). (2)

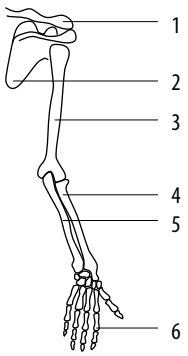
1.4.3 Will form only monosaccharides and amino acids after digestion. (2)

1.4.4 Are not involved in the formation of cell membranes. (2)

1.4.5 Contain more than 50% of a nutrient that is the primary source of energy. (2)

[10]

1.5 Study the diagram below and then answer the questions that follow.



1.5.1 Provide labels for the parts numbered 1 to 6. (6)

1.5.2 Name the type of joints that form:

i between parts 2 and 3

ii between parts 3 and 4. (2)

1.5.3 List TWO functions of the human skeleton. (2)

[10]

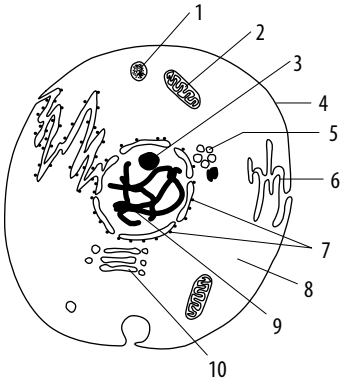
Total Question 1: [50]

Total Section A: [50]

Section B

Question 2

2.1 Study the diagram of a cell and then answer the questions that follow.



2.1.1 Does this diagram represent a plant cell or animal cell? (1)

2.1.2 Give TWO reasons for your answer to Question **2.1.1** (2)

2.1.3 Write down the numbers and names of TWO organelles which are surrounded by a single unit membrane. (4)

2.1.4 Write down the number and name of ONE organelle which is surrounded by a double membrane. (2)

2.1.5 State ONE function of organelle 2. (1)

2.1.6 Explain TWO ways in which organelle 2 is structurally suited for its function. (4)

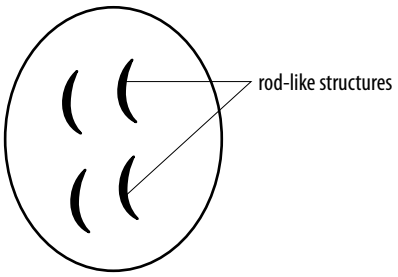
[14]

2.2 Draw and label a diagram to represent a chloroplast. **[6]**

Total Question 2: [20]

Question 3

3.1 The diagram below shows a cell that is about to undergo mitotic division. Answer the questions based on it.



3.1.1 What are the rod-like structures in the cell? (1)

3.1.2 Each rod is made up of many small units. What is each unit called? (1)

3.1.3 Name TWO regions in a flowering plant where dividing cells may be found (2)

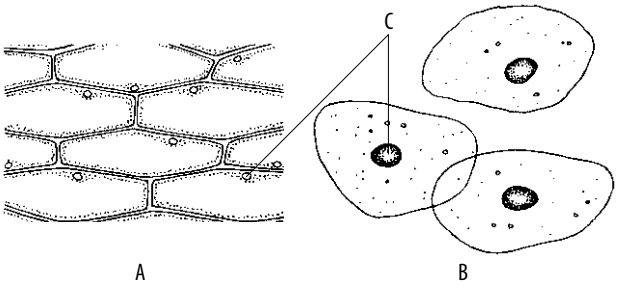
3.1.4 How many of the rod-like structures will be found in each of the daughter cells? (1)

3.1.5 How many cells will there be at the end of this cell division? (1)

3.1.6 State THREE ways in which mitosis is biologically important. (3)

[9]

3.2 Study the following diagrams and then answer the questions which follow.



3.2.1 Which of the drawings (A or B) represent:
- **i** plant cells? (1)
- **ii** animal cells? (1)

3.2.2 Tabulate TWO visible differences between cells A and B. (4)

3.2.3 List TWO visible similarities between cells A and B. (2)

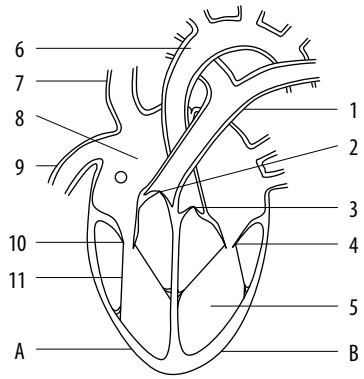
3.2.4 Explain why structure C is said to 'control all the activities of the cell' (3)

[11]

Total Question 3: [20]

Question 4

4.1 Study the diagram of the human heart and then answer the questions based on it.



4.1.1 State the number and name of the blood vessel that carries oxygenated blood. (2)

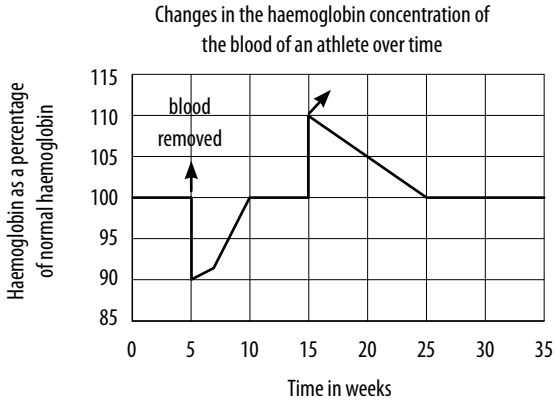
4.1.2 Explain why there is a difference in the thickness of the walls of marked A and B. (2)

4.1.3 Name the following parts: 2, 3, 4 and 11. (4)

4.1.4 Explain how the structure of part 11 makes it suitable for its function. (3)

[11]

4.2 In the Olympic Games held in Athens in 2004, a long distance athlete had 500 ml of his own blood removed, stored and returned to his body a few days before he completed the marathon. This increases the haemoglobin content in the blood. This practice, called blood doping, is banned by athletics officials. Study the graph below, showing the haemoglobin content of the blood in the athlete's body over a period of 35 weeks and answer the questions that follow.



4.2.1 In which week was the blood removed from the athletes body? (1)

4.2.2 How many weeks did it take for the athlete's haemoglobin level to go back to normal after the blood had been removed? (1)

4.2.3 Explain what advantage this athlete would have had, compared to an athlete who did not undergo blood doping. (2)

4.2.4 Why do you think that officials would find it difficult to detect this form of blood doping? (2)

4.2.5 Do you consider this act of blood doping to be acceptable or not? (1)

4.2.6 Explain your answer in **4.2.5**. (2)

[9]

Total Question 4: [20]

Question 5

5.1 An athlete's heartbeat was recorded before, during and after a race for a total time of 100 minutes. The results are shown in the table below.

Time (minutes)	0	10	20	30	40	50	60	70	80	90	100
Heartbeat per minute	60	60	61	62	84	105	108	100	88	70	64

5.1.1 Use the data from the table and draw a graph. Use the *x*-axis for time and the *y*-axis for heartbeats per minute. (10)

5.1.2 What is the heartbeat at rest? (1)

5.1.3 After how many minutes:

i did the athlete start the race (1)

ii was the athlete's heartbeat 84 times per minute, and (1)

iii did the athlete stop running? (1)

5.1.4 How long does one complete heartbeat last at:

i rest, and (2)

ii the end of the of the race? Show your calculations. (4)

[20]

Total Question 5: [20]

Total Section B: [80]

Section C

Question 6

6.1 Describe the movement of water through a typical mesophyte plant (i.e. a plant which is adapted to neither a particularly dry nor particularly wet environment), from the soil solution until it reaches the air cavities of the leaves and from there to the atmosphere. In your description also give attention to the forces involved in the upward movement of water and the structural suitability of the different tissues involved. [20]

Total Question 6: [20]

Total Section C: [20]

TOTAL: [150]

Life Sciences Examination: Exemplar Paper 2

Marks: 150 **Time: 2½ hours**

This question paper consists of 10 pages.

Instructions and information

1. Read the following instructions carefully before answering the questions.
2. Answer ALL the questions.
3. Write ALL the answers in your ANSWER BOOK.
4. Start the answers to each question at the top of a NEW page.
5. Number the answers correctly according to the numbering system used in this question paper.
6. Present your answers according to the instructions of each question.
7. Do ALL drawings in pencil and label them in blue or black ink.
8. Draw diagrams or flow charts only when asked to do so.
9. The diagrams in this question paper are NOT necessarily drawn to scale.
10. Do NOT use graph paper.
11. You may use a non-programmable calculator, protractor and a compass.
12. 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 The entire section of the Earth's surface that supports life is called the:
- **a** biome
- **b** biosphere
- **c** ecosystem
- **d** community

1.1.2 Which of the following processes occur during the nitrogen cycle?
- **i** Consumption of dead material by herbivores
- **ii** The decay of dead organisms by decomposers
- **iii** The conversion of nitrates to nitrites by bacteria
- **iv** The absorption of nitrates by plants

- **a** **i**, **ii** and **iii**
- **b** **ii**, **iii** and **iv**
- **c** **i** and **iv**
- **d** **i**, **ii** and **iv**

1.1.3 Organisms that live in water are called:
- **a** aquatic
- **b** buoyant
- **c** terrestrial
- **d** motile

1.1.4 Carl Linnaeus was:
- **a** the father of modern taxonomy
- **b** a character in a Shakespeare play
- **c** a politician in 17th century Europe
- **d** a fictional character in a book

1.1.5 Which of the following is not one of the key criteria used to classify organisms into separate kingdoms:

a body structure
b cell wall composition
c mode of nutrition
d whether the organisms live on land or in water

1.1.6 Algae and fungi are similar in that:

a both are decomposers in the ecosystem
b the plant body is a thallus
c both are autotrophic organisms
d sexual reproduction does not occur

(6 x 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** to **1.2.10**) in your ANSWER BOOK.

1.2.1 A set of alternative descriptions that help you to identify plant or animal species
1.2.2 A type of diagram that uses branches to show relationships between organisms
1.2.3 A unicellular organism that can exist in coccus, spirillum or bacillus form
1.2.4 Organisms that cause diseases
1.2.5 The gametophyte in ferns
1.2.6 A group of plants that produce flowers and ovules within an ovary
1.2.7 Remains or traces of once living organisms that are preserved in sedimentary rocks
1.2.8 An advanced primate subgroup that included monkeys and apes and shares anthropoid features with humans
1.2.9 The time at which one-half of the atoms of a radioactive isotope have decayed
1.2.10 A method of chronometric dating based on the decay of carbon 14

[10]

1.3 Choose an item from Column B that matches a description in Column A. Write only the letter (**a** to **f**) next to the question number (**1.3.1** to **1.3.5**) in your ANSWER BOOK, for example **1.3.6 g**.

Column A	Column B
1.3.1 The lowest level in a classification hierarchy	**A** Kingdom
1.3.2 Phylum that includes vertebrates	**B** Genus
1.3.3 Moths, ants and ant-lions belong to the same:	**C** Species
1.3.4 Mosses, ferns and grasses belong to the same:	**D** Chordata
1.3.5 Group name for the most closely related species	**E** Class
	F Venn diagram

[5]

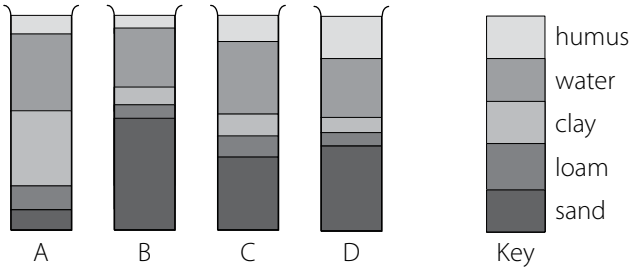
1.4 Choose the most appropriate description from the box below which fits each of the descriptions **1.4.1** to **1.4.8**. Write the question number and next to each the correct term e.g. **1.4.9** scavengers.

producers	primary consumers
secondary consumers	omnivores
predators	prey
scavengers	decomposers

Description	
1.4.1	eat both plants and animals – e.g. bears and humans
1.4.2	feed primarily on plant material; they are herbivores, e.g. rabbits, caterpillars, cows, sheep, and deer
1.4.3	feed on dead and decaying organisms and on the undigested parts of plant and animal matter in the faeces; they do not 'eat' the food like scavengers, as they have no mouth-parts; instead they break down solid matter into liquids which they can absorb, e.g. bacteria and some fungi
1.4.4	are the organisms that predators feed on, e.g. fox and rabbit; Cape robin and caterpillar; wolf and lamb
1.4.5	feed on dead animals, they perform a useful cleaning-up function, e.g. crow, vulture, buzzard and hyena
1.4.6	green plants; all food chains start with them, because they can make food by photosynthesis
1.4.7	kill for food; they are either secondary or tertiary consumers, e.g. lions, eagles
1.4.8	feed primarily on animal material; they are carnivores, e.g. cats, dogs and lions

[8]

1.5 Equal volumes of four different types of soil (A, B, C, and D) were analysed for their mineral and humus content. This was done by shaking each up with 100 ml of distilled water in a measuring cylinder. Each was allowed to settle. The results after five days are shown in the diagram below.



1.5.1 If you ignore the humus, which type of soil took the longest to settle, leaving the water clear? Give a reason for your answer. (2)

1.5.2 Write down the letter of the soil sample that is most likely to come from a:

i well-drained forest (1)

ii vegetable garden with light soil (1)

iii desert (1)

1.5.3 Which sample would:

i recover water best from the subsoil during drought (1)

ii have the fewest earthworms per acre (1)

iii have the highest nitrogen content (1)

1.5.4 List **two** advantages of soil A for crop production. (2)
1.5.5 State **two** disadvantages of soil A for crop production. (2)
1.5.6 State **three** reasons why soil should contain sufficient humus. (3)
[15]

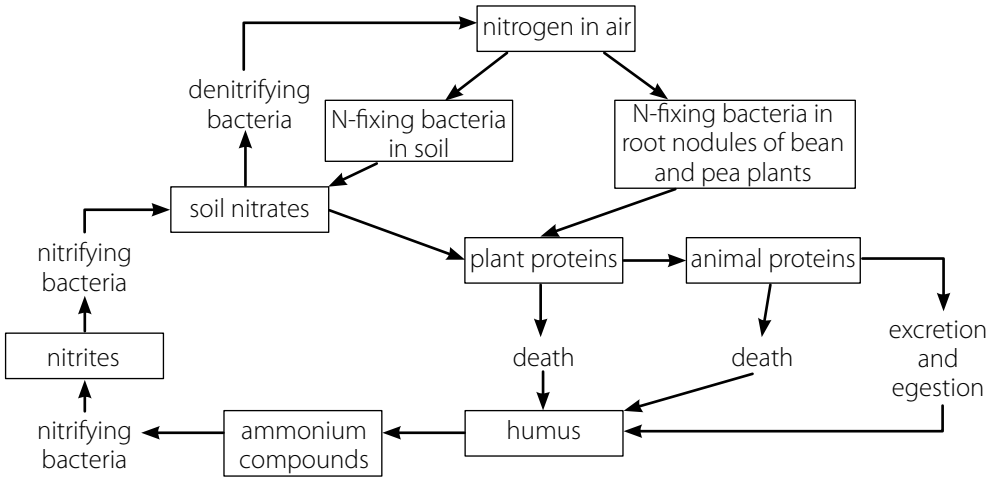
Total Question 1: [50]

Total Section A: [50]

Section B

Question 2

2.1 Study the diagram of the nitrogen cycle and then answer the questions that follow.



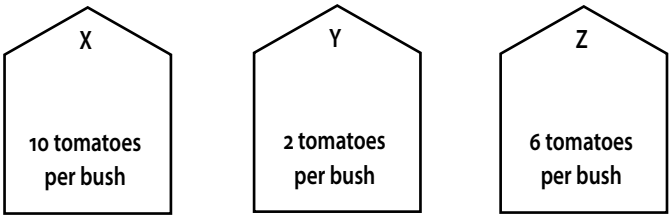
2.1.1 Why do plants need nitrogen? (1)
2.1.2 How do plants obtain their source of nitrogen? (2)
2.1.3 In a natural habitat the amount of nitrate available in the soil for the plants to use would roughly be the same every growing season.
i How would this change if the habitat was ploughed and used to grow wheat for several years? (2)
ii Suggest why this change occurs. (3)
2.1.4 A farmer may try to improve his soil for the next crop by applying an artificial fertiliser containing ammonium salts. How could this improve the soil? (3)
2.1.5 Suggest another method that the farmer could use to get the same effect without using an artificial fertiliser and explain how this method would improve his crop. (4)
2.1.6 Explain how the method you have suggested would improve the soil in one other way. (2)
2.1.7 Why are denitrifying bacteria a problem to farmers? (2)
2.1.8 Name the process that results in the production of humus after death of an organism. (1)
[20]

Total Question 2: [20]

Question 3

3.1 The information below shows the yields obtained by a gardener from three greenhouses in which he deliberately maintained different environmental conditions. Each greenhouse received the same amount of sunlight. The three sets of conditions maintained in the greenhouse are shown in the table below.

Set of conditions	1	2	3
Carbon dioxide (as a percentage)	0,2	5,0	5,0
Temperature (in ° C)	15	15	20



3.1.1 Which set of conditions was likely to be found in greenhouse X? (1)

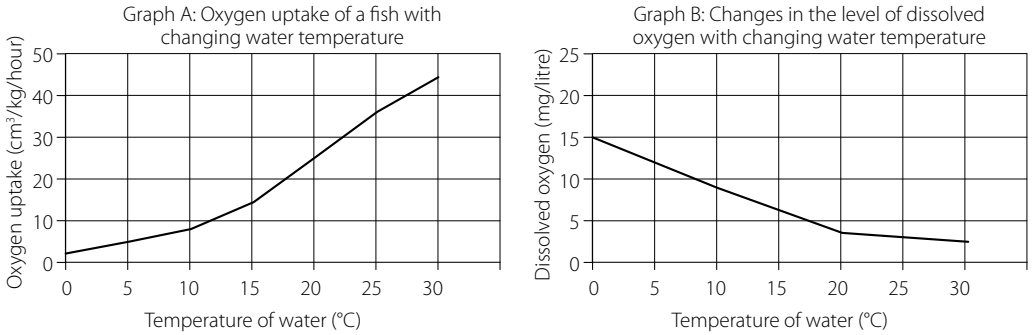
3.1.2 Give an explanation for your answer in **2.1.1** (3)

3.1.3 Suggest a practical way in which the gardener could alter the conditions in the greenhouse from those indicated for set 1 to those of set 2? (2)

3.1.4 Name **two** other factors that the gardener must keep as similar as possible in the three greenhouses in order to make a fair comparison. (2)

[8]

3.2 Two abiotic factors that can affect organisms living in fresh water are oxygen level and water temperature. An investigation was carried out to study the above phenomenon. The results of this study are presented in the graphs below.



3.2.1 Suggest a hypothesis for this investigation. (2)

3.2.2 Identify the:

i dependent variable for graph A (1)

ii independent variable for graph A (1)

iii dependent variable for graph B (1)

iv independent variable for graph B (1)

3.2.3 By how much does the oxygen uptake of fish increase when the temperature increases from 4,5 °C to 25,5 °C? (1)

3.2.4 A factory situated along the banks of a river used the river water as a coolant at 4,5 °C. On one occasion the water discharged back into the river at 30 °C. Calculate the percentage change in the level of dissolved oxygen between the river at 4,5 °C and the discharge at 30 °C. (3)

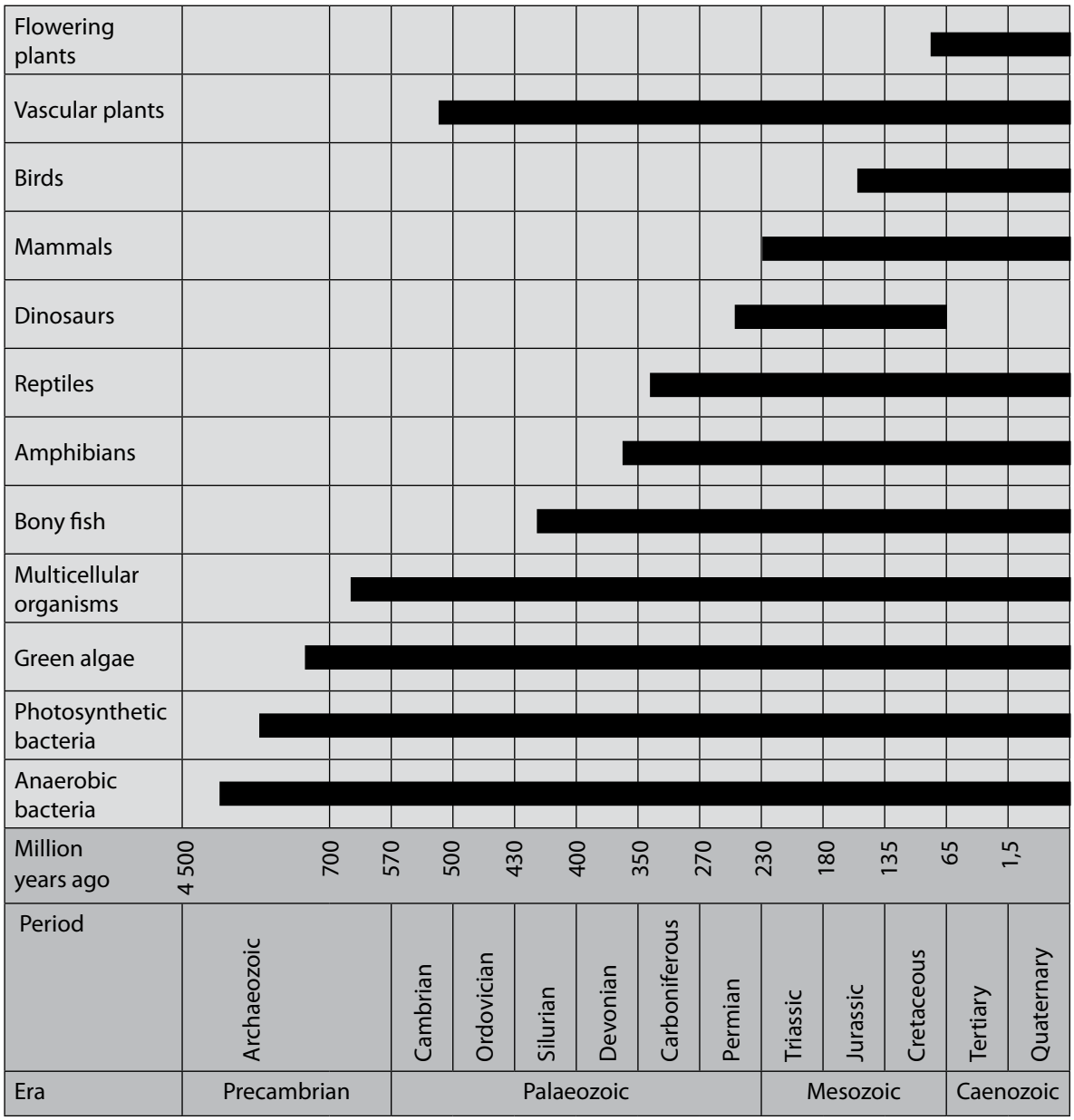
3.3.5 Using the data from both graphs, suggest why, after the discharge of hot water, fish were seen dying lower downstream. (2)

[12]

Total Question 3: [20]

Question 4

4.1 The diagram below represents a geological time scale with the distribution of different organisms. The time axis is NOT drawn to scale.



4.1.1 How many million years ago did the mammals first appear? (1)

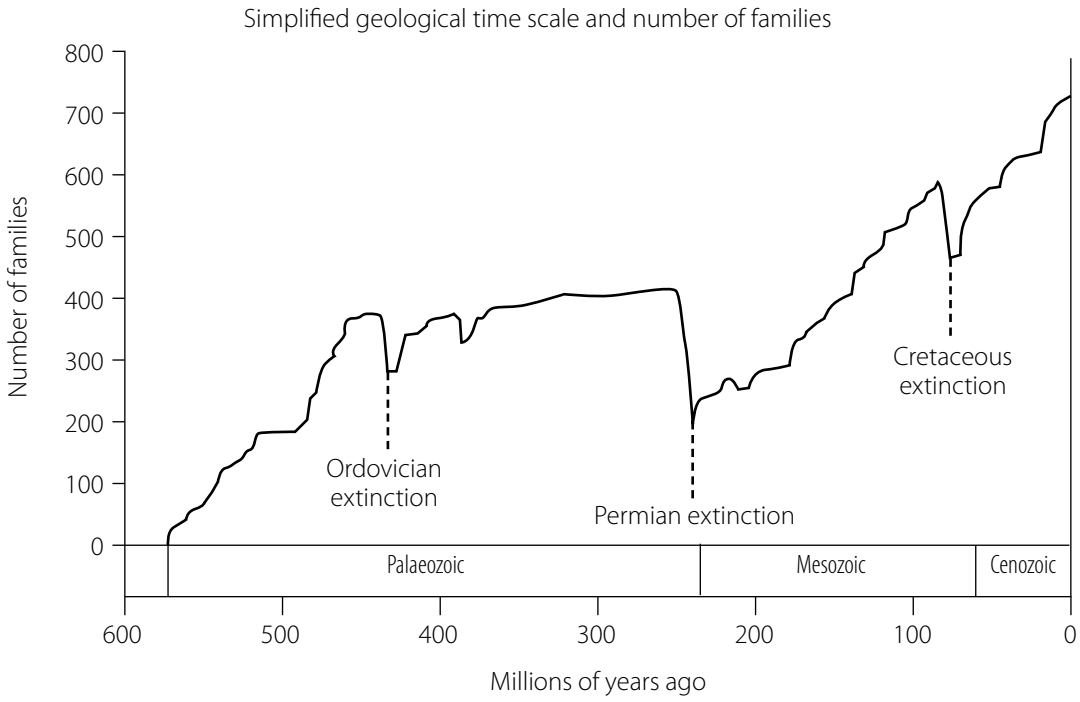
4.1.2 In which era did the flowering plants first appear? (1)

4.1.3 How many years ago did the dinosaurs become extinct? (2)

4.1.4 Give **one** reason why anaerobic bacteria appeared before photosynthetic bacteria. (2)

[6]

4.2 The diagram below represents a simplified geological time-scale showing how the number of families (groups of related species) has changed over time.



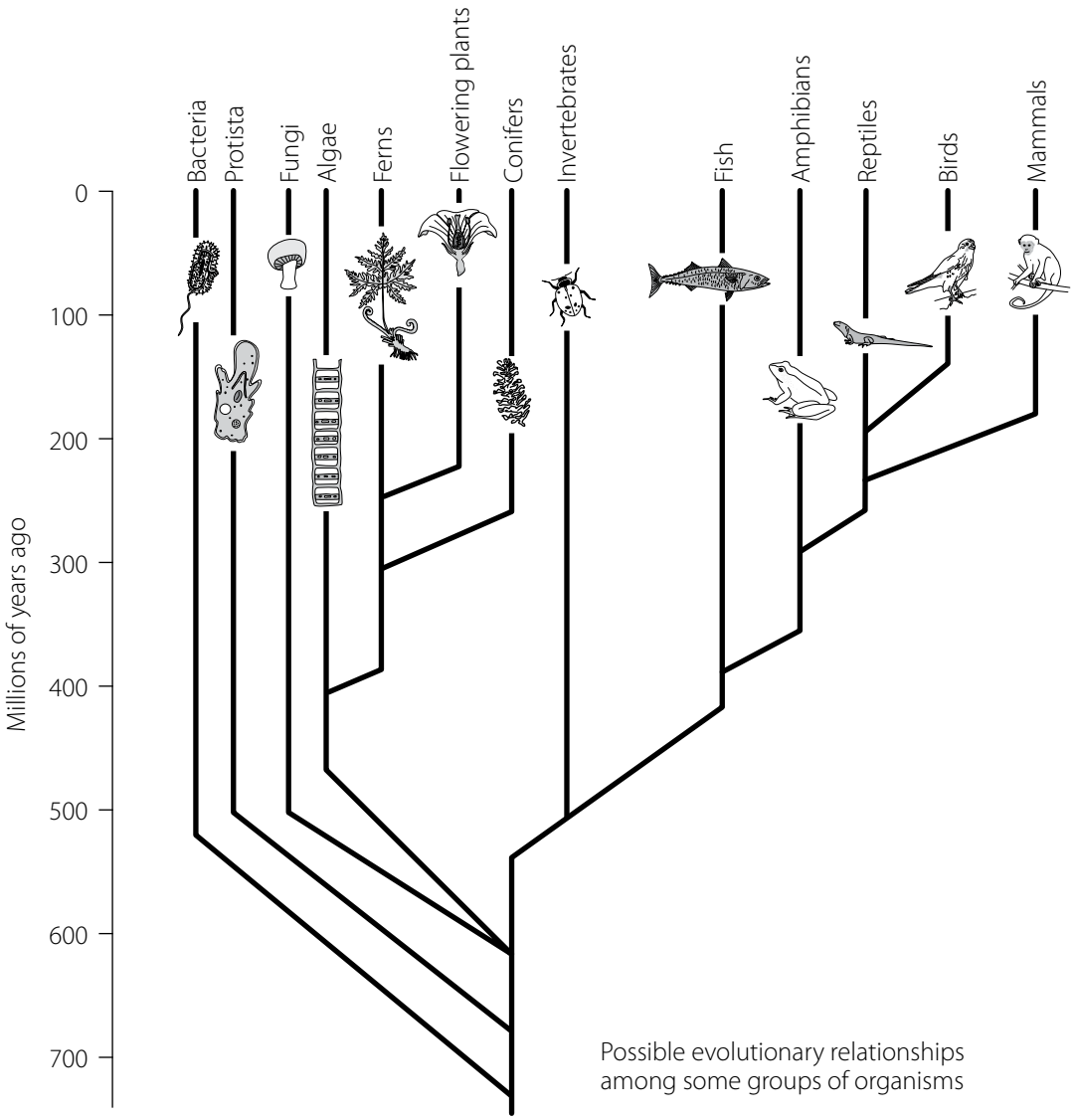
4.2.1 When did the Caenozoic era begin? (2)

4.2.2 Which mass extinction took place towards the end of the Palaeozoic era? (1)

4.2.3 Approximately how many families of species died out at the end of the Palaeozoic era? Show ALL working. (3)

[6]

4.3 Study the diagram showing possible evolutionary relationships among some groups of organisms.



4.3.1 According to the diagram:

i How many million years ago did the conifers evolve? (1)

ii Which were the first organisms that lived on Earth? (1)

iii From which group of animals did the reptiles evolve? (1)

iv Which is the most recent group of animals to evolve? (1)

4.3.2 Name **two** fields of study, other than embryology and biochemistry, that scientists may have used to propose the evolutionary relationships shown in the diagram. (2)

4.3.3 Explain why we cannot be sure that the evolutionary relationships displayed in the diagram in **Question 4.3.1** are absolutely correct. (2)

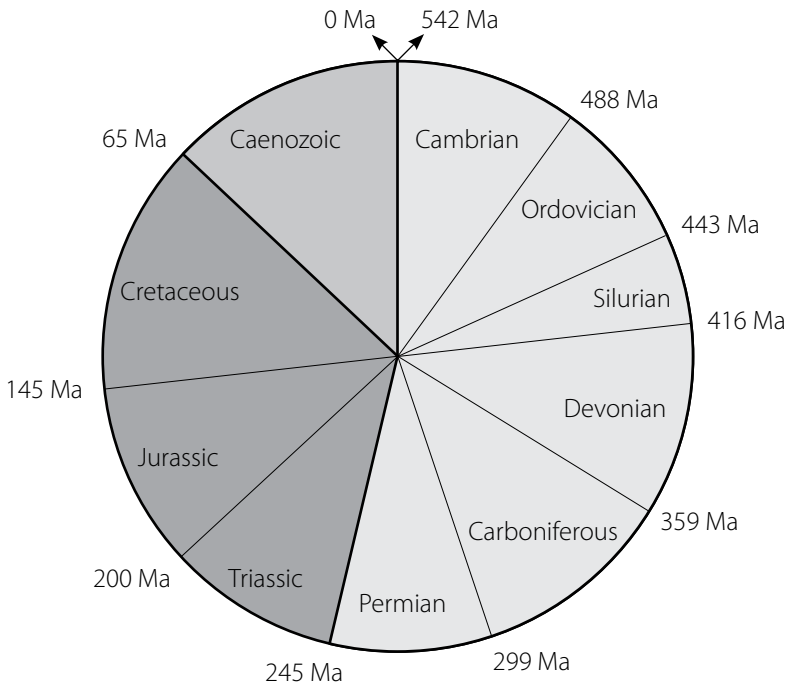
[8]

Total Question 4: [20]

Question 5

5.1 Study the pie chart below, which shows some geological periods of the three eras and answer the questions that follow.

Some geological periods of the three eras



5.1.1 Which of the three eras had the longest duration? (1)

5.1.2 The biggest mass-extinction took place 250 million years ago.

i State in which era this occurred. (1)

ii State in which period this occurred. (1)

5.1.3 In which era did modern humans appear on Earth? (1)

5.1.4 Scientists think that "something large" from outer space struck the Earth when the Cretaceous period ended.

i How many years ago did this "something large" strike the Earth? (1)

ii Name a possible structure that hit the Earth at the end of the Cretaceous period. (1)

iii Describe how this structure named in **Question 5.1.4 ii** could have caused the mass extinction of many species. (4)

[10]

5.2 The table below contains information on changes that occur in a river, downstream from a sewage outflow.

Distance downstream from the point of entry of sewage (m)	Concentration of dissolved oxygen (%)	Number (arbitrary units)		
		Bacteria	Algae	Fish
0	95	88	20	20
100	30	79	8	6
200	20	74	7	1
300	28	60	21	0
400	42	51	40	0
500	58	48	70	0
600	70	44	83	0
700	80	42	90	0
800	89	39	84	0
900	95	36	68	4
1 000	100	35	55	20

5.2.1 Explain why the number of bacteria was the highest at 0 metres. (2)

5.2.2 Describe the changes in the concentration of oxygen dissolved in the water downstream from the point of sewage entry. (2)

5.2.3 Explain what might have caused changes in the oxygen concentration downstream from the point of sewage entry (4)

5.2.4 State **two** ways in which the degree of water pollution caused by sewage can be reduced. (2)

[10]

Total Question 5: [20]

Total Section B: [80]

Section C

Question 6

6.1 Describe the flow of energy in an ecosystem. **[20]**

Total Question 6: [20]

Total Section C: [20]

TOTAL: [150]

Life Sciences Examination: Exemplar Paper 1 Memorandum of answers

Section A

QUESTION 1

1.1

1.1.1 **b**
1.1.2 **b**
1.1.3 **a**
1.1.4 **b**
1.1.5 **c**
1.1.6 **a**

(6 x 2) **[12]**

1.2

1.2.1 Water
1.2.2 Fat/lipid
1.2.3 pH
1.2.4 Amino acids
1.2.5 Mitochondrion
1.2.6 Leucoplasts
1.2.7 Cellulose
1.2.8 Chromoplasts
1.2.9 Sieve tubes
1.2.10 Cohesion/cohesive

[10]

1.3

1.3.1 Both **a** and **b**
1.3.2 Both **a** and **b**
1.3.3 **b** only
1.3.4 None
1.3.5 None
1.3.6 Both **a** and **b**
1.3.7 Both **a** and **b**
1.3.8 Both **a** and **b**

[8]

1.4

1.4.1 Cheese, peanut (2)
1.4.2 Cheese, chicken (2)
1.4.3 Potatoes, beans (2)
1.4.4 Apple, sugar (2)
1.4.5 Sugar, bread (2)

[10]

1.5

1.5.1 1 – clavicle; 2 – scapula; 3 – humerus; 4 – radius; 5 – ulna; 6 - phalanges (6)

1.5.2 i ball and socket
ii hinge (2)
1.5.3 Support and protection (2)

[10]

Total Section A: [50]

SECTION B

QUESTION 2

2.1

2.1.1 Animal (1)
2.1.2 no cell wall / no vacuole / presence of centrosome with centrioles (2)
2.1.3 Any two of: 1– lysosomes; 2 – ER; 10 – Golgi apparatus (4)
2.1.4 2 – mitochondrion (2)
2.1.5 mitochondrion – involved with cellular respiration (1)
2.1.6 Inner membrane is folded to form cristae which increases the surface area for the process of cellular respiration; enzymes are present in the matrix as well as between the membranes, thus making the process of cellular respiration efficient (4)

[14]

2.2 Mark for: shape – 1; proportion – 1; (4 labels) – double membrane, lamella, granum, stroma **[6]**

Total Question 2: [20]

QUESTION 3

3.1

3.1.1 Chromosomes (1)
3.1.2 genes / nucleotides (1)
3.1.3 two of: root tip, stem tip, cambium (2)
3.1.4 4 (1)
3.1.5 2 (1)
3.1.6 Any three of: responsible for growth of an organism; repairs and replaces worn out and damaged tissue; produces new individual during asexual reproduction (3)

[9]

3.2

3.2.1 i A (1)
ii B (1)
3.2.2

Cells A	Cells B
In addition to a cell membrane plant cells have a cell wall	Animal cells have no cell wall
Cells have a regular shape	Cells have an irregular shape

(4)

3.2.3 Any two of : a nucleus is found in both cells; a cell membrane is found in both cells; cytoplasm is found in both cells (2)
3.2.4 The nucleus controls all the metabolic activities of the cell and transmits genetic information from cell to cell. (3)

[11]

Total Question 3: [20]

QUESTION 4

4.1

4.1.1 6 – aorta (2)
4.1.2 The left ventricle wall (B) is thicker than the right ventricle wall (A) because B has to pump blood to all parts of the body and therefore it requires a greater force while A pumps blood a short distance to the lungs (2)
4.1.3 2– pulmonary valve; 3– aortic valve; 4 – mitral valve; 11 – tendon (4)
4.1.4 11 is inelastic thereby preventing the valve from being pushed inwards and hence preventing the back flow of blood (3)

[11]

4.2

4.2.1. Fifth week (1)
4.2.2 Five weeks (1)
4.2.3 At the time of the race, the athlete's haemoglobin level is higher than normal. The athlete's blood will be able to carry more oxygen. More oxygen will be taken to the athlete's muscle cells. More energy will be released during cellular respiration. This will improve the athlete's performance, compared to other competitors. (3)
4.2.4 The officials would not be able to detect any foreign substance in the athlete's blood since he has returned his own blood to his own body. (2)

4.2.5 Not acceptable OR acceptable. (1)

4.2.6 All athletes should have the same benefits and no-one should be able to have an unfair advantage in competition OR no foreign substances were used to enhance performance, person is using his own blood. (1)

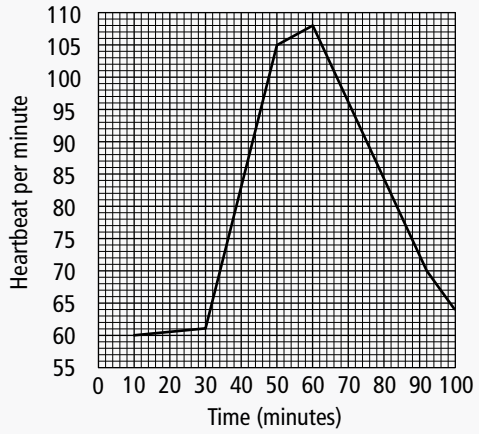
[9]

Total Question 4: [20]

QUESTION 5

5.1

5.1.1 (10)



5.1.2 60 times per minute (1)

5.1.3 i after 30 minutes (1)

ii after 10 minutes (40–30) (1)

iii after 30 minutes (60–30) (1)

5.1.4 i 60/60 = 1 second (2)

ii 60/108 = 0,55 second (4)

[20]

Total Question 5: [20]
Total Section B: [80]

SECTION C

QUESTION 6

6.1 Movement of water from soil into root xylem:

- water potential of soil solution is higher than the vacuolar sap of the root hair
- therefore diffuses by osmosis from soil solution through the permeable cell wall and selectively permeable cell membrane and cytoplasm through tonoplast and vacuole of root hair
- turgor pressure of root hair increases
- water potential of root hair is higher than that of cortex cells
- water diffuses down the water potential gradient mainly through the cell walls of the cortex and also between the cells of the endodermis into the xylem of the root

Structural suitability of root hair:

- possesses large surface area in contact with water
- large vacuole with lower water potential in cell sap than in ground water
- thin cell wall without cuticle

Movement of water along/up the xylem:

- high water potential develops in xylem as a result of root pressure
- water moves along root xylem to xylem of stem in xylem vessels and tracheids to the leaves
- vertical movement of water starts at leaves as water molecules diffuse out of the stomata
- the water potential in the mesophyll air spaces is decreased
- it is now lower than the water potential in moist cell walls
- water molecules diffuse into the air spaces
- this loss of water from the cell sap of mesophyll cells results in the lowering of their water potential
- water molecules diffuse from cell sap to walls of these cells
- this loss leads to a water potential gradient across mesophyll to terminal endings of xylem in stele of leaf
- columns of water in vessels and tracheids are in a state of tension known as adhesion and cohesion
- this tension extends down from leaves to stem to roots

Structural suitability of xylem and tracheids:

- form elongated tubes for rapid movement
- they overlap and water conduction from cell to cell is facilitated by pits linking one cell to another
- are made up of a series of tubular vessels with large lumen
- thickened secondary walls impregnated with lignin to withstand extreme tension of adhesion and cohesion are non-living and form long hollow conducting tubes
- pits in walls allow for lateral transport of water

[20]

Total Question 6: [20]
Total Section C: [20]

TOTAL: [150]

Life Sciences Examination: Exemplar Paper 2
Memorandum of answers

Section A

QUESTION 1

1.1

1.1.1 **b**
1.1.2 **d**
1.1.3 **a**
1.1.4 **a**
1.1.5 **d**
1.1.6 **c**

(6 x 2) **[12]**

1.2

1.2.1 dichotomous key
1.2.2 phylogenetic/family
1.2.3 bacterium
1.2.4 pathogens
1.2.5 prothallus
1.2.6 angiosperms
1.2.7 fossils
1.2.8 hominins
1.2.9 half-life
1.2.10 radiocarbon dating

[10]

1.3

1.3.1 **c**
1.3.2 **d**
1.3.3 **b**
1.3.4 **a**
1.3.5 **e**

[5]

1.4

1.4.1 omnivores
1.4.2 primary consumers
1.4.3 decomposers
1.4.4 prey
1.4.5 scavengers
1.4.6 producers
1.4.7 predators
1.4.8 secondary consumers

[8]

1.5

1 5

1.5.1 **A** – because it has the highest clay content (2)
1.5.2 i **A** (1)
ii **C** (1)
iii **B** (1)
1.5.3 i **B** (1)
ii **B** (1)
iii **D** (1)
1.5.4 has a high water holding capacity, has a high mineral content (2)
1.5.5 drains slowly and therefore becomes waterlogged, it has poor aeration (2)
1.5.6 Humus: acts a sponge to increase the water holding capacity of the soil, organic material decays and adds minerals to the soil, and it improves the aeration of heavy soils. (3)

[15]

Total Section A: [50]

SECTION B

QUESTION 2

2.1

2.1.1 to make proteins (1)
2.1.2 in the form of nitrates, by active absorption from soil (2)
2.1.3 i level of nitrates decreases (2)
ii plants removed, therefore not all plant material decomposes to form humus, therefore reduced nitrates returned for use (3)
2.1.4 The ammonium salts will be converted to nitrates by nitrifying bacteria (3)
2.1.5 By adding compost, breakdown by bacteria, through ammonium compounds/nitrites, adds nitrates to soil, by growing leguminous plants, action of nitrogen fixing bacteria, in root nodules, adds nitrates to soil (4)
2.1.6 It could increase the humus content, which could improve drainage/aeration/water holding capacity (2)
2.1.7 They decrease the nitrate concentration in the soil (2)
2.1.8 Decomposition (1)

[20]

Total Question 2: [20]

QUESTION 3

3.1

3.1.1 set 3 (1)
3.1.2 increased photosynthesis due to increased carbon dioxide and increased temperature (3)
3.1.3 could burn coal/candle/paraffin/wood to increase carbon dioxide level (2)
3.1.4 similar soil/soil composition/minerals; same variety of tomato; same amount of water; equal number of plants per unit area (2)

[8]

3.2

3.2.1 The uptake of oxygen increases with the increase in the water temperature, thus decreasing the concentration of dissolved oxygen in the water. (2)
3.2.2 i oxygen uptake (1)
ii temperature of water (1)
iii dissolved oxygen (1)
iv temperature of water (1)
3.2.3 35 cm^3/kg/hour (1)
3.2.4 Change in level of dissolved O_2 = 12,5–2,5 mg/litre
= 10 mg/litre

$$\% \text{ change} = \frac{10}{15} \times 100$$

= 66,67% (3)
3.2.5 With an increase in water temperature the amount of dissolved oxygen decreases so that there is less oxygen available for the fish downstream. (2)

[12]

Total Question 3: [20]

QUESTION 4

4.1

4.1.1 230 million years ago (Ma) (1)
4.1.2 Mesozoic (1)
4.1.3 65 Ma (2)
4.1.4 Since O_2 levels were low at that time anaerobic bacteria could survive (2)

[6]

4.2

4.2.1 55–60 Ma (2)

4.2.2 Permian extinction (1)

4.2.3 400 – 200 = 200 families of species
OR
400 – (210 to 230) = (190 to 170) families of species (3)
[6]

4.3

4.3.1 i 300 million years ago (1)

ii bacteria (1)

iii amphibians (1)

iv birds (1)

4.3.2 Studying fossils/palaeontology; Anatomy; Taxonomy; Biogeography (2)

4.3.3
- We cannot observe these changes because they took place millions of years ago.
- Gaps in the fossil records/comparative anatomy, biochemistry, embryology (2)

[8]

Total Question 4: [20]

QUESTION 5

5.1

5.1.1 Palaeozoic Era (1)

5.1.2 i Palaeozoic Era (1)

ii Permian (1)

5.1.3 Caenozoic (1)

5.1.4 i 65 Ma (1)

ii Comet/star/meteorite/asteroid (1)

iii
- Extraterrestrial object hit the Earth
- Climate change occurred due to dust clouds
- Sunlight was blocked
- Ice age occurred
- Reduction of CO_2 in the atmosphere
- Photosynthesis decreased
- Many plants died
- Many animals died/dinosaurs became extinct (4)

[10]

5.2

5.2.1 High sewage level makes bacteria reproduce rapidly/ anaerobic bacteria flourish in sewage (2)

5.2.2 The concentration of dissolved oxygen decreased after the point of entry up to 300 m downstream and then increased further downstream. (2)

5.2.3 Initially the bacteria population increased resulting in a decrease of the oxygen level close to the point of entry of sewage. Eutrophication took place downstream, the number of algae increased, which released more oxygen during photosynthesis. Therefore water became re-oxygenated. 4)

5.2.4
- Proper sanitation.
- Sewage must be purified before it enters the river.
- Education to make people aware of proper waste disposal measures.
- Research – more efficient ways of treating sewage. (2)

[10]

Total Question 5: [20]
Total Section B: [80]

SECTION C

QUESTION 6

6.1 A food chain represents a path of energy flow from the sun through plants, animals, and micro-organisms at different feeding levels known as trophic levels. Energy is used, stored and lost, some energy is trapped as chemical potential energy during the process of photosynthesis and used by green plants or producers, which constitute the first trophic level, for their own metabolic processes. Some is stored as chemical potential energy, mainly in the form of glucose and starch. The most energy, however, is lost as heat during cellular respiration.

Plant-eating animals or herbivores constitute the second trophic level and use some energy for their own metabolic processes and for locomotion and keeping the body temperature constant and some is stored as carbohydrates, fats and proteins. Most energy is lost as heat during cellular respiration.

Carnivores constitute the third trophic level. They consume other animals to satisfy their energy needs and use, store and lose energy.

In the same way decomposers, such as bacteria and fungi, form the final trophic level. They break down the dead or decaying organic compounds such as plant and animal bodies as well as droppings and urine of animals. They use this energy to maintain their own life processes. As food is passed on from one trophic level to the next only a small proportion of the energy which was originally obtained from the sun is available to each subsequent trophic level. Energy is not recycled.

[20]

Total Question 6: [20]
Total Section C: [20]

TOTAL: [50]

SECTION C

PLANNING

Year planner

Year _____

Week	Planned date (week ending)	Completion date (week ending)	Topic for the week
TERM 1			
Week 1			Inorganic compounds Organic compounds
Week 2			Organic compounds
Week 3			Cells: molecular make up Microscopy
Week 4			Cell structure and function
Week 5			Cell structure and function
Week 6			Cell structure and function
Week 7			The cell cycle (including mitosis) Chromosomes
Week 8			Cancer Medical biotechnology Plant and animal tissues
Week 9			Plant and animal tissues
Week 10			Plant and animal tissues Formal assessment and practical task
TERM 2			
Week 1			Applications of indigenous knowledge systems and biotechnology
Week 2			Organs Anatomy of dicotyledonous plants
Week 3			Transpiration Wilting Guttation Uptake of water and minerals
Week 4			Transport of water and minerals to leaves Translocation of manufactured food
Week 5			Skeletons
Week 6			Human skeleton Functions of skeleton
Week 7			Bones, muscles and joints in locomotion
Week 8			Voluntary skeletal muscle Diseases that affect the skeleton
Week 9			June exam
Week 10			June exam
TERM 3			
Week 1			Mammalian blood circulation system
Week 2			Cardiac cycle
Week 3			Lymphatic system Diseases of heart and circulatory system
Week 4			Start ecology fieldwork project Biosphere
Week 5			Biomes Environment
Week 6			Ecosystems

Week	Planned date (week ending)	Completion date (week ending)	Topic for the week
Week 7			Ecosystems
Week 8			Energy flow through ecosystems Trophic structure (food pyramids)
Week 9			Ecotourism
Week 10			Assessment
TERM 4			
Week 1			Biodiversity and classification
Week 2			Life's history Geological time scale
Week 3			Cambrian explosion Significant changes in species occurring in Africa
Week 4			Mass extinctions Fossil formation Methods of dating
Week 5			Key events in life's history – evidence from southern Africa
Week 6			Impact of humans on biodiversity and the natural environment Fossil tourism
Week 7			Revision
Week 8			Formal exams and practical exams
Week 9			Formal exams and practical exams
Week 10			Formal exams and practical exams

SECTION D

TEACHING GUIDELINES

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



STRAND 1

MOLECULES TO ORGANS

Unit 1: The chemistry of life
Unit 2: Cells: the basic unit of life
Unit 3: Cell division: mitosis
Unit 4: Plant and animal tissues

Learner's Book pages 19–45
Duration: 10 hours

UNIT 1 The chemistry of life

TERM 1

Activity and self assessment question memos

Activity 1 Fertilisers and eutrophication *(Specific Aim 1)*

Learner's Book page 24

1 **a** Leaching – the washing out of minerals from the soil.
b Eutrophication – the process by which mineral nutrients accumulate in a fresh water body.

2 The rapid growth of algae and other water plants causes oxygen to be used up rapidly because light is blocked out and less photosynthesis occurs (photosynthesis releases oxygen). Also fungi and bacteria use and so deplete oxygen.

3 Oxygen depletion makes animals leave or die because they need oxygen for cellular respiration.

4
- do not overuse fertilisers
- only use fertilisers during the dry season so that there is no run-off
- do not over irrigate soil
- any other logical reason.

PPA

Activity 2 Testing for the presence of a carbohydrate (glucose) *(Specific Aim 2)*

Learner's Book page 26

1 So that heat is evenly distributed.

2 fructose, lactose and maltose

PPA

Activity 3 Testing for the presence of starch *(Specific Aim 2)*

Learner's Book page 27

1 Bread, rice, mealie meal, pasta, and so on.

2 Chalk, glucose, egg albumin, and so on.

3 Add some starch to the solution. If a blue-black colour is produced, then iodine is present in the solution.

PPA

Activity 4 Testing for the presence of fats and oils – the translucent spot test *(Specific Aim 2)*

Learner's Book page 28

1 Light can pass through but it is not transparent so that you can see through as, for example, in glass.
2 ether/methylated spirits

Activity 5 Fats and heart disease *(Specific Aims 1 and 3)*

Learner's Book page 31

1 Saturated fat – Every carbon in the fat molecule is fully bonded to four other atoms by single bonds. Unsaturated fats – One carbon atom in the fat molecule has a double bond with another carbon atom (unsaturated); if two or more double bonds are found in the fat molecule then it is a polyunsaturated fat.
2 Saturated fat, because this can cause a build up of plaque that can clog arteries.
3 Explanations of the terms:
   - Atheroma – blockage of an artery by fatty deposits.
   - Atherosclerosis – the narrowing of the artery wall.
   - Coronary thrombosis – blood clot formed as a result of atheroma in a coronary artery.
   - Angina is a condition that occurs when a coronary artery is partially blocked, which results in pain in the chest during exertion, and, if severe, during rest.
4 Less oxygen and fuel is supplied to muscles and less carbon dioxide and wastes are removed. Cells cannot undergo maximum cellular respiration, therefore less energy is available during vigorous exercise.
5 Poor diet containing high levels of cholesterol or saturated fats. Poor lifestyle factors such as smoking, lack of exercise, and leading a stressful existence. Genetic factors, such as a family history of heart disease can also predispose to the condition.
6 The genetic risk can be modified by modifying lifestyle factors – stop smoking, take regular exercise and eat a healthy diet.

PPA

Activity 6 Testing for the presence of proteins (Millon's reagent test) *(Specific Aim 2)*

Learner's Book page 33

Learners see that the solution in test tube A becomes a brick-red precipitate (positive result) and no colour change occurs in test tube B (negative result).

RPA

Activity 7 An alternative test for proteins – the Biuret test *(Specific Aim 2)*

Learner's Book page 33

1 albumin
2 milk or any meat

RPA

Activity 8 Food composition *(Specific Aim 2)*

Learner's Book page 34

1 Cheese, peanuts
2 Cheese, chicken
3 Potatoes, beans
4 Apple, sugar
5 Sugar, bread

Activity 9 Using food tests *(Specific Aim 1)*

Learner's Book page 35

1 **a** B **b** A
2 E 3 E 4 D

RPA

Activity 10 Testing the composition of an unknown sample of food *(Specific Aim 2)*

Learner's Book page 35

Answers will differ between groups depending on the types of food that the groups test. Learners should present their findings in a table.

PPA

Activity 11 Investigating the effect of temperature on enzyme activity *(Specific Aim 2)*

Learner's Book page 38

1 To monitor the temperature of each water bath – to maintain the correct temperature at all times.
2 Pepsin only functions in an acidic medium.
3 37 °C

PPA

Activity 12 Investigating the effect of pH on enzyme activity *(Specific Aim 2)*

Learner's Book page 39

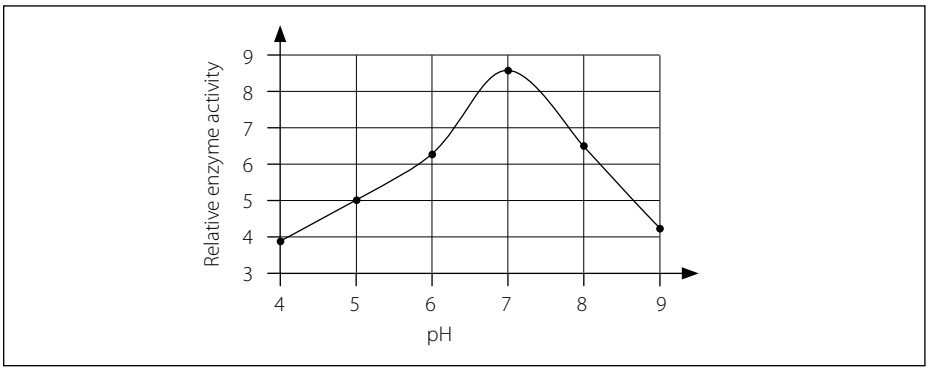
1 HCl – creates an acidic pH; sodium bicarbonate – creates an alkaline pH; water – increases the rate of the reaction.
2 It is the optimum temperature for the action of the pepsin.
3 Yes. Changes in pH can denature (change the shape of the active site) the enzyme.

RPA

Activity 13 The properties of enzymes *(Specific Aim 2)*

Learner's Book page 40

1



2 Enzymes are sensitive to pH. This enzyme works best at pH 7. Its activity increases from pH 4 to pH 7. Its activity decreases from pH 7 to pH 9.

3 **a** 40 °C
b Enzymes structure is changed/altered – it becomes denatured.
c At 20 °C activity was 1,7–1,8. At 30 °C enzyme activity was 3,3–3,4.
d approximately two times
e An acid – this enzyme works best in an alkaline medium. An acid would denature the enzyme and it would not function in an alkaline medium.

RPA

Activity 14 Ph and enzyme activity *(Specific Aim 2)*

Learner's Book page 40

1 Approximately pH 6
2 pH 3 to pH 8
3 An increase in alkalinity causes a drop in enzyme activity because the shape of the enzyme molecule is altered, which means that the enzyme is denatured and at pH 9 enzyme activity stops.

PPA

Activity 15 Designing a simple investigation *(Specific Aim 2)*

Learner's Book page 41

1 The teacher should provide the materials for the investigation if necessary. Materials required: pieces of cloth (all of the same size), biological washing powder, ordinary washing powder, eggs.
2 Make sure that all variables for the experiment and control are the same except for the difference in the washing powder used.
3 The teacher should reinforce the concept of an experiment and a control.

RPA

Activity 16 Making models of molecules *(Specific Aim 2)*

Learner's Book page 41

This activity is important because it allows learners to consolidate the concepts of hydrolysis and the condensation reaction.

Activity 17 The structural differences between DNA and RNA *(Specific Aim 1)*

Learner's Book page 43

DNA	RNA
Double helical structure	Single stranded structure
Made up of A, C, G and T	Made up of A, C, G and U
Nitrogenous bases pair off – A with T and G with C	Limited pairing of bases
Has deoxyribose sugar	Has ribose sugar
Found in nucleus making up chromosomes	Found in nucleolus and cytoplasm

Self assessment questions

1 The paragraph should include all seven features of living organisms, with a brief sentence about each feature.
2 Inorganic molecules do not contain chains of carbon atoms. Examples include water, mineral salts such as salt, calcium salts, magnesium salts and potassium salts.
3 See pages 36-37 in Learner's Book.
4 The paragraph should include the full names of DNA and RNA, the fact that they are nucleic acids, the fact that DNA forms chromosomes and is made up of four nucleotides (named), and where each is found in the cell.
5 A vitamin is an organic compound that is essential for the maintenance of many metabolic activities in the body. Mention should be made of water and fat soluble vitamins. Learners will choose different vitamin deficiency diseases.

Learner's Book pages 46–75
Duration: 12 hours

UNIT 2 Cells: the basic unit of life

TERM 1

PPA

Activity 1 Setting up and using a compound light microscope *(Specific Aim 2)*

Learner's Book page 49

Reviewing the structure of the compound microscope.

2 *Eyepiece*: magnifies the specimen on the slide.
Objective lens: this lens is movable; it is used to view slides under different magnifications.
Stage: the platform on which the slide is placed.
Stage-clips: clips that hold the slide in place on the stage.
Coarse adjustment knob: this part moves the body tube to focus the slide clearly (big movements).
Fine adjustment knob: moves the body tube to focus the slide clearly (small movements).
Body tube: a structure that moves up or down only, and is used for focusing.
Arm: the part you use to hold the microscope.
Base: the part that is placed on the work surface.
Mirror: reflects light onto the slide.

Calculating the total magnification of the object.

2 Magnification = 10 × 40
= 400

RPA

Activity 2 Determining the size of a mitochondrion *(Specific Aim 2)*

Learner's Book page 53

Real length of mitochondrion

$$= \frac{\text{length in mm} \times \text{the length of the scale line in } \mu\text{m}}{\text{the length of the scale-line in mm}}$$

$$= \frac{84 \text{ mm} \times 2 \ \mu\text{m}}{10 \text{ mm}}$$

= 16,8 μm

PPA » Activity 3 Observing plant cells *(Specific Aim 2)*

Learner's Book page 53

Note: If this is the first time that your learners are making slides, you should first demonstrate the technique of making a wet mount slide.

1–6 Give instructions to the learners on how to prepare a wet mount of plant tissue.

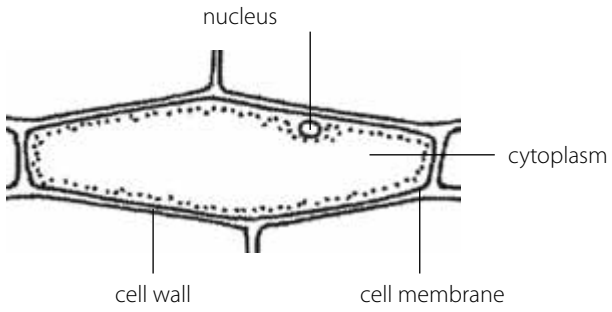
7 Cell wall

8 Cell membrane

9 Yes

10 Regular/hexagonal (more or less)

11



Onion epidermis

12 Iodine makes the cell blue/black.

PPA » Activity 4 Observing animal cells *(Specific Aim 2)*

Learner's Book page 54

1–9 Give instructions to the learners on how to prepare a wet mount of animal tissue.

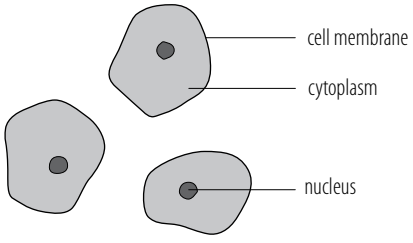
10 Irregular to round.

a No

b No, they do not have a cell wall.

c Cheek cells stick together in clumps. This is because they do not have a cell wall and the cell contents of the cells are sticky.

11



Epithelial cells from inner cheek

12 a

Differences between plant and animal cells		
	Plant cells	**Animal cells**
1	In addition to the cell membrane, plant cells have a cellulose cell wall.	Animal cells have no cell wall.
2	Most cells are regular in shape.	Most cells are irregular in shape.
3	Most cells have chloroplasts.	They have no chloroplasts.
4	Most cells have very large vacuoles, which contain cell sap.	The cells have only small vacuoles.
5	Many cells have stored starch granules.	The cells do not have stored starch granules (although they may have glycogen granules).

b

Similarities between plant and animal cells		
Characteristic	**Plant cells**	**Animal cells**
There is a membrane surrounding the cell.	✓	✓
The cell has cytoplasm.	✓	✓
The cell has a nucleus.	✓	✓

RPA

Activity 5 Comparing plant and animal cells *(Specific Aim 2)*

Learner's Book page 56

1 More detail of each cell can be seen now. Organelles that were too small to be seen with a mirror microscope can now be clearly seen in Figures 2.10 and 2.11.

2 Learners must write down the names of all those organelles/structures they did not name in Question **1**.
Mitochondria
Golgi apparatus
Vacuole
Lysosome
Centrioles
Ribosomes
ER

Plant cell	Animal cell
do not have centrioles	have centrioles
do not have lysosomes	have lysosomes
large vacuole(s) present	small vacuole(s) present
presence of cellulose cell wall	no cell wall
regular in shape	most cells irregular in shape
most cells have chloroplasts	have no chloroplasts
many cells have starch granules	no starch

4 Both have cell membranes.
Both have nuclei.
Both have mitochondria, ER, ribosomes, vacuoles, Golgi apparatus.

PPA

Activity 6 Observing diffusion in liquids *(Specific Aim 2)*

Learner's Book page 60

1 It leaves a trail of colour.
2 The crystals are at the bottom of the beaker.
3 Molecules of crystals move from the region of high concentration of those molecules (bottom of beaker) to a region of low concentration (rest of beaker) until they are evenly dispersed across the whole beaker.
4 No, molecules still have kinetic energy and move continuously.
5 Substances (oxygen, carbon dioxide, mineral salts, food, and so on) move from one part of the plant to another by diffusion.

PPA

Activity 7 Observing osmosis using potato tissue *(Specific Aim 2)*

Learner's Book page 62

1 No
2 Plants absorb water from the soil by osmosis. Also water moves within the plant by osmosis.
3 Put the limp vegetables into pure cold water. The cells of the vegetables have a lower concentration of water compared to the pure water. Water therefore moves by osmosis (endosmosis) into the cells of the vegetables.

Activity 8 Movement of water between cells *(Specific Aim 1)*

Learner's Book page 64

1 A to B
2 Water always moves from an area of high concentration of water molecules to an area of low water molecules through a selectively / differentially permeable membrane.
3 Osmosis
4 a Water molecules will move out of the cells into the sugar solution by osmosis, causing them to shrink.
b Water molecules will move into the cells causing them to become stiff / turgid.

RPA

Activity 9 Investigating plastids *(Specific Aim 2)*

Learner's Book page 70

The practical part of this activity could be assessed by using the checklist for the preparation of a wet mount (on page 55 of Learner's Book).

Chloroplasts

1 Chloroplasts are oval-shaped.
2 Green, chlorophyll.
3 Chloroplasts could move to where the light enters the cell. Another advantage is that the movement allows for the distribution of substances to all parts of a cell.
4 Plants with chloroplasts (and chlorophyll) are the only organisms capable of trapping sunlight to make food and release O_2 during the process of photosynthesis. This food is the basis of all food chains on Earth. Without plants, there would be no food for all other organisms.

Leucoplasts

1 Oval shaped and colourless.

2 They do not contain thylakoids and chlorophyll.

» Activity 10 Plant and animal cells *(Specific Aim 1)*

Learner's Book page 72

1 Plant cell
- surrounded by cell wall, 1
- large vacuole, 7, is present
- chloroplasts, 10, occur.

2 nucleoplasm and cell sap

3 **a** vacuole, 7
b tonoplast, 5
c cell membrane, 8
d nucleus, 4

» Activity 11 Understanding organelles *(Specific Aim 1) (Formal Assessment Task)*

Learner's Book page 73

1 Organelle 1: chloroplast.
Organelle 2: mitochondrion.

2 Use this checklist to assess the drawing of a chloroplast.

Size	1
Shape	1
Quality of line	1
Correct proportions	1
Labels:	
double membrane	1
stroma	1
granum	1
thylakoid	1
Caption	1
Total	**9**

3 Grana

4 Leaves

5 Mitochondria function in aerobic respiration: where energy is released by breaking down food in the presence of oxygen.

6 More mitochondria will be found in the muscle cell, because it is the more active cell and needs more energy.

7

Chloroplast	Mitochondrion
found only in plant cells	found in both plant and animal cells
surrounded by two smooth membranes	outer membrane is smooth, inner membrane is folded to form cristae
has chlorophyll	no chlorophyll
has thylakoid membranes arranged in a stack to form grana	no grana
contains enzymes for the process of photosynthesis	contains enzymes for aerobic respiration
photosynthesis takes place here	aerobic respiration takes place here
CO_2 absorbed	O_2 absorbed
O_2 released	CO_2 released
Any 5	

8 **a** *Chromatin network*: carriers of hereditary characteristics, which are passed on from parent to offspring (also from one cell to another in the same organism).

b *Nucleolus*: involved in the synthesis of proteins in a cell.

c *Ribosomes*: the sites of protein synthesis in a cell; it is on the ribosomes that amino acids are linked together to form proteins.

d *Golgi apparatus*: a secretory function; many Golgi bodies are found in gland cells which have a secretory function.

e *Vacuole*: maintains the turgidity of plant cells; vacuoles also have a storage function.

f *ER*: provides surfaces for the attachment of ribosomes; proteins are synthesised on the ribosomes and transported throughout the cell by the RER; SER synthesises lipids and steroids.

g *Chloroplast*: responsible for the process of photosynthesis where food is produced and O_2 is released as a by-product.

h *Cell wall*: gives shape, strength and rigidity to the plant cell; it is fully permeable to most substances because of the relatively large spaces between the cellulose microfibrils.

Activity Self assessment questions

1 **a** Protoplasm
Nucleus
Cytoplasm, cell membrane, cytosol, mitochondria, vacuoles, Golgi apparatus, ER, ribosomes

b plastids
cell wall

c protoplasm

d It is non-living and is found outside the protoplasm.

2 **a** Differentially permeable/selectively permeable.

b Learners need to explain the following terms in their account: bilayer, phospholipid, hydrophilic, hydrophobic

PPA

Activity 1 Looking at mitosis *(Specific Aims 1 and 2)*

Learner's Book page 82

1 A: Cell membrane.
B: Centriole.
C: Chromosome.

2 6

3 An animal cell, because no cell wall present (only a cell membrane is present). Also, centrioles are present, which are found mostly in animal cells.

4 Metaphase, because chromosomes are arranged along the equator of the spindle which is characteristic of metaphase.

5 6

6 46

7 One daughter cell has one half of a chromosome (one chromatid) that has an identical half (one chromatid) in the other daughter cell.

RPA

Activity 2 Understanding the process of mitosis *(Specific Aims 1 and 2)*

Learner's Book page 82

This activity will help learners to understand exactly how the process of mitosis takes place. Each pair of learners must follow the instructions given in the activity.

Activity 3 Cancer *(Specific Aim 1)*

Learner's Book page 87

1 Many people are dying of cancer because it is diagnosed when it is too late for treatment.

2 Nowadays there is more exposure to cancer causing agents, for example radiation, carcinogenic chemicals, etc. People also make poor lifestyle choices such as excessive drinking, smoking and drug taking.

3
- Cancer patients should get free treatment at state hospitals.
- Cancer patients should get subsidised treatment at state hospitals.

Learner's Book page 87

Use the following checklist to assess the learner's projects.

The poster	Yes	No
Contains a detailed sketch of the human body, showing the exact position of the organ affected by cancer.		
Has a few lines clearly describing the normal function of the organ.		
Includes a description of the symptoms of the cancer affecting that organ.		
Gives a description of the carcinogenic agent that could have caused the cancer.		
Lists some measures that could be taken to prevent contracting the cancer.		
Lists the treatment that the patient would undergo in order to destroy the cancer.		
The presentation	**Yes**	**No**
Was interesting and held the attention of the audience.		
Was insightful and showed comprehension of the working and the effects of the disease.		
Was well researched and complemented the poster.		
Clearly explained the measures that could be taken to prevent contracting the cancer.		
Showed a clear understanding of the treatment that the patient would undergo in order to destroy the cancer.		

» Activity Self assessment questions

1 Learners should include information on the types of nuclear division – mitosis and meiosis, the number of chromosomes in the daughter cells of each type of division and explain the processes that occur during the cell cycle.

2 Learners should describe each phase in turn, explaining what happens to the cell and the chromosomes in each phase.

3 Learners should mention that mitosis is the means by which a zygote grows into a multicellular organism, that mitosis is responsible for the replacement of cells and the repair of tissues, and that mitosis produces new individuals during asexual reproduction.

4 Learners' answers will differ.

5 Learners should include lifestyle changes for prevention, radiation therapy, chemotherapy and surgery.

Activity 1 Test yourself: Understanding tissues, organs and systems *(Specific Aim 1)*

Learner's Book page 92

1 lungs: organ
skin: organ
neuron: cell
earthworm: organism
root hair: cell
eye: organ
root: organ
all the bones in your body: tissue
erythrocyte: cell
xylem: tissue

2 The division of labour is when different cells are specialised to carry out particular functions, for example, muscle cells contract and relax and cause movement of an organism, skin cells protect the inner part of a body, and so on.

3 An organelle is the structure found within a cell, for example, mitochondria and chloroplasts.

An organ consists of many tissues grouped together to make a structure with a special function, for example, the heart or the eye.

4 Yes, for example, amoeba, bacterium or any other unicellular organism.

Activity 2 Plant tissues *(Specific Aim 1)*

Learner's Book page 95

Plant tissue	Location	Function(s)	Structural adaptation to function
1 Meristematic	Apical meristem: at the tips of the main and lateral shoots and near the tips of roots. Lateral meristem: found on sides of stem or root.	For growth in length (primary growth). For growth in width (secondary growth).	Thin-walled with a large nucleus so that rapid mitosis can take place.
2 Parenchyma	Occurs in the pith and cortex of stems and roots and the mesophyll of the leaf.	The large vacuoles fulfil a storage function. Intercellular air spaces store gases for the process of photosynthesis and respiration, as well as to allow water to pass through. When they contain chloroplasts (chlorenchyma), they synthesise food.	Have large vacuoles for storage of nutrients. Also, thin walls allow for easy diffusion of gases and nutrients. Intercellular air spaces allow free circulation of oxygen and carbon dioxide throughout the tissue.

Plant tissue	Location	Function(s)	Structural adaptation to function
3 Chlorenchyma	In green leaves and green stems.	Photosynthesis	Chloroplasts inside these thin-walled cells allow these cells to undergo photosynthesis. The thin walls also allow for easy diffusion of oxygen and carbon dioxide.
4 Aerenchyma	In stems and roots growing in water-logged soil.	Stores gases for photosynthesis and respiration.	These are parenchyma tissue that has large intercellular air spaces to store gases.
5 Collenchyma	In herbaceous stems.	Provides mechanical support and strengthening of the organ in which it is present, as well as allowing flexibility of the organ.	The corners of the cell walls are thickened with pectin and cellulose. This strengthens the cell but allows flexibility.
6 Sclerenchyma	In roots, stems, leaves and fruit.	Thick cell walls (often cemented by lignin) give strength and support to the organ in which it is found.	Possess thick cell walls with lignin, which strengthens the cell wall to support the parts of the plant in which sclerenchyma is found.
7 Xylem	In leaves, stems and roots in vascular bundles.	Rapid transport of water and mineral salts.	Xylem vessels are arranged end to end to form long tubes, which makes the vessels structurally adapted to transport water. The vessels have the cell walls thickened with lignin to withstand the hydrostatic pressure. The different types of cell wall thickenings allow for flexibility of roots and stems in which xylem vessels are found. Xylem tracheid's cell walls are also thickened with lignin for support and strength for the stem and root.
8 Phloem	In leaves, stems and roots in vascular bundles.	They are adapted for the transport of food throughout the plant.	Sieve tube elements are elongated and are arranged end to end to form tubes for transport of food in plants. The cross walls between the sieve tube elements are perforated to allow food to pass through.

Plant tissue	Location	Function(s)	Structural adaptation to function
9 Epidermis	In protective covering over roots, stems and leaves.	Protection of the underlying tissues. Epidermal cells are transparent, allowing light to penetrate into the interior tissues of stem and leaf for photosynthesis.	Epidermal cells are transparent to allow light to pass through to photosynthetic cells. They secrete a transparent waxy layer called the cuticle to reduce water loss through evaporation. Some epidermal cells (especially on lower epidermis of leaves) are modified to form guard cells, which are structurally adapted to open and close the stomata.

PPA

Activity 3 Permanent tissues *(Specific Aims 1 and 2) (Formal Assessment Task)*

Learner's Book page 96

1 If no slides are available, pictures may be used.

2 and **3** Use the following checklist to assess the drawings:

Size		1
Shape		1
Quality of line		1
Correct proportions		1
Caption		1
Labels:	(variable)	4
Total		**9**

4
- Parenchyma have large vacuoles for storage function, and intercellular air spaces store gases for the process of photosynthesis and respiration. These spaces also allow water to pass through. When they contain chloroplasts (chlorenchyma), they synthesise food.
- The corners of the cell walls of collenchyma are thicker than the rest of the wall. This is for mechanical support and strengthening of the organ in which it is present. This structure also allows the organ in which it is present to be flexible.
- Sclerenchyma cells possess thick cell walls (often cemented by lignin). This gives strength and support to the organ in which it is found.
- Epidermis contains brick-shaped cells. Most of the epidermal cells in leaves and stems have thicker outer cell walls for protection of the underlying tissues. Epidermal cells are transparent, allowing light to penetrate into interior tissues of stem and leaf for photosynthesis.
- Xylem vessels are long, tubular structures found end to end to form long tubes. They are adapted for conduction of water. Xylem vessels have thickened cell walls for strengthening. Xylem tracheids are long, slender and tapered at the ends and with thickened cell walls. They have a strengthening and support function as well as the conduction of water function.

- Phloem sieve tubes consist of a vertical row of elongated sieve tube elements. They are adapted for the transport of food throughout the plant.

5 Collenchyma
Sclerenchyma
Xylem vessels
Xylem tracheids
Phloem/xylem fibres
All of them have a supporting and strengthening function.

6 Parenchyma
Companion cells
Sieve tubes
Some epidermal cells
These allow for transport of substances into and out of the cells.

7

Sclerenchyma	Collenchyma
Strong, hard and rigid cell walls, which are lignified.	Flexible non-lignified cell walls.
Cells lack protoplasts at maturity, are more permanent and not capable of cell division by mitosis.	Cells contain living protoplasts and are capable of cell division by mitosis.
Do not have chloroplasts.	May have chloroplasts for the process of photosynthesis

8

Xylem	Phloem
Conducts water and mineral salts in plants.	Conducts dissolved food in plants.
Xylem vessels, tracheids and fibres have thickened cell walls.	Only phloem fibres have thickened cell walls.
Made up of vessels, tracheids, fibres and parenchyma.	Made up of sieve tubes, companion cells, fibres and parenchyma

9 Root epidermis lacks a cuticle, has no guard cells and therefore no stomata and has special outgrowths called root hairs. Leaf epidermis has a cuticle, has guard cells and therefore has stomata.

10 Xylem vessels are long, tubular structures arranged end to end to form long tubes for water conduction. They also have thickened cell walls to withstand the cohesive and adhesive forces of water conduction in the vessels. Xylem vessels have no living contents and are therefore hollow – adapted for rapid transport of water and mineral salts.

11 Parenchyma Sieve tubes
Collenchyma Companion cells
Epidermis

» Activity 4 Four types of epithelium *(Specific Aim 1)*

Learner's Book page 105

	Squamous	Columnar	Ciliated	Cuboidal
Location	Lines mouth, oesophagus, capillaries and alveoli of lungs.	Lines intestines.	Lines nasal cavities, tracheae and bronchi.	Lines glands.
Structure	Single layer of flat cells.	Tall, column-like cells.	Tall, column-like cells with cilia.	Cuboidal shape.
Function(s)	Protects underlying tissues. Differentially permeable allowing certain substances to pass through.	Absorption of nutrients. Goblet cells secrete mucus.	Cilia and mucus from goblet cells trap dust and other particles entering the air passages.	Secretory function.

RPA

» Activity 5 Altitude and red blood corpoSCles *(Specific Aim 2)*

Learner's Book page 109

1 People at low altitude have fewer red blood corpuscles than those at high altitude / People at high altitude have more red blood corpuscles than those at low altitude.

2 **a** The dependent variable is the number of red blood corpuscles.

b The independent variable is the height above sea level / altitude.

3 **a** The greater the altitude, the greater is the number of red blood corpuscles in a person's blood.

b Air is thin at high altitudes, so a person needs more red blood corpuscles to carry as much oxygen as possible.

c Lamontville Golden Arrows live and train at low altitude (sea level), hence have fewer red blood corpuscles. When in Gauteng (high altitude), less oxygen is available, and so not enough oxygen goes to the body cells for cellular respiration. Less energy is available and the Arrows players become very tired.

d The Arrows team need to train and live for a few weeks at high altitude so that more red blood corpuscles can develop before they play in Gauteng.

e Table shows the number of red blood corpuscles (in millions per 1 mm^3 of blood) at different altitudes.

Altitude (m)	Number of red blood corpuscles (millions/mm^3 of blood)
0	5,0
1 000	5,5
2 000	6,1 – 6,2
3 000	6,8 – 6,9
4 000	8,0

f No. The scientist probably took blood from a sample of individuals and calculated the average result.

Activity 6 Investigation into the discovery of penicillin
(Specific Aims 1 and 3)

Learner's Book page 114

Answers will vary but learners should show evidence of research from as many different sources as are available to them.

PPA

Activity 7 Investigating biotechnology *(Specific Aims 1, 2 and 3)*

Learner's Book page 118

Give learners the following newspaper articles that they can use for research, but encourage them to find other sources as well if possible.

Tailor-made treatments

Scientists send skin cells back to embryo stage, writes **Maggie Fox**

US researchers said yesterday that they have created a new human embryo stem cell by fusing an embryonic stem cell to an ordinary skin cell.

They hope their method could someday provide a way to create tailor-made medical treatments without having to start from scratch using cloning technology.

This would mean generating the valuable cells without using a human egg, and without creating a human embryo, which some people, including US President George Bush, find objectionable.

But the team, led by stem cell expert Dr Douglas Melton, Kevin Eggan and others at Harvard Medical School, stress in a report to be published in next Friday's issue of the journal *Science*, that their method is not yet perfect.

Stem cells are the body's master cells, used to regenerate tissues, organs and blood. Those taken from days-old embyros are considered the most versatile. They can produce any kind of tissue in the body.

Doctors hope to someday use embryonic stem cells as a source of perfectly matched transplants to treat diseases.

But because some people object to the destruction of or experimentation on a human embryo, US law restricts the use of federal funds for this type of research.

It is a hot debate in Congress and several bills have been offered for consideration when the Senate comes back next month. Their conclusion would either relax the federal restrictions or tighten them.

Melton has complained about the restraints and used private funding to pursue stem cell work. He and other experts say they only want to understand how to reprogram an ordinary cell and hope the use of human embryos would be a short-term and interim step to learning how to manufacture these cells.

Currently, embryonic stem cells are either taken from embryos left over from fertility clinics, or generated using cloning technology called nuclear transfer. This requires taking the nucleus out of an egg cell and replacing it with the nucleus of an adult cell, called a somatic cell, from the person to be treated.

Done right, this reprograms the egg, which starts dividing as if it had been fertilised by a sperm.

"On the basis of previous experiments with mouse embryonic stem cells we reasoned that human embryonic stem cells might provide an alternative source of material for the reprogramming of human somatic nuclei," the Harvard team wrote.

They fused embryonic stem cells to human adult skin cells, and managed to reprogram them to an embryonic state.

The new cells acted like stem cells, forming tumours called teratomas when injected into mice. The cells also appeared to be very long-lived, another test of a true embryonic stem cell.

And when cultured in lab dishes, the cells differentiated, or matured, into the three major basic types of cells.

"In conclusion, these findings show that human embryonic stem cells have the capacity to reprogram adult somatic cell chromosoms after cell fusion," the researchers wrote.

But there is a "substantial technical barrier", they warned. The newly fused cells contain chromosomes from the original embryonic stem cell. Therefore, it would not be a perfect genetic match to the patient. Researchers hope that if they can get around this problem, they will have found a way to generate the valuable cells.

Source: Reuters, reprinted in Daily News, *August 23 2005*

First stem cell banks for SA

South Africa's first state-of-the-art human stem cell bank opens in Cape Town early next month.

Now parents of new-borns will be able to take out health insurance of a different sort by storing umbilical stem cells at the bank which is not only the first in the country, but the first and only on the continent.

The stem cells of new-born children, which are contained in the blood of the umbilical cord, will be frozen and can be used later in the treatment of more than 45 diseases, should any of these be contracted by the child, including a whole range of cancers, genetic diseases, immune system deficiencies and blood disorders.

The bank, owned by Lazaron Biotechnologies, includes a laboratory, a storage facility and offices. It will be situated at the Tygerberg Hospital complex.

Dr Daniel Barry, a well-known researcher and Stellenbosch University lecturer, who heads the bank, said two pregnant women had already agreed to the procedure, which involved taking a sample of cord blood within a 15-minute window period after the child was born.

One of them is Norma Saayman who works for the university.

She said when she first heard about it she immediately thought about cloning and other horror stories.

But when she found out more about the bank she realised it would be "a good investment" for the future of her first child. "This is the best thing I could do for my child."

Barry said cord blood collected from a new-born had a one in four chance of matching the cellular makeup of siblings, providing potential relief in these cases.

Unlike embryo stem cell research there was no controversy because it had no detrimental effect on the mother or the baby.

Stem cells were the primary cells in the body and had the potential to develop into many different types of tissues and could be induced in a laboratory environment to become cells with special functions, such as contracting cells of the heart muscle or insulin-producing cells of the pancreas.

Barry said, "There is a short window period once the baby is born when a small sample of blood is extracted from the cord before the blood starts to clot. After extraction, the storage procedure takes four to five hours."

The stem cell bank was aiming at receiving 10 samples a day or 3 600 a year. Extraction fees would cost about R6 500 and storage fees R110 a year.

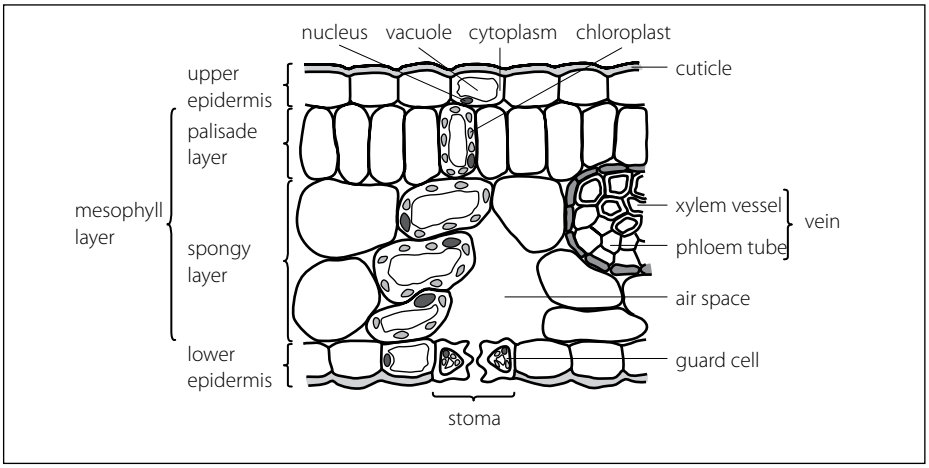
Until now it cost South African parents between R12 000 to R25 000 for collection of cord blood, and storage in various banks abroad, plus annual storage fees of between R600 and R1 000 a year.

They are in the final stages of equipping and furbishing the facility and it should be fully operational next month.

Saayman said that this was a unique opportunity for expectant parents to "insure" their children's future health.

Source: Melanie Peters, Daily News, *August 23 2005*

Learner's Book page 118



4 Learners will find the fnction of each tissue in the Learner's Book.

» Self assessment questions

1 Learners should mention xylem and phloem and explain the function of each.
2 Meristematic tissues are tissues made up of cells that are actively dividing.
3 Learners should mention epithelia, connective, muscle and nerve tissue. Blood tissue is a liquid connective tissue.
4 An antibody is a chemical substance that the body produces when it is invaded by a pathogen. An antigen is a chemical substance that is found on the surface of pathogens, which is specific to a particular pathogen.
5 A pathogen is an organism or substance that causes harm when it invades the body.
6 Learners should show that they understand the concept of antibodies, antigens and memory cells and that the invading pathogen is destroyed before it can do any damage because the memory cells recognise it.
7 Learners should find the Expanded Programme of Immunisation for South Africa – EPI-SA.

Age	Antigen	Route of administration
Birth	OPV and BCG	Orally and intradermal
6 weeks	OPV, DPT-Hib and Hep B	Orally and intramuscular (IMI) x 2 thigh
10 weeks	OPV, DPT-Hib and Hep B	Orally and IMI x 2 thigh
14 weeks	OPV, DPT-Hib and Hep B	Orally and IMI x 2 thigh
9 months	Measles	IMI thigh
18 months	OPV, measles and DPT	Orally and IMI deltoid
5 years	OPV, DT	Orally and IMI deltoid

Key: OPV – oral polio vaccine; BCG - Bacille Calmette-Guérin (against tuberculosis); DPT – diphtheria, pertussis (whooping cough), tetanus; Hib – *Haemophilus influenzae* – Type B; Hep B – hepatitis B; IMI – intramuscular injection

Other vaccines may be added in the private sector, such as chicken pox (varicella).

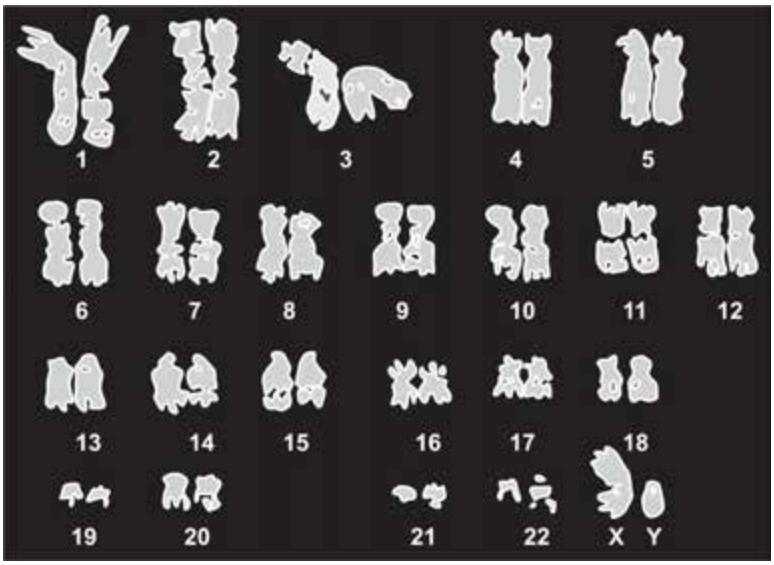
8 Learners should mention that the leaf is flattened, the cuticle and epidermis are transparent, the xylem allows water to move through the tissues for photosynthesis, the pallisade cells are arranged at right angles to the epidermis for maximum exposure to light, the mesophyll tissue is situated between two transparent epidermal layers for maximum exposure to light, the leaf contains air spaces to allow rapid diffusion of carbon dioxide to the mesophyll cells, stomata control the intake of carbon dioxide, the loss of water and the release of oxygen, the phloem transports the products of photosynthesis away from the leaf, the spongy mesophyll cells are thin-walled for rapid diffusion of carbon dioxide and water, and the vacuoles store the products of photosynthesis.

Extension activities

These activities may be done at the discretion of the teacher and if time allows.

» Activity Studying human chromosomes *(Specific Aim 1)*

Study the figure shown on this page, which shows chromosomes taken from a body cell of a human male. Answer the questions that follow.



1 Count and write down the number of chromosomes found in a human cell.
2 Describe the appearance of each pair of chromosomes.
3 Name the two strands that make up the chromosome.
4 What chemical substance is the main constituent of chromatids?
5 State why the two chromatids are identical to each other.
6 Define a gene.
7 Name any three characteristics that are controlled by genes.
8 What do the abbreviations RNA and DNA stand for? State the function of each substance.
9 Why do you think the chromosomes in the figure appear in pairs?

Memo

1 46 chromosomes
2 Each of the pairs has a similar structure. The last pair (23rd) is different: one is larger than the other.
3 Chromatids
4 DNA: deoxyribonucleic acid.
5 DNA is capable of duplicating itself.
6 A gene is a block of DNA that controls one characteristic of the organism.
7 Eye colour
Height (how tall)
Shape of nose
Accept any other characteristic.
8 RNA: ribonucleic acid.
Plays an important role in the synthesis of proteins in a cell.
DNA: deoxyribonucleic acid.
Carries and transmits genetic characteristics from one cell to another and from one organism to another.
9 One of each pair came from the mother (egg cell) and one from the father (sperm cell).

» Activity Looking at X-rays *(Specific Aim 1)*

Bring X-ray photographs of bones to school. Some of your friends and family are likely to have had their chests X-rayed if they had been ill, or have had parts of their limbs X-rayed if they had broken a bone. Try to identify the bone from the X-ray. Bone is made up of living tissue, since they are able to repair themselves.

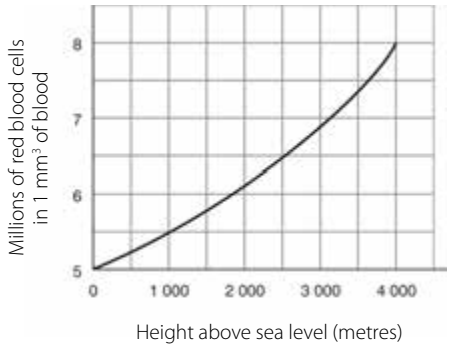
» Activity More about the blood *(Specific Aim 1)*

The function of the erythrocytes is to carry O_2 around the body. They can do this because they are packed with an iron-containing pigment called haemoglobin. Haemoglobin joins with O_2 to form an unstable compound called oxyhaemoglobin.

haemoglobin + oxygen ↔ oxyhaemoglobin

1 The reversible reaction sign (↔) shows that oxyhaemoglobin splits easily. What is formed when oxyhaemoglobin splits?
2 Erythrocytes have no nuclei. They lose their nuclei before they go into the bloodstream. Without a nucleus, erythrocytes have a larger surface area and contain as much haemoglobin as possible. In terms of exchanging and carrying oxygen, explain the advantages of having:
a a large surface area
b as much haemoglobin in the cell as possible.
3 Iron in our diet is essential for the synthesis of haemoglobin. If there is a shortage of iron in our diet, we become anaemic. Anaemic people have fewer red blood cells and less haemoglobin in each red blood cell. Explain why people who are anaemic:
a look pale
b often feel tired and cold.

4 Study this graph and answer the questions that follow.



a What is the relationship between the number of red blood corpuscles and the height above sea level?
b Suggest a reason for this relationship.
c The Natal Sharks rugby team often get very tired in the last quarter of their matches when they play Gauteng Lions in Gauteng. Explain why in terms of the information from the graph above.
d Explain how the Natal Sharks team can overcome this problem.

5 Read this passage and then answer the questions that follow.

When fuels, such as petrol and natural gas, burn completely, they produce CO_2 and water. If there isn't enough oxygen to burn them completely, some carbon monoxide is produced as well. Industries and vehicles are the chief producers of carbon monoxide. Carbon monoxide is a poisonous gas – it cannot be seen or smelt. The symptoms of carbon monoxide poisoning are headaches and confusion, followed by difficulty in breathing, then by a coma and finally death. How does carbon monoxide poison you? The haemoglobin in your red blood corpuscles absorbs carbon monoxide more easily than it absorbs O_2. Carbon monoxide combines with haemoglobin to form cherry red carboxyhaemoglobin. This reaction is irreversible. So, this haemoglobin can no longer carry oxygen. The brain is the first organ to suffer from a lack of oxygen.

a Write a word equation for the reaction between haemoglobin and carbon monoxide.
b Explain how this reaction is different from the reaction between haemoglobin and oxygen.
c Explain the symptoms of carbon monoxide poisoning.

Memo

1 Haemoglobin + O_2
2 **a** More O_2 can be carried by the erythrocyte.
b More haemoglobin can combine with O_2 to form oxyhaemoglobin.
3 **a** Blood of an anaemic person has fewer red blood corpuscles and therefore less haemoglobin. The blood is therefore less red and anaemic people therefore appear pale.

b Less O_2 is carried to body cells by red blood corpuscles. Cells cannot undergo maximum aerobic respiration, hence less energy is available for physical activities and less energy is available to generate heat to keep body warm.

4 **a** The greater the altitude, the greater is the number of red corpuscles.

b Air is rarified (has less O_2) at high altitudes, so a person needs more red blood corpuscles to carry as much O_2 as possible.

c The Sharks live and train at low altitude (sea level), hence have fewer red blood corpuscles. When they go to Gauteng (high altitude), less O_2 is available, and so not enough O_2 goes to body cells for cellular respiration. Less energy is available, therefore, and the Sharks become very tired.

d The Sharks need to train at high altitude before a match in Gauteng, or arrive weeks in advance of a match in Gauteng so that more red blood corpuscles can develop.

5 **a** Haemoglobin + carbon monoxide → carboxyhaemoglobin
[dull red] [irreversible] [cherry red]

b The reaction of haemoglobin and oxygen is reversible, so that haemoglobin is available to carry more O_2 after oxygen is used up, but in the reaction between carbon monoxide and haemoglobin, it is irreversible, so that haemoglobin is not available to carry O_2 at all; no O_2 is available to cells.

c When the brain receives less O_2, the person gets confused; brain cannot function; O_2 cannot attach itself to haemoglobin since carbon monoxide out competes it. Less O_2 goes to body cells; cells cannot undergo aerobic respiration, resulting in death.

» Activity Blood groups *(Specific Aims 1 and 3)*

1 Find out what blood group you belong to. Ask your parents or you may need to be tested to find out.
2 From which people can you safely receive blood?
3 To which people can you donate your blood?
4 Explain why people with blood group AB are called universal recipients.
5 Explain why people with blood group O are called universal donors.
6 Research the reasons why agglutination takes place if you receive the wrong blood group. (You will learn more about this in Grade 11).

Memo

1–3 Answers will vary.
4 People with blood group AB can receive blood from any other blood group.
5 Anyone can receive blood group O in an emergency, so people with blood group O are called universal donors.
6 Answers will vary, but learners should start to understand the agglutination process.

Making a model of a cell *(Specific Aim 2)*

Apparatus:

- 1 m × 1 m card
- waste material, such as paper, plastic, wood, tin, plasticine, polystyrene, marbles, wood shavings
- glue
- paints
- brushes

In this project learners will build a three-dimensional plant or animal cell, which will help them to learn more about cell organelles and to distinguish between plant and animal cells. They need to research one or two organelles and then use the waste materials, glue and paint to construct their three-dimensional plant or animal cell. Use the card as a base on which to build the cell.

The size of the model should be in proportion to the size of the actual cell. Use this table to calculate the size of the organelle that they are going to construct.

Organelle	Real size	Size for model (1 m × 1 m)
Plant cell	50 μm	1 m
Animal cell	30 μm	1 m
Mitochondrion	2 μm long/1 μm across	
Plastid 5	μm long/3 μm across	
Cell membrane	7 nm thick	
ER	2 μm in diameter	
Golgi apparatus	7 nm in diameter	
Vacuoles	3 μm in diameter	
Ribosomes	20 nm in diameter	
Nucleus	7 μm	
Nucleolus	3 μm in diameter	
Lysosomes	0,1–0,5 μm	

Note: 1 micrometre (1 μm) = 1×10^{-6} metres
1 nanometre (1 nm) = 1×10^{-9} metres

The calculation for the size of the ribosome in a plant cell is:
Size of organelle in poster (1 m × 1 m)

$$= 1 \text{ m} \times \frac{\text{real size of organelle}}{\text{size of real cell}}$$

$$= \frac{1 \text{ m} \times 20 \times 10^{-9}}{50 \times 10^{-6} \text{ m}}$$

$$= \frac{20 \times 10^{-3} \text{ m}}{50}$$

$$= 0{,}4 \times 10^{-3} \text{ m}$$

$$= 0{,}4 \text{ mm}$$

Making a model of areolar tissue *(Specific Aim 2)*

Refer to the diagram of areolar tissue on page 106 of the Learner's Book to make a model of it.

Apparatus

- 50 g gelatine and hot water (to make the matrix)
- elastic bands (yellow elastic fibres)
- fibrous string (white non-elastic fibres)
- broad beans (adipose tissue)
- star-shaped structure, for example aniseed (fibroblasts)
- plasticine (to shape five to ten amoeboid structures and oval mast cells)
- a cardboard plate.

Learners may use any other materials, as long as they have a key that states what the material represents.

These are the instructions for making the model:

1. Mix 50 g of gelatine in a glass of hot water.
2. Spread about 50 broad beans on the cardboard plate.
3. Pour the liquid gelatine onto the plate.
4. Place the elastic bands so that they criss-cross one another, forming a network on the plate.
5. Place the fibrous string in the same way.
6. Cut ten amoeboid shapes and ten oval shapes from the plasticine and spread them on the liquid gelatine.
7. Spread the star-shaped structures on the liquid gelatine.
8. Wait about five to ten minutes for the gelatine to set (you can put the cardboard plate in the fridge to speed up the process).
9. Draw a key to show what each structure on the cardboard plate represents.

Learners should answer these questions about their model.

1. What material would you add a lot of if you wanted the model to represent a tendon? Give a reason for your answer.
2. What material would you add a lot of if you wanted the model to represent a ligament? Give a reason for your answer.

Memo

1. Fibrous string. It represents white non-elastic fibres. Tendons have a large number of white non-elastic fibres.
2. Elastic bands. They represent yellow elastic fibres. Ligaments have a large number of yellow-elastic fibres.

STRAND 2

LIFE PROCESSES IN PLANTS AND ANIMALS

Unit 1: Support and transport systems in plants
Unit 2: Support systems in animals
Unit 3: Transport systems in mammals (humans)

Learner's Book pages 126–147
Duration: 12 hours

UNIT 1 Support and transport systems in plants

TERM 2

Activities and self assessment question memos

Activity 1 Examining root and stem structure *(Specific Aim 2)*

Learner's Book page 131

This activity allows learners to see root and stem structure for themselves either under the microscope or using photomicrographs.

Refer to Figure 1.3 and Figure 1.6 in the Learner's Book to check that the learners' drawings are correct. Make sure that they have correctly identified and labelled the xylem vessels.

Activity 2 Aging trees *(Specific Aims 1 and 2)*

Learner's Book page 133

1 b
2 a
3 a

Activity 3 Demonstration of transpiration through leaves *(Specific Aim 2)*

Learner's Book page 136

1 A control allows you to state for sure that transpiration takes place through the leaves.
2 You seal the shoots with a plastic bag to trap water vapour inside the bag.
3 If the underside of the leaf were smeared with petroleum jelly, very little, if any, water vapour would be transpired because most stomata are on the underside of the leaf.
4 The liquid is water – you can test this because water turns blue cobalt paper pink.

PPA

Activity 4 Investigating the effect of environmental factors on the rate of transpiration *(Specific Aim 2)*

Learner's Book page 138

1 Any four of:
- Cut the leafy twig obliquely to prevent damage to the tissues.
- When leafy twig is cut, insert it immediately into water to prevent air from entering the xylem vessels.
- Make sure the apparatus is airtight (seal with petroleum jelly).
- Let the twig acclimatise to the various conditions before taking readings.
- Handle the potometer with care; it breaks easily.

2 Under windy conditions, the bubble took less time to move from one point to another than it did under any other conditions. This indicates that transpiration is fastest under windy conditions.

3 Under humid conditions the bubble took a longer time to move from point to point than it did under any other set of conditions. This shows that transpiration is slowest under humid conditions.

RPA

Activity 5 Rates of transpiration *(Specific Aim 2)*

Learner's Book page 140

1 Transpiration is the loss of water in the form of water vapour from the intercellular spaces of aerial parts of the plant through the stomata.

2 a potometer

3 plant B

4 Thick cuticle with cutin is almost impermeable to water and therefore reduces transpiration; three layered upper epidermis is present; sunken stomata reduce rate of transpiration; hairs/trichomes trap water vapour, which is not easily removed by a breeze.

5 14:00

RPA

Activity 6 Water movement in plants *(Specific Aim 2)*

Learner's Book page 141

1 To measure the rate of transpiration under different environmental conditions

2 Any two of: wind speed, temperature, humidity

3 Any one of: fittings must be airtight; leafy twig must be cut under water; leave entire apparatus 20 minutes for plant to become adjusted to the factor being investigated; take a number of readings and calculate the average; use a freshly picked leafy twig; allow only one air bubble to enter the capillary tube.

4 The water vapour concentration of trapped air will increase. High humidity decreases the rate of transpiration and rate at which bubble moves will decrease.

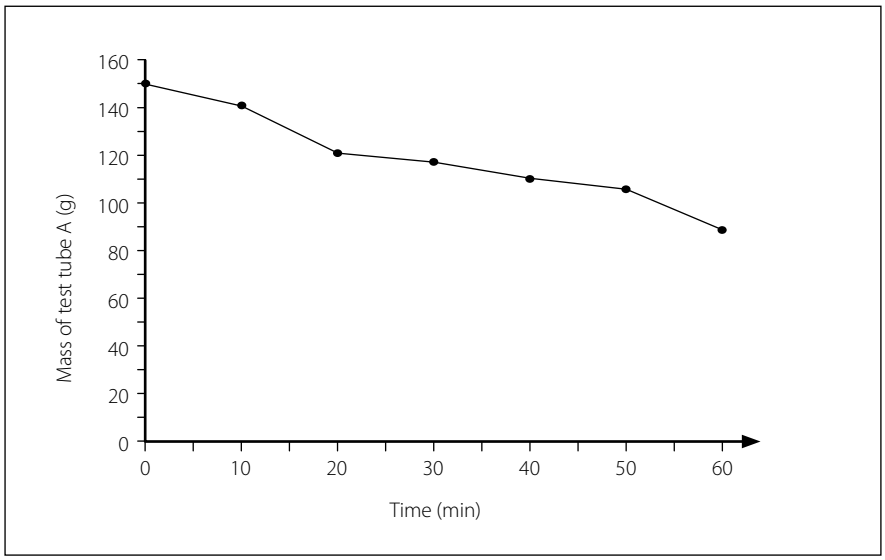
5 Some water is used by the plant for its own physiological processes, for example in photosynthesis and hydrolysis.

PPA

Activity 7 An investigation into transpiration *(Specific Aim 2)*
(Formal assessment task)

Learner's Book page 142

1



2 Transpiration

3 To act as a control.

4 150 g – 89 g = 61 g

5 Evaporation through cotton wool.

PPA

Activity 8 Demonstrating water uptake by roots and through the xylem of the plant *(Specific Aim 2)*

Learner's Book page 144

1 The xylem tissues were dyed red. The learners' drawings should show the following:
- Root: a plan drawing of a T/S of the root should show that the central part and the radiating arms are coloured red.
- Stem: the inner part of each vascular bundle is coloured red.
- Leaf: the upper part of the vascular bundle should be coloured red.

2 **a** Washing before placing it in eosin removes soil so that the absorption of the dye is not blocked.

b So that you do not contaminate the other tissues with eosin dye during the cutting process.

3 Take a plant such as balsam, which is translucent, so that you can see how fast the dye is absorbed and transported into the xylem from the roots and the leaves, using a stopwatch to time the process.

Self assessment questions

1
- Root hairs absorb water and mineral salts from the soil.
- Parenchyma cells allow osmosis and diffusion of water from the root hairs to the central xylem tissue. They also store starch.
- The pericycle forms lateral/side roots.
- The endodermis regulates the amount of water passing into the xylem tissue and it prevents toxins from passing into the xylem.
- The xylem transports water and mineral salts from the roots to the stems and leaves. Xylem tissue also strengthens and supports the plant because it has thick cell walls.

- The phloem transports manufactured food from the leaves to the roots.
- The vascular cambium forms secondary xylem and secondary phloem to increase the girth of the dicotyledonous root.

2
- The cuticle found on the epidermis is transparent, allowing light to pass through so that photosynthesis can take place in chlorenchyma cells below the epidermis. The cuticle also reduces water loss by transpiration.
- The stomata found on the epidermis allow for gaseous exchange.
- Sclerenchyma and collenchyma cells strengthen the stem and help to keep it upright.
- Parenchyma cells store food and the intercellular spaces allow for gaseous exchange and for transport of water.
- The sclerenchyma cap gives the stem support and strength and helps to keep it upright.
- Xylem transports water and mineral salts from the roots to the leaves. Xylem also supports and strengthens the stem.
- Phloem transports manufactured food from the leaf to the roots.

3 Secondary growth is the growth that causes the increase in diameter of dicotyledonous roots and stems. Every year a new ring of secondary xylem is formed and is called wood. This forms concentric rings called annual rings. Each annual ring is made up of a wider, lighter coloured portion called spring wood and a narrower, darker coloured portion called autumn wood. Counting these rings allows us to age trees.

4 Transpiration is the loss of water in the form of water vapour through evaporation. It takes place through the stomata of leaves. Transpiration is affected by wind (increases the rate), humidity (high humidity decreases the rate) and temperature (high temperature increases the rate).

5 Learners should mention that in wilting, water is lost through the open stomata during the day. On a very hot day, enough water may be lost to cause loss of turgor and so the plant wilts.
Guttation is the presence of drops of xylem sap on the tips or edges of leaves of plants such as grasses, and is caused by root pressure at night when the stomata are closed.

6 Learners should mention capillarity, root pressure and transpiration pull. They should show that they understand that transpiration pull is the most likely way in which water and minerals move through plants.

7 Translocation

Activity 1 Structural support *(Specific Aim 1)*

Learner's Book page 150

1 **a** Vertebrates have a backbone or vertebral column. Invertebrates do not have a backbone.

b An endoskeleton is a skeleton found inside the body. An exoskeleton is a skeleton found on the outside of the body, for example the shell of a crab.

c Bone is made up of living tissue, strengthened with calcium phosphate. Chitin is a non-living substance, which is hardened with calcium carbonate.

2 Coelenterates (for example jellyfish), platyhelminthes (for example tapeworm), molluscs (for example snails and slugs), echinoderms (for example starfish), annelids (for example earthworms).

PPA

Activity 2 Identifying bones in the skeleton *(Specific Aim 2)*

Learner's Book page 152

This self-discovery activity should be done in pairs. Learners identify the bones on the diagrams (or model of a skeleton) in their own bodies.

RPA

Activity 3 The skull *(Specific Aim 2)*

Learner's Book page 152

1 The skull cannot be rigid during the birth process. The membranous fontanels enable the skull of newborns to be compressed slightly, helping the head to squeeze out through the birth canal.

2 The cranium protects the brain.

3 The facial bones protect and support the sense organs (eyes, ears, tongue, nose). They also form the jaw bones.

4 The lower jaw is movable.

5 32

6 Incisors: 2 Canines: 1 Premolars: 2 Molars: 3

RPA

Activity 4 Pectoral girdle *(Specific Aim 2)*

Learner's Book page 154

This is a self-discovery activity, where learners match the diagram or model with their own bodies.

2 The scapula is more or less triangular in shape.

5 You have 14 phalanges in one hand (two in the thumb and three in each of the fingers). The advantage of the phalanges of the hand being very long, thin and lightweight is that it can be extremely flexible to be able to grasp and hold on to objects.

Activity 5 Pelvic girdle *(Specific Aim 2)*

Learner's Book page 155

This is another self-discovery activity. Learners are required to match the diagram or model with their own bodies.

6 The knee is a hinge joint because, just like a hinged door, it permits movement in one direction or on one plane only.

7 The patella is roughly round in shape. It protects the knee joint.

11 There are 14 phalanges in the one foot.

12 The phalanges of the toes are short and sturdy so that they are able to support the weight of the body.

13

Pectoral girdle	Pelvic girdle
Made up of the scapula and clavicle, and connected to the upper limb: humerus, ulna, radius, carpals, metacarpals and phalanges.	Made up of two hip bones, and connected to the lower limb: femur, tibia, fibula, tarsals, metatarsals and phalanges.
The pectoral girdle is flexible.	The pelvic girdle is sturdy, to be able to support the body's weight.
The two shoulder blades are separated and flexible.	Two hip bones are fused and rigid.
The humerus fits into the glenoid cavity of the shoulder blade.	The femur fits into a deep socket called the acetabulum of the hip bone.
Phalanges are long and thin.	Phalanges are short and sturdy.

Any three of the above.

Activity 6 Review *(Specific Aim 1)*

Learner's Book page 158

1 Cartilage is smooth, somewhat flexible, and can be slightly compressed.

- **a** The slightly flexible cartilage gives shape to the tip of the nose.
- **b** Cartilage forms the intervertebral discs which can be slightly compressed and thus absorbs shock and protects the vertebrae from damage.
- **c** Because cartilage is smooth, it allows bones to connect, join or link with each other.
- **d** Cartilage rings keep the trachea open and give flexibility to the trachea.

2 Bones are made up of living cells called osteocytes. Osteocytes need nutrients and oxygen, and need to have metabolic waste removed from them. Blood transports nutrients and oxygen to the osteocytes, and also carries waste away from these cells.

3 Red bone marrow is the site where white blood cells, red blood corpuscles and blood platelets are made.

4

- **a** In growing children, vitamin D is important for the absorption of calcium from food. It is the calcium that makes bones hard and strong. Therefore, a lack of vitamin D leads to poor absorption of calcium and, in turn, weak bones.
- **b** Radiant energy from sunlight is used to make vitamin D in the skin of human beings. Vitamin D allows for calcium to be absorbed from our food, which strengthens our bones.

5 **a** Calcium phosphate is responsible for the ''hardness'' of bones. As calcium phosphate is lost due to osteoporosis, the bone tissue becomes hollow and brittle and therefore breaks more easily.

b In osteoporosis, the vertebrae of the spine also lose calcium phosphate. Therefore, the vertebrae become compressed and the person becomes shorter.

c In osteoporosis, the bone loses density. The density of bone becomes less than that of water and therefore the person would float more easily in water.

d The loss of calcium in the vertebrae also causes weakness. This causes the spine to gradually begin to curve, and the person becomes hunched.

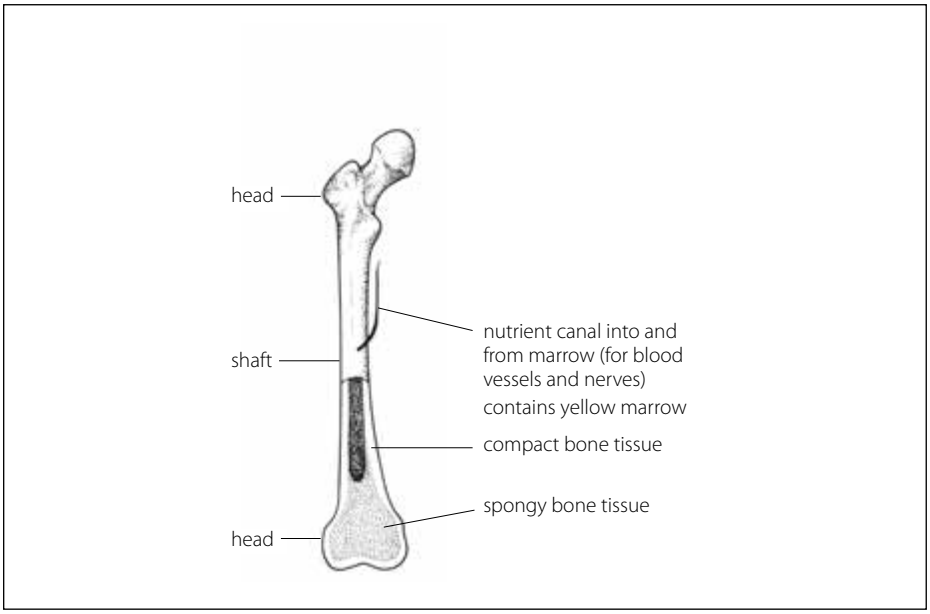
PPA

Activity 7 Investigating the structure and function of bones, cartilage, tendons, ligaments and joints *(Specific Aim 2)*

Learner's Book page 160

A

3



Learners will see the gross features of long bone in cross section.

5 The bones are hard and inflexible, so they cannot be bent.

B

1 Learners will identify the features of the bones they have brought from the butcher.

C

1

	Ligament	Tendon
Structural	Has a large number of yellow elastic fibres.	Has a large number of white non-elastic fibres.
Functional	Joins bone to bone at joints.	Attaches muscle to bone.

2 Ligaments need to be elastic so that they can stretch a little to allow bones to move at joints. Tendons cannot stretch because they have to be able to transmit the contraction and relaxation of the muscles to the bones so that movement can take place.

3 Tendons would not be able to transmit the contraction and relaxation of the muscles to the bones, and so no movement would take place.
4 When a dislocation occurs, ligaments are also damaged, stretched or torn. Therefore, it becomes easier for bones to move out of position.
5 You would be unable to move your foot because the Achilles tendon attaches the muscles of the leg to the heel of the foot.

PPA

Activity 8 The role of joints in locomotion *(Specific Aims 1 and 2) (Formal Assessment Task)*

Learner's Book page 163

1 The synovial membrane secretes synovial fluid, which lubricates the joint and reduces friction between bones in joints.
2 Two other hinge joints are the knee joint and the joints in the ankle.
3 The hip joint is also a ball and socket joint.

RPA

Activity 9 Skeletal muscle *(Specific Aims 1 and 2)*

Learner's Book page 163

1–2 Learners draw the example of striated muscle.
3 Yes, because the muscle fibres have alternating dark and light bands, which gives voluntary / skeletal / striped muscle its characteristic striped appearance.
4 Yes. Nerve fibres are found attached to the sarcolemma. This nerve fibre transmits messages from the cerebrum of the brain that stimulates the contraction and relaxation of the fibres, which in turn, causes movement.

PPA

Activity 10 Biceps and triceps *(Specific Aim 2) (Formal Assessment Task)*

Learner's Book page 165

At the end of this activity, learners should be able to understand that muscles work in pairs, in an antagonistic fashion, to bring about movement.

Learners should be able to apply the knowledge acquired in this activity to explain how their lower leg moves.

When you flex your lower leg (bringing it towards you) the muscle behind the thigh contracts and the muscle on the front of the thigh relaxes. The opposite happens when you extend your lower leg away from you.

Activity Self assessment questions

1 A hydrostatic skeleton provides effective support to the body but at the same time ensures a considerable degree of flexibility of the body for movement.
The disadvantages of the hydrostatic skeleton:
- Organisms with hydrostatic skeletons cannot grow to be very large.
- They need to be aquatic organisms or live in a moist environment.
- A hydrostatic skeleton does not provide protection to the vulnerable and soft parts of the body.
- Organisms with a hydrostatic skeleton cannot move very fast.

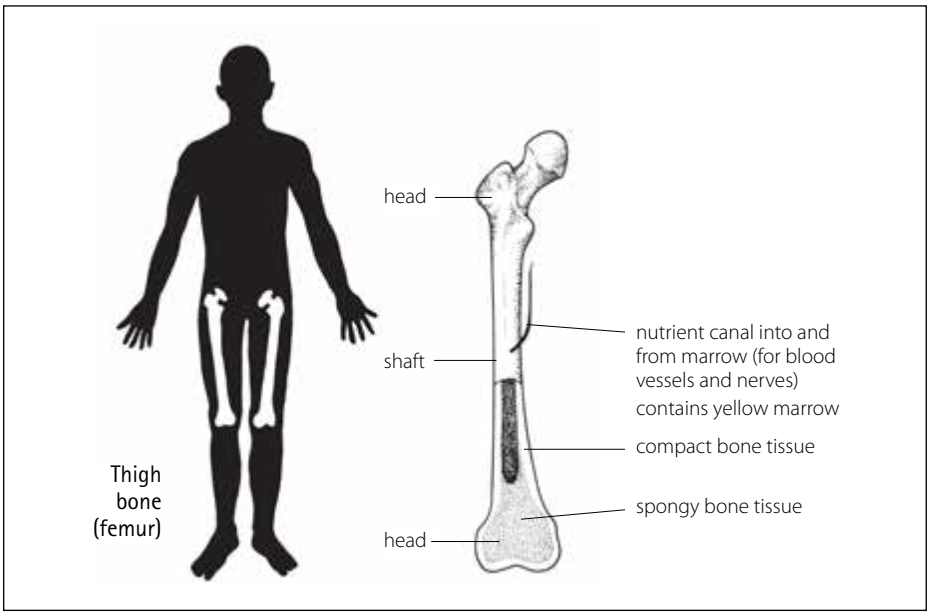
2 The appendicular skeleton is divided into two sections: the pectoral (shoulder) girdle and the pelvic (hip) girdle. The upper (anterior) limbs are attached to the pectoral girdle and the lower (posterior) limbs are attached to the pelvic girdle.

- The pectoral girdle:
  - clavicle (collar bone) and scapula (shoulder blade)
  - arm bones: humerus, radius and ulna
  - hand bones: carpals, metacarpals and phalanges (fingers).
- The pelvic girdle:
  - fused bones at the hip:
  - leg bones: femur (thigh bone), patella (knee cap), tibia and fibula.
  - foot bones: tarsals, metatarsals and phalanges (toes).

3 The axial skeleton consists of:
- the skull: cranial bones and facial bones
- the rib cage: sternum (breastbone) and ribs (12 pairs)
- the vertebral column: vertebrae (26) and intervertebral discs.

4 The human skeleton provides support, protection, movement, blood cell formation and mineral storage.
- Support. The skeleton supports and anchors the muscles in the body. The vertebral column and leg bones are especially important for support.
- Protection. It protects some of the soft tissues and organs inside the body. The bones of the skull, the vertebral column and rib cage all protect soft tissues and organs inside them.
- Movement. The bones give the muscles something to pull on, and so the skeleton helps the body to move.
- Blood cell formation. Some bones contain regions where red blood corpuscles and white blood cells are produced. The ribs, skull, sternum and pelvis contain specific regions for producing blood components.
- Mineral storage. Bones are a reservoir for calcium and phosphorus, the deposits and withdrawals of which help maintain ion concentration in body fluids, especially blood.

5 Learners should mention the head and the shaft of long bones, the spongy bone tissue.



6 Cartilage allows bones to move easily over one another because it is smooth. Cartilage is found at the end of bones.

7 A ligament is connective tissue that joins bone to bone. A tendon is connective tissue that attaches muscle to bone.

8 You will find ball and socket joints at the hip and at the shoulder.

9 Learners should mention that antagonistic muscles work together to bring about movement, for example, when the triceps contracts, the biceps relaxes and when the biceps contracts, the triceps relaxes. This allows extension and flexion of the forearm – as an example.

10 Learners should mention that actin and myosin form filaments and that the myosin filaments lie between actin filaments. These filaments slide between each other in response to impulses sent by the brain, which results in contraction of the muscle.

11 Children develop rickets because their bodies cannot metabolise vitamin D or because they do not take in enough vitamin D in their diet or because they are not exposed to enough sunshine.

Learner's Book pages 172–194
Duration: 12 hours

UNIT 3 Transport systems in mammals (human)

TERM 3

PPA

Activity 1 Dissection of the heart *(Specific Aim 2)*

Learner's Book page 172

The purpose of this activity is to get learners to develop manipulative skills and at the same time to investigate the structure of a mammalian heart. Make arrangements with your local butcher to provide sheep or pig hearts, preferably with all the blood vessels intact. Also orientate the heart for the learners: looking at the front view, the left side of the sheep/pig's heart is on the right and vice-versa.

3 The sheep's heart is very similar to the human heart.

4 Cardiac muscle makes up the heart.

5 Coronary arteries are the blood vessels that branch out over the heart. They branch from the aorta and deliver oxygenated blood and food to the cells of the heart itself.

6 The atria need thin walls because they have to produce only enough force to push blood into the ventricle just below them. The left ventricle has extra thick muscular walls compared to the right ventricle. The reason for this is that the left ventricle has to be able to produce a much bigger force to push blood all around the body. The right ventricle has to push blood to the lungs only, which are close to the heart.

7–8 Arterial walls are thicker and more muscular than venous walls.

10 The semi-lunar valves in the aorta and pulmonary arteries close when the ventricles relax, so that blood does not flow back into the ventricles.

12 The right ventricle is smaller than the left ventricle. The left ventricle has extra thick muscular walls, as discussed above.

13 septum

14 Each sketch should be clearly labelled and have a caption below the drawing. The semi-lunar valves are half moon-shaped. The bicuspid valve has two flap-like cusps. The cusps are held in position by tiny white tendinous chords, called the chordae tendinae.

Activity 2 Heartbeat *(Specific Aim 1)*

Learner's Book page 180

	Atrial systole	Ventricular systole	General diastole
Atrium: *contracted or relaxed*	contracted	relaxed	relaxed
Valve between atrium and ventricle: *open or closed*	open	closed	open
Ventricle: *contracted or relaxed*	relaxed	contracted	relaxed
Semi-lunar valves: *open or closed*	closed	open	closed

RPA

Activity 3 Investigating the heartbeat *(Specific Aim 2)*

Learner's Book page 181

1 The number of times that the heart beats per minute.

2 **a** 70
b 100

3 aerobic exercise, e.g. skipping, running, cycling, swimming

4 18 – 6 = 12 minutes

5 Place the middle finger of your one hand on the thumb-side of your other hand's wrist and locate the pulse. Count the number of pulse beats in 30 seconds and multiply by two to get the number of heartbeats per minute.

6 **a** stethoscope
b lubb, dup
c blood leaving and entering the heart

PPA

Activity 4 Blood vessels *(Specific Aims 1 and 2)*

Learner's Book page 182

This activity can be used as a formal assessment task.

1 Learners draw labelled diagrams – see diagrams on page 183 in the Learner's Book for reference.

2

Structural differences between an artery and a vein	
Artery	**Vein**
Relatively narrow lumen.	Relatively large lumen.
Walls are thick and strong.	Walls are thin.
Walls contain many muscles and large amounts of elastic fibres.	Walls contain far fewer muscles and elastic fibres than arteries.
Arteries rely on the high pressure to keep blood flowing in the right direction – no semi-lunar valves present (except in the aorta and pulmonary arteries).	Veins contain semi-lunar valves to keep blood flowing in the right direction.

3 **a** Arteries carry blood away from the heart.
b Veins carry blood to the heart.

4 The walls of capillaries are extremely thin, made up of a single layer of cells, so that they can take blood as close as possible to all cells, allowing rapid transfer (diffusion) of substances between cells and blood. Also, as red blood corpuscles carrying oxygen squeeze through a capillary, they are brought to within as little as 1 micrometer of the cells outside the capillary that needs the oxygen.

5 Blood leaving the heart is at a very high pressure. To withstand such high pressures, artery walls must be extremely strong. This is achieved by the thickness and composition of the artery wall. The presence of elastic fibres allows the wall to stretch as pulses of blood surge through at high pressure.
6 By the time blood enters a vein, its pressure has dropped significantly. This very low pressure means that there is no need for veins to have thick walls. They have the same three layers as arteries, but the middle layer is much thinner, and has far fewer elastic fibres and muscle fibres.
7 Because of the low pressure in veins, they have semi-lunar valves in them to stop the blood flowing backwards.
8 Valves are not needed in the arteries, because the force of the heartbeat keeps blood moving forwards through them.
9 The pulmonary artery transports deoxygenated blood.
10 The pulmonary vein transports oxygenated blood.
11 The presence of oxygen attached to haemoglobin (in the form of oxyhaemoglobin) of the red blood corpuscles gives arterial blood its bright red colour. In veins, red blood corpuscles have very little oxygen attached to haemoglobin, hence it is dull red.

RPA

Activity 5 Investigating the heart *(Specific Aim 2)*

Learner's Book page 183

1 The pressure is highest in the arteries.
2 This is because the blood in arteries is forced out of the heart by the contraction of the ventricles. There is no force pumping blood in the veins.
3 The arterioles show the greatest drop in pressure.
4 This is because arterioles are very narrow and this slows down the blood flow so that by the time the blood reaches the capillaries, the red blood corpuscles are moving in single file under very little pressure.
5 The lowest pressure is in the veins.
6 Semi-lunar valves.

PPA

Activity 6 Pulse rates *(Specific Aim 2)*

Learner's Book page 185

Use the following checklist to assess the table that the learners design:

Checklist for the construction of a table	Mark
Caption	1
Informative column headings	1
Informative row headings	1
First column: independent variable	1
Inclusion of units in headings	1
No units in body of table	1
Neatness	1
Full set of results recorded in table	1
Total	**8**

Pulse rate	Learner 1 (rate per minute)	Learner 2 (rate per minute)
At rest		
After exercise		
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		

From the results in the table, the learner should draw a double line graph, clearly indicating which line represents learner 1 and which line represents learner 2.

Use the following checklist to assess the double line graph.

Assessment for two line graphs on the same system of axes			
Line graph	**Mark allocation**		
Correct type of graph	1		
Title of graph	1		
Correct label for *x*-axis including correct units	1		
Correct label for *y*-axis including correct units	1		
Appropriate scale for *x*-axis	1		
Appropriate scale for *y*-axis	1		
Plotting of points for graph 1	2: plotted half or more of the points correctly	1: plotted less than half of the points correctly	0: no points plotted
Plotting of points for graph 2	2: plotted half or more of the points correctly	1: plotted less than half of the points correctly	0: no points plotted
Label for graph 1	1		
Label for graph 2	1		
All plotted points joined	1		
Two sets of axes used: Mark first graph only. *Wrong type of graph drawn*: Marks lost for "correct type of graph" as well as for plotting of points. **Total: ____ out of 13 marks**			

Expected answers for questions based on table and graph:

1 You should find that your pulse rate increases considerably with exercise. How much it increases, and how quickly it returns to the normal resting rate, depends on your level of fitness. The average resting pulse rate is about 70. If you are fit it can be considerably lower.

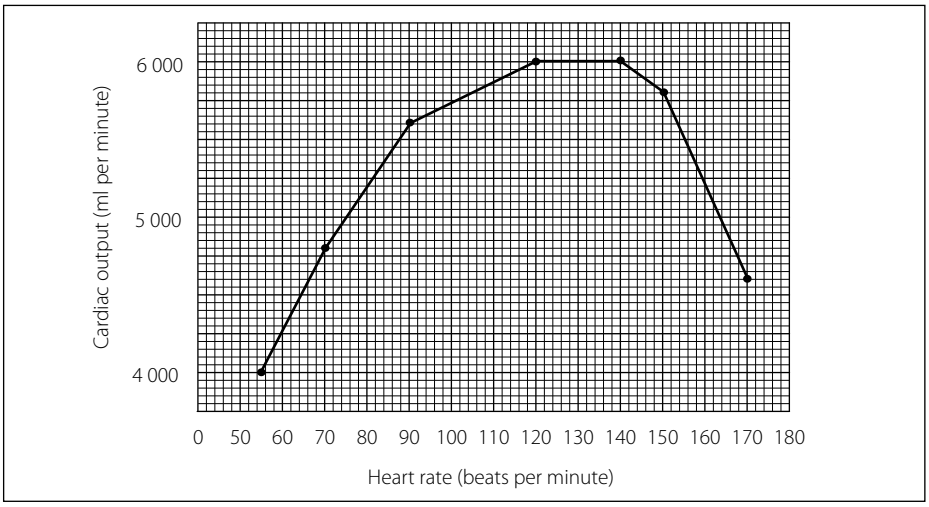
2 A faster pulse rate indicates a faster heart rate. During exercise, your body, especially your skeletal muscles, burns up more glucose. A faster heart rate meets the demands of an increased respiration rate; the blood delivers glucose and oxygen to the respiring cells faster and removes CO_2 from the respiring cells faster.

3 The learner who is the fitter of the two will be the one whose pulse rate returns to the resting pulse rate the quickest.

RPA » **Activity 7 Investigation** *(Specific Aims 1 and 2)*

Learner's Book page 188

1 The learners' line graphs should look something like this:



Use the checklist below to assess the graph.

Teacher assessment: Line graphs				
Line graph	**Mark allocation**			
Correct type of graph	1			
Title of graph	1			
Correct label for *x*-axis	1			
Correct label for *y*-axis	1			
Correct unit for *x*-axis	1			
Correct unit for *y*-axis	1			
Appropriate scale for *x*-axis (constant intervals)	1			
Appropriate scale for *y*-axis (constant intervals)	1			
Plotting of points	3: plotted all points correctly	2: plotted half or more of the points correctly	1: plotted less than half of the points correctly	0: no points plotted
All plotted points joined	1			
Transposition of axes: marks will be lost for incorrect labelling of axes but marks will be awarded for plotting and joining of points if correctly done. *Wrong type of graph drawn*: marks lost for "correct type of graph" as well as for plotting of points but credit will be given for other criteria that have been met. **Total: ____ out of 12 marks**				

2 5 750 ml per minute

3 6 000 ml of blood pumped out at each beat

$$= \frac{6\,000 \text{ ml/beat}}{120 \text{ beats}}$$

$$= 50 \text{ ml}$$

4 Efficiency is lower at 160 beats per minute because less blood is being pumped per minute at 160 beats per minute than at 140 beats per minute. The heart is pumping at a faster rate at 160 beats per minute but the amount of blood coming back to the heart from the inferior and superior vena cavae and from the pulmonary veins is the same.

Self assessment questions

1 Use Figure 3.1 Learner's Book page 174 for reference.

2 The mammalian circulatory system is closed because the blood remains within the heart, lungs and blood vessels and does not come into contact with body tissues.

3 Learners should cover the way in which the atrioventricular valves and the semi-lunar valves work, stating where these valves are found, and how the ventricular blood pressure affects the opening and closing of the valves.

4 Learners should show that they understand the concept of the heart as two pumps – a right pump (deoxygenated blood) and a left pump (oxygenated blood) – which work in the same rhythm. They should describe the way in which the blood circulates through the body, propelled by these two pumps. They must mention that in one complete journey around the body, the blood goes through the heart twice.

5 Learners describe measuring the pulse at the radial artery and state that the pulse rate is increased with exercise.

6 Use the figure on page 187 of the Learner's Book and the table on page D37 of the eacher's Guide as a reference.

7 Learners mention the atrioventricular node, the sino-atrial node and in their explanation of the control of heart rate, the Purkinje tissue, which make up the conducting system of the heart. They describe how this works, using information from the text.

8 Lymphatic fluid is made up of the tissue fluid that is formed when blood plasma leaks out of the capillaries. The tissue fluid drains into the lymphatic capillaries and is then called lymph.

Lymph nodes contain large numbers of white blood cells that destroy bacteria and protect the body against disease.

Extension activities and further formal assessment tasks

These activities may be done at the discretion of the teacher and if time allows.

Activity The effect of blocking a leaf's surfaces on transpiration

(Specific Aim 1)

This activity can be used as a formal assessment task for individual learners.

Look at the following description of an experiment and answer the questions that follow.

Four large leaves of similar size were removed from a shrub and treated as follows:
Leaf A – petroleum jelly was applied to both surfaces
Leaf B – no petroleum jelly applied
Leaf C – petroleum jelly applied to lower surface only
Leaf D – petroleum jelly applied to upper surface only
Each leaf was then attached to a potometer. The four potometers were kept under identical environmental conditions and the distance travelled by the bubble was recorded every two minutes for each leaf over a period of 10 minutes. The results are shown in the table below.

Total distance travelled by bubble (mm)				
Time (in min)	**Leaf A**	**Leaf B**	**Leaf C**	**Leaf D**
Start	0	0	0	0
2	1	30	6	20
4	2	80	12	50
6	3	128	16	92
8	3	168	24	130
10	3	200	30	158

1 State two ways in which variables were controlled in this investigation.
2 State an hypothesis for this investigation.
3 State one way in which the investigation could have been improved.
4 Which leaf showed the greatest rate of transpiration? Explain your answer.
5 Which leaf was not able to lose water by transpiration?
6 What information in the table justifies the claim that the rate of movement of the bubble is not exactly equal to the rate of transpiration?
7 What does the movement of the bubble in the potometer actually measure?
8 Which surface of the leaf possesses more stomata? Explain how you arrived at your answer.

Memo

1 Any two of:
- The leaves were of similar size.
- The leaves were from the same shrub.
- The potometers were kept under identical environmental conditions.

2 The hypothesis is that there are more stomata on the upper surface of leaves, or there are more stomata found on the lower surface of leaves.

3 An increased number of leaves could have been used under each condition.

4 Leaf B: because the stomata and the cuticle were not covered with petroleum jelly so transpiration took place normally.

5 Leaf A.

6 The results from leaf A. Although no transpiration took place, some water was absorbed by the leaf.

7 It measures the rate of absorption of water.

8 The lower surface, because:
- Results from leaf D (petroleum jelly on the upper surface) show almost the same results as those from leaf B (no petroleum jelly applied).
- This shows that most transpiration took place through the lower surface.
- Also, leaf C (petroleum jelly on the lower surface) showed very little transpiration, which indicates that more stomata are found on the lower surface of the leaf.

» Activity Investigating the structure of bone *(Specific Aim 2)*

Learners may work in pairs or larger groups depending on the quantities of bone available.

1 Bring at least two small, uncooked bones of a chicken, a sheep, a cow or a pig to school

2 Try bending the bones. Explain why this is difficult to do.

3 Place one bone in a beaker and pour some vinegar (acetic acid) over it and leave it for a few hours

4 Remove the bone from the vinegar and try to bend it now. Explain why bending the bone is easier now. (Hint: Acid removes the calcium salts, leaving behind the organic fibrous connective tissue)

5 Hold the second bone with a pair of forceps and heat it over a Bunsen burner for five minutes. The heat will burn the organic fibrous connective tissue away.

6 Allow the bone to cool and try to crush the burnt part with the forceps. The bone is now brittle and is easily shattered.
Note: The organic fibrous connective tissue and the calcium salts makes bone hard, strong, inflexible and resilient

Memo

2 The bones are hard and inflexible.

4 Bone becomes flexible because the acid has removed the calcium salts, which made the bone hard, leaving behind the organic, fibrous connective tissue.

Activity The pathway of blood *(Specific Aim 1)*

This activity could be used as homework.

Imagine you are a red blood corpuscle in the iliac artery of your leg. Trace the pathway that you will travel from the time you leave the iliac artery until you reach the carotid artery. Name all the blood vessels that you will travel through and state the changes that take place when you are in the lung.

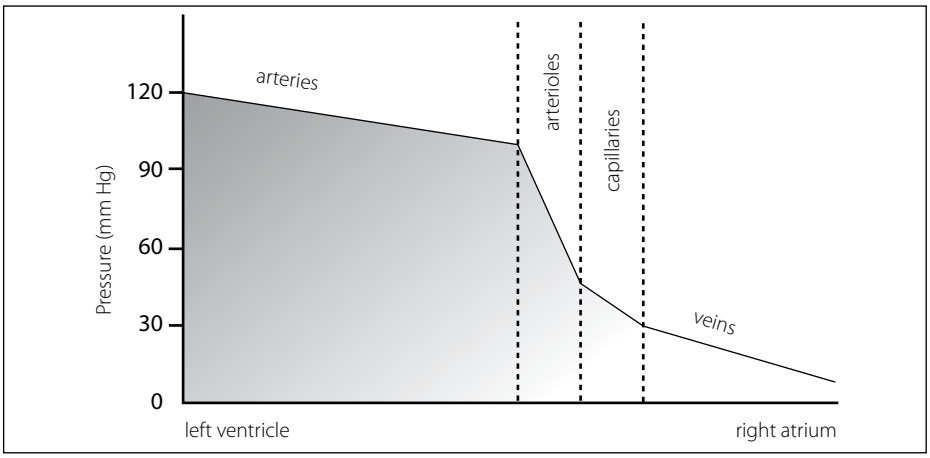
Memo

Expected answer:
The iliac artery divides up into capillaries supplying the cells of the leg with O_2 and nutrients, and receiving CO_2 and metabolic wastes (for example urea) from the cells. The capillaries of the leg join to form the iliac vein in which is found deoxygenated blood and blood that contains metabolic wastes. The iliac vein joins up with other veins from the body to form the inferior vena cava. The inferior vena cava carries deoxygenated blood into the right atrium of the heart. From here the deoxygenated blood is pumped into the right ventricle. When the right ventricle contracts, deoxygenated blood is pumped via the pulmonary arteries to the lungs. The pulmonary artery breaks up into capillaries, which surround the alveoli in the lungs. Oxygen from the alveoli diffuses into the capillaries. The oxygen combines with haemoglobin found on red blood corpuscles to form oxyhaemoglobin. This oxygenated blood is transported by pulmonary veins to the left atrium of the heart. From the left atrium, the oxygenated blood is pumped into the left ventricle. When the left ventricle contracts oxygenated blood is forced into the aorta. From the aorta, the oxygenated blood is carried to the carotid artery (a branch of the aorta), which supplies oxygenated blood to the neck and head.

Activity Blood pressure *(Specific Aim 1)*

The pumping action of the heart produces a pressure that pushes blood round the circulatory system. As you know, this wave of pressure can be felt in arteries that are close to your skin. This wave of pressure is called the pulse.

The graph shows the blood pressure throughout the circulatory system, from the left ventricle to the right atrium. Note: Arteries divide up into smaller blood vessels called arterioles.



Blood pressure throughout the circulatory system, from the left ventricle to the right atrium

1 In which type of blood vessel is the pressure the highest?
2 Suggest a reason for your answer in question 1.
3 In which type of blood vessel is the drop in pressure the greatest?
4 Suggest a reason why this is so.
5 In which type of blood vessel is the pressure the lowest?
6 What structure in the blood vessels ensures that blood flow continues in one direction?

Memo

1 The pressure is highest in the arteries.
2 This is because blood in arteries is forced out of the heart by the contraction of the ventricles. There is no force pumping blood in veins.
3 The arterioles show the greatest drop in pressure.
4 This is because arterioles are very narrow and this slows down the blood flow so that by the time the blood reaches the capillaries, the red blood corpuscles are moving in single file under very little pressure.
5 The lowest pressure is in the veins.
6 Semi-lunar valves.

Additional information on blood pressure

Measuring blood pressure

- To take someone's blood pressure, a hollow cuff, connected to a pressure gauge, is wrapped around the person's upper arm.
- The cuff is inflated with air to a pressure greater than ventricular systole. At this high pressure, no sounds can be heard through a stethoscope positioned below the cuff and above the artery in the arm because no blood is flowing through the artery.
- Air inside the cuff is released slowly. This allows some blood to flow into the artery.
- A soft tapping sound is heard through the stethoscope. When this tapping sound is first heard, this represents the systolic pressure (normally it is 120 mm mercury (Hg) in adults at rest).
- Slowly more air is released from the cuff until the sound heard is dull and muffled and the tapping sound ends. This also means that blood is flowing continuously in the artery and it corresponds to diastolic pressure at the end of a cardiac cycle (normally this reading is about 80 mm Hg).
- Normal blood pressure is thus 120/80 (120 over 80) – 120 is the systolic pressure and 80 is the diastolic pressure.

» Activity Heart disease *(Specific Aims 1 and 3)*

This activity is a good comprehension exercise. It could be done by individual learners or by small groups.

Read the following article and answer the questions that follow.

"Heart of Soweto" study reveals high rate of heart conditions in the Soweto population

Cardiovascular diseases, particularly those related to atherosclerosis (fatty lesions in the blood vessels) and high blood pressure, are often perceived to be problems unique to the "developed world" or high-income countries.

However, in many regions of the world, physically active lives have been replaced with inactive ones with people consuming calories out of proportion to their daily needs. Modern and commercial ways of processing food also promote obesity and the development of diabetes, and may be important contributors to the development of the diseases of affluence.

In 2005 the World Health Organisation re-emphasised the importance of chronic (noncommunicable) diseases, in particular cardiovascular disease, as a neglected global health issue.

The "Heart of Soweto" study'

It is within this context that the Soweto Cardiovascular Research Unit, part of the Wits Cardiology Unit at the Chris Hani Baragwanath Hospital, under the leadership of Wits Professor Karen Sliwa-Hanhle and her team, has over the past few years focused their research activities on heart conditions almost specific for Africa.

They initiated the unique Heart of Soweto Study that monitors the ''heart health'' of the one-million strong Soweto population via: 1) an advanced clinical registry of all patients attending the hospital and 2) community-based surveillance programmes.

''We selected Soweto as it now represents one of the largest urban areas on the African continent,'' says Sliwa-Hanhle. ''As in many other developing regions, populations move from rural to urban areas and in that process change their way of living. Soweto is home to more than one million people and the population has benefited from improved economic conditions and public health advances in recent years. Unfortunately, the 'cost' of these improved conditions has seen an increase in the number of individuals seeking medical care from the Wits Cardiology Unit at the Baragwanath Hospital for heart disease or its common precursors.''

Results of the Heart of Soweto Study were published on the 14th March 2008 in *The Lancet*, in collaboration with the Baker Heart Research Institute in Melbourne, Australia (Professor Simon Stewart) and the University of Queensland (Professor David Wilkinson).

The failing heart health of Africa

Like many other parts of the globe, Africa is experiencing a transition towards greater wealth and prosperity. It has been estimated that within the next 20 years, 1,3 million people per year will be affected by heart disease in Africa. Says Sliwa-Hanhle: ''Heart disease has the potential to not only cause disabling symptoms but also to result in premature death in those who would have otherwise survived to a relatively old age. Fortunately, many of the causes of heart disease (e.g. high blood pressure, obesity, diabetes and smoking) are either treatable or completely preventable.''

She adds: ''Africa also faces a threat from other forms of heart disease due to unique conditions like peripartum cardiomyopathy, an often deadly cardiac condition affecting African women after childbirth. It is vitally important that the full range of common and African-specific forms of heart diseases is fully researched on this continent with the intention of developing effective treatments and health care programmes.''

Results of the study published in *The Lancet* on 14 March 2008

''In 2006, we identified 4 162 cases of cardiovascular disease, of which 1 593 were newly diagnosed, presenting to the Cardiology Unit at Baragwanath Hospital,'' says Sliwa-Hanhle. ''The major findings from the largest and most comprehensive study of heart disease in Africa indicated that most patients had multiple risk factors commonly associated with affluent heart disease in the developed world. For example, many women were obese and more than one in two patients had a history of high blood pressure. Among the 1 593 newly diagnosed cases, heart failure was the most common primary diagnosis (44% of cases) and many patients presented with advanced forms of heart disease.''

She adds: ''These findings suggest that this phenomenon is likely due to combinations of lack of awareness of this condition, paucity (lack of) and (poor) quality of primary care facilities and that there are now multiple threats to the current and future 'heart health' of Soweto, including a high prevalence of modifiable risk factors for atherosclerotic disease and a combination of infectious and noncommunicable forms of heart disease, with late clinical presentations.

''The overall challenge is now how to increase scarce health resources to the people in developing countries. One of the commonly recurring themes in studies of health in Africa is the lack of reliable statistics. The results of this registry, emanating from one of the largest urban populations of Black Africans, goes a long way to correcting this deficit for heart disease in Soweto.''

This ongoing study will be able to provide important insights into the prevalence of heart disease in the Soweto community, which is the first step to mitigate the modern global epidemic of cardiovascular disease.

''Reports of changes over time via future reports will be able to document the velocity and nature of the continuing epidemiological transition towards more affluent [forms of] heart disease,'' says Sliwa-Hahnle. ''Changes in risk factors will be documented and hopefully improvements in mortality and morbidity from various forms of heart disease will occur by instituting the preventive strategies and management programmes that are suggested by this important work.''

Wits University Communications Department

1 What is atherosclerosis?
2 The study states that most people with heart disease living in Soweto had multiple risk factors. What are these?
3 Besides lifestyle factors, what other factors can place one at risk of heart disease?
4 If the population of Soweto is one million, what percentage of that population were admitted to the Cardiology Unit at Chris Hani Baragwanath Hospital with heart disease?
5 What percentage of the cases of heart disease were newly diagnosed?
6 According to the article, what were the factors leading to this number of people presenting with heart disease in Soweto?
7 According to the article, what other forms of heart disease are common in Soweto?
8 Why do you think that black people in an area such as Soweto are suffering from increased rates of atherosclerotic heart disease?

Memo

1 Atherosclerosis is a hardening of the arteries because fatty substances (called atheroma) are laid down in the lining of the artery wall.
2 The risk factors are: high blood pressure, obesity, smoking and diabetes.
3 Other factors are: genetic factors and infectious diseases that can lead to heart disease.
4 0,4%
5 38,3%
6 The factors were multiple risk factors associated with heart disease in the developed world – specifically obesity, high blood pressure and diabetes.
7 Infectious and noncommunicable forms of heart disease.
8 Learners should comment on the change in lifestyle as people move from rural to urban areas, leading to modifiable risk factors for heart disease.

» Activity Bypass surgery *(Specific Aims 1 and 3)*

This activity can be used as a comprehension exercise. Learners can work alone or in small groups.

Read the following passage. Use the information in the passage, and your own knowledge, to answer the questions that follow.

The benefits of by-pass surgery

The coronary artery supplies the cardiac muscles with oxygenated blood and nutrients. Several smaller coronary vessels branch off from the coronary artery. These vessels sometimes become partially blocked. The narrowing of the coronary vessels reduces blood flow to the cardiac muscles. One symptom of coronary artery problem is pain in the region of the heart and the left arm. This pain is a symptom of angina. Patients with poor coronary circulation are unable to perform vigorous exercise, because the supply of oxygen to the cardiac muscles is inadequate. They run a high risk of a heart attack, which could be fatal.

Coronary by-pass surgery can relieve the pain of angina and improve the quality of life of people with coronary artery disease. During surgery, a damaged coronary artery can be by-passed. A healthy piece of blood vessel is taken from another part of the patient's body, usually from a leg, and attached to the heart. The new piece of blood vessel carries blood past the damaged coronary artery to the cardiac muscle. Coronary by-pass operations have saved many lives. Comparative studies have been carried out to see what happened to patients who have had this surgery, or were treated only with drugs. The studies found that five years after treatment, 92% of patients who had had coronary by-pass surgery were still alive. Only 83% of those treated only with drugs were still alive. Twelve years after treatment, 71% of surgery patients and 67% of those treated with drugs were still alive. This suggests that coronary by-pass surgery is a better treatment for sufferers from coronary problems than the use of drugs alone. However, twelve years after treatment, the difference between the two groups is not very great. This is partly because the by-pass grafts tend to deteriorate with time. This may mean that a second by-pass operation is needed, which is much riskier than the first.

The implication of these studies is that mild coronary problems are probably better treated at first with drugs rather than surgery. This means that if a bypass operation does turn out to be needed later, there is less likelihood that a second, risky one will have to be used. But severe coronary artery disease should be treated with by-pass surgery immediately.

Adapted from Biology, Jones and Jones, Cambridge University Press

1 Why does coronary artery disease limit a person's ability to perform vigorous exercise?
2 Give one symptom of coronary artery disease.
3 Give three factors that may increase a person's risk of suffering from coronary artery problems.
4 Describe how coronary artery by-pass surgery is done.
5 In the comparative studies that were done, name any three variables that needed to be controlled in the group of patients who had by-pass surgery and those who were treated with drugs.
6 What evidence is there from this study that coronary by-pass surgery is more successful than the use of drugs in treating coronary artery disease?
7 Explain why it is recommended that mild coronary artery disease should initially be treated with drugs rather than surgery.
8 Do you agree with the adage that ''prevention is better than cure'' concerning the above passage? Explain your answer.

Memo

1 Patients with poor coronary circulation are unable to perform vigorous exercise because the supply of O_2 to the heart muscle is inadequate (not enough).
2 Pain in the region of the heart and left arm. This pain is called angina.
3 The factors contributing to a patient's risk of coronary artery disease are:
- poor diet
- being overweight
- smoking
- stress
- lack of exercise
- genetic factors.

4 A portion of a blood vessel is removed from the patient's leg. This vessel is then used to ''by-pass'' or replace the blocked part of the coronary vessel on the heart so that normal blood flow takes place.
5 They must be more or less the same age and weight. They would have similar diets, be the same sex, and have a similar genetic predisposition.
6 Five years after treatment, 92% of patients who had coronary by-pass surgery were still alive. Only 83% of those treated with drugs were still alive.
7 By-pass grafts tend to deteriorate with time. This may mean that a second by-pass operation is needed, which is much riskier than the first. It is better to use drugs first and than resort to by-pass surgery later (if needed).
8 Yes. By controlling the factors that increase a person's risk of suffering from coronary artery problems (mentioned in 3 above), the chances of having by-pass surgery would be lessened.

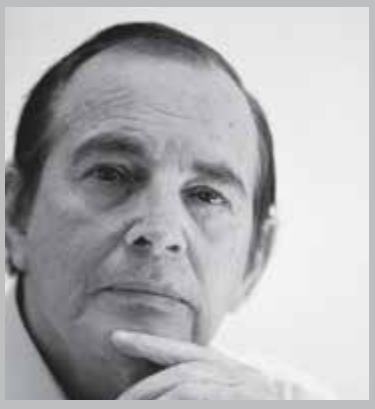
Activity Heart transplants *(Specific Aims 1 and 3)*

This activity can be used as a comprehension exercise. Learners can work in groups.

Study the following document and answer the questions that follow.

Heart transplants

A heart transplant is a surgical procedure in which a diseased heart is replaced with a healthy heart from a donor (who has died or is brain dead). If someone is brain-dead, it means that the patient's brain shows no signs of life while his or her body is being kept alive by a machine. The first successful human heart transplant in the world was done on 3 December 1967. It was performed by a South African surgeon, Dr Christiaan Barnard, at Groote Schuur Hospital in Cape Town. The recipient of the healthy heart was Mr Louis Washkansky and the donor was a road accident victim, Denise Darvall. Although Washkansky lived for only 18 days after the successful transplant, the operation was hailed throughout the world. Mr Washkansky died of pneumonia because his body was left vulnerable to opportunistic diseases when he was given large doses of immune-suppressing drugs. If he had not been given the drugs, his body would have rejected the new heart. Dr Barnard's second patient, Philip Blaiberg, lived for 18 months after a successful operation. Dr Barnard's longest surviving patient, Dirk van Zyl, lived with a transplanted heart for 23 years. He died of complications of diabetes, which was one of the reasons that he had heart disease in the first place. Diabetics are far more likely to suffer from heart disease than people without diabetes.



Christiaan Neethling Barnard, 1922 to 2001

Heart transplant surgery has now become a relatively standard procedure and many successful heart transplants have been done since 1967.

There are two main obstacles to successful heart transplants:

- The rejection of the donor heart by the patient. Cyclosporin and other immunosuppressants to prevent rejection of organs have greatly improved the survival rates of transplant patients.
- The availability of donor hearts. A patient may wait for months or years for a donor heart and many patients do not live long enough to undergo transplant surgery.

Discuss the following issues using the document that you have read.

1. Heart transplants are expensive procedures. Should state hospitals perform these procedures free of charge?
2. What is your group's view about trying out new technical devices on human beings?

3 Prevention is better than cure. Discuss how we can take care of our hearts now, so that we do not end up with cardiovascular diseases later in our lives.

Memo

Divide learners into groups of four or five. Give learners time to study the document. Each group could discuss each of the three issues outlined. Choose one group to report on the first issue. The other groups can fill in what was missed out by this one group. Then another group can report on the second issue, and so on.

STRAND 3

ENVIRONMENTAL STUDIES

Unit 1: Fieldwork
Unit 2: From biosphere to ecosystems
Unit 3: Living and non-living resources
Unit 4: Nutrient cycles and the environment
Unit 5: Energy flow within an ecosystem

Learner's Book pages 197–209
Duration: one or two terms

UNIT 1 Fieldwork

TERM 3

PPA »

Activity 1 A herbivorous animal *(Specific Aim 2)*

Learner's Book page 199

This project will be done over one or two terms. The learners' work will undergo group and teacher assessment.

It is suggested that you assess selected skills, procedures and products, for example, action plans, the scientific quality of field notes, the learners' competence in microscopy, and so on. The choice of skills to be assessed will depend on the particular competencies that you need to assess for either diagnostic, formative, summative or other priorities.

The rest of the assessment may be done by the groups. This may be done during the presentation session. Parts of work in progress may also take the form of self-assessment. For group assessment, it is recommended that a suitable set of assessment criteria be agreed upon, in consultation with the learners, and that copies of this be issued to each group, so that every group assesses the team that is giving the presentation.

The dominant code that emerges from this may then be used to indicate the level of competence attained. If, however, there are wide discrepancies between the suggested codes from different groups, then it would be wise to resolve this with a discussion led by yourself, until all parties reach an agreement. This may be a very useful and powerful formative exercise for groups that are not yet skilled in peer assessment.

Before starting the practical investigation, a few aspects need to be considered.

1 This is a substantial investigation, with the purpose of providing learners with some idea of how scientists operate in the field. It is highly recommended that at least one section is conducted over a weekend, with the entire class together in one location. It is also recommended that colleagues or parents join in to assist you. The concentrated time generally stimulates learners to greater effectiveness in learning.

If the investigation is to take place over a weekend, away from school, it is essential to plan the trip in detail, with the cooperation of the learners. Group leaders or mentors may be assigned to take responsibility for stocking the kit box with all the equipment, materials and reference books required.

2 If such an excursion is not possible, then it is recommended that regular progress monitoring be done over the entire period allocated for the investigation. Regular classroom time may be set aside for this purpose.

3 Drawing up a group contract, similar to the example below, is recommended. This helps to encourage the learners to monitor their own progress and to engage in meta-cognition and self-appraisal. Keep a copy on file to monitor the learners' progress.

You may use the grid on page D54 to assess the learners' projects. The rubric is partially analytical. It is meant to serve as a guide only, and you may decide to use only a section or sections of it, to suit your own assessment priorities.

Group work contract

Project title: .....

Members' names: .....

.....

.....

.....

Our strategies for success

Action plan and deadlines

Member	Responsibilities and tasks	Date completed

Task	**Date**
All practical investigations completed. Data manipulation and conclusions drawn. Poster and display materials ready. Presentation done.	

I agree to give my full co-operation towards enhancing the quality of this learning experience.

Signatures:

Group leader: .....

Members: .....

.....

.....

Ecocology research project
Teacher assessment

Learner's name .....

Performance code	7–6	5–3	2–1
Group work	Shows a high degree of collaboration, sharing of workload and knowledge. Effective action plan, carried out well, with highly effective time management. Continued mutual support	Some degree of collaboration, sharing of workload and knowledge. Effective action plan but did not always meet agreed upon deadlines. Fair amount of mutual support.	Little or no collaboration shown. Not all members contributed equally to the tasks at hand. Action plan was seldom referred to. Some/all members tended to procrastinate, resulting in rushed tasks.
Accessing knowledge	Highly skilled in accessing information. Used a variety of resources and applied selected information where appropriate.	Mastered skill of accessing information but tended to settle for limited resources. Still requires practice in selecting only the relevant facts and data.	Poor mastery of accessing information. Required a great deal of assistance. Tended to lose focus of relevant information. Struggled to bring facts into context.
Following instructions, handling apparatus and materials	Quick to grasp and carry out instructions, efficiently. Mastered skills related to handling of apparatus and materials.	Still requires some assistance in following instructions and handling apparatus. Somewhat negligent in carrying out procedures.	Required a great deal of assistance and prompting. Negligent in carrying out procedures, left apparatus in a disorderly state.
Observations and recording of data	Detailed observations and scientifically recorded data.	Some vague, incorrect, incomplete observations. Data not well ordered.	Very vague and inappropriate observations and data.
Data manipulation, analysing, synthesising and drawing conclusion	Relevant data selected and reworked into concise, graphical or tabulated format. Focused and appropriate conclusions.	Some difficulty in critical thinking and manipulation of data. Not all aspects/ variables considered when drawing conclusions.	Data manipulation skills are still very under-developed. Experienced great difficulty in drawing appropriate conclusions. Requires more practice.
Poster and oral presentation	Well-ordered poster, displaying all relevant aspects. Enthusiastic and professional verbal rendering of project components, highlighting some aspects of particular interest.	Attractive poster, but not altogether scientifically sound. Kept the interest of the audience but did not display any particular degree of creativity in the verbal report-back.	Poster was not well planned. Some aspects of research were omitted. Did not display any degree of confidence or enthusiasm for the topic.

Be a reflective practitioner

At the end of this activity, it may be very useful to have a reflective session with all the learners who participated. What problems were experienced? How can this be improved upon? What was particularly useful, enjoyable or beneficial? This may be further exploited for the next research activity.

Learner's Book pages 210–224
Duration: 6 hours

UNIT 2 From bioshphere to ecosystems

TERM 3

RPA

Activity 1 Looking at biomes *(Specific Aims 1 and 2)*

Learner's Book page 218

1 The learners work in groups to select a biome from the tables on pages 215–217 of the Learner's Book.

2 Make a large number of reference books available to the learners, and try to provide access to the Internet to help the learners with their research on the biome they have selected. It is a good idea to give the local library advance notice so that sufficient and appropriate books can be made available. Learners usually thoroughly enjoy discovering unknown places, and you should try to exploit this natural curiosity as much as possible. This is a valuable opportunity to get everyone involved, and to stimulate "latent researchers" to develop a positive attitude and the required skills to perform such tasks.

3 and **4** After the learners have made their posters to illustrate the landscape and dominant plants and animals that make up the biome they have studied, the posters are displayed on the classroom walls and one member of each group gives a five-minute talk on the characteristic features of the biome. Encourage the groups to construct food webs, using model animals, drawings, plants, and so on, to complement their poster and presentation.

5 The learners brainstorm a suitable set of criteria for peer assessment, and use this to assess the poster and the presentation of the other groups. They may suggest the following:

- Are all the names of the continents, countries and geographic position clearly indicated?
- Did all members of the group use the resources efficiently?
- Were most of the dominant plants and animals included?
- Were good examples of adaptations of plants and animals displayed?
- Was a logical food chain, characteristic of the biome, displayed?
- Did the group engage in good strategies of labour division to complete the activity on time?
- Is the poster complete, attractive and eye-catching?
- Is the layout of the poster logical?
- Was the report back concise, well ordered and presented with confidence?

Learner's Book page 219

1 Before learners write down their response regarding the statement, they need some time to discuss it.
Animals use oxygen during the process of cellular respiration. This oxygen is taken (borrowed) from the external atmosphere. During cellular respiration carbon dioxide is given off as cellular waste product. This is done either by diffusion or by breathing.
Plants use carbon dioxide during the process of photosynthesis. This carbon dioxide (mostly exhaled by animals) is taken (borrowed) from the external atmosphere. Plants as living organisms also respire and use oxygen from the external atmosphere. During photosynthesis oxygen is given off as a product. The amount of this oxygen is much more than what plants used during cellular respiration.

2 Plants help to conserve soil in the following ways:
- The leaves of plants break the impact of raindrops that fall to Earth at great speed. Compaction of soil is minimised, no or little damage is done to the crumb structure of the soil at microscopic level, and degradation of soil is prevented.
- The vegetation cover slows down the flow of rainwater over the surface of the soil. This allows for water to infiltrate and soil erosion is reduced.
- The roots of plants bind the soil and help to hold the soil in place. This will reduce wind erosion.
- The organic matter (humus) formed from decaying vegetation acts like a sponge. This will not only improve the water-retaining ability and soil structure, but will also reduce soil erosion. Humus also increases the population of soil organisms, the rate of decomposition and the levels of nutrients released into the soil.

3 Cavity-nesting animals such as woodpeckers, wood-hoopoes, screech-owls, barbets, hornbills and squirrels have very little, if any, shelter available. The number of these types of animals would be reduced. Insect populations would increase because of fewer insect-eating birds. Trees and other plants that enjoy protection from dead trees, could be negatively affected. The removal of dead wood could have a negative effect on the diversity of bird and mammal species by removing cover and nesting material.

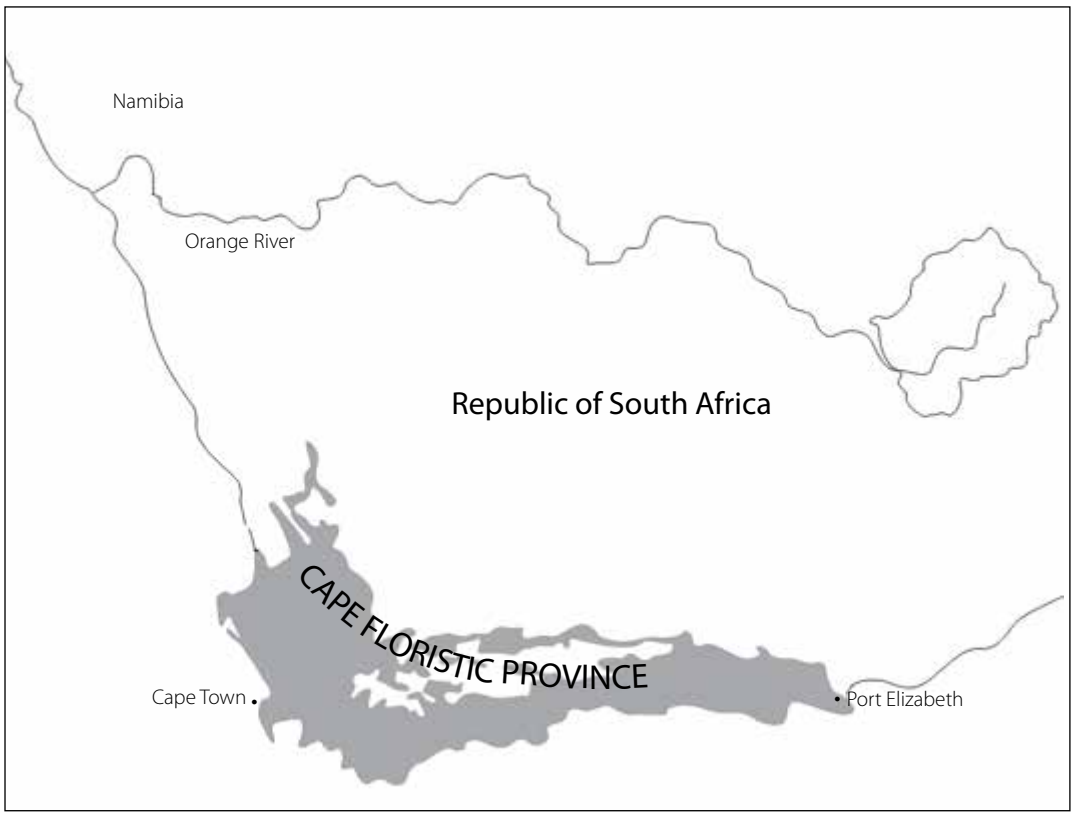
4 Rainforests are plundered for the following reasons:
- To sell the timber. Many poor countries borrow lots of money from rich countries. Selling timber from their rainforests is a way of paying the interest on their debts. People worldwide use 15 times more tropical timber today than in 1950.
- To clear land for farming purposes. Forests are cleared mainly for cattle farming and cultivation of certain crops. Often the forest soil can support only about two or three seasons of crops before it is exhausted. This soil is often not suitable for cattle grazing and needs lots of fertilisers. As a result of this, the soil is abandoned in favour of new exposed forest soil. In this way the destructive process continues.
- Today it is easier to clear forests. In the past the cutting down of trees and the clearing of scrub were done by hand. It was an exhausting and slow-moving process. Today chain saws and bulldozers are used to do the work much faster.
- The forest wood is used for hut-building and firewood.

5 Forests are of great economic value. The forests of the Garden Route, for instance, provide employment for many people in the region, and make up an important part of its economy. The management and exploitation of the forests provide employment to people who work in conservation, the curio and tourism industries, and manufacturers.

- *Management and conservation personnel*. This includes the scientists, forest officers and labourers who are responsible for the well-being and maintenance of the forest, as well as the harvesting of small quantities of wood that are made available to the furniture and curio industries.
- *Furniture and curio industry personnel who manufacture and sell curios*. These include cabinet-makers, saw-operators, sculptors and sales people who bring the finished product to the public.
- *Manufacturing industries*. These include equipment and tool manufacturers, suppliers and maintainers, who provide their goods and services to the timber and furniture industries.
- *Tourism trade personnel*. This includes tour guides, hotel staff, transport personnel and others who are involved in bringing visitors to the forests, and so on.

6 **a** Give each learner with blank map of South Africa so that they can complete this question.

The shaded area on the map below indicates the Cape Floristic Province (hotspot), which represents the Cape Floral Kingdom. The Cape Floral Kingdom consists mainly of fynbos.



Source: 2002 Conservation International GIS and Mapping Laboratory

b The four main types of vegetation that scientists consider to be characteristic plants of the fynbos, are the: proteoids (proteas); ericoids (ericas); restioids (Cape reeds); geophytes (Gladiolus, Disa). Learners make drawings or collect pictures of these types.

c
- Veld fires
- Expansion of agriculture
- Human population growth
- Drought
- Overgrazing in certain areas
- Industrial development

d About 98% of lowland fynbos is on private land. The existence of lowland fynbos is largely dependent on farmers and landowners.

e Fynbos is of economic value for the following reasons:
- This vegetation uses less water than exotic tree plantations and agricultural crops under irrigation.
- Well-managed fynbos areas allow more run-off water after rains to reach the streams and dams than in the case of grassveld.
- Rooibos tea and honey tea are products that come from plants that are endemic to the fynbos.
- The great variety of plants and the beauty and variety of the areas in which they grow, make the fynbos an ideal destination for local and foreign visitors alike.
- Fynbos provides a large fast-growing industry with many species of plants that can be used in the fresh and dried cut-flower markets.

(Source: *Conservation of our Environment* – A.V. Milewski, UCT)

f Landowners can help to conserve fynbos by:
- identifying sensitive areas on their properties that should be conserved
- declaring these areas as private nature reserves, natural heritage sites or sites of conservation significance, which will increase the conservation status of the land
- establishing a conservancy with their neighbours, which will show that they care, without legally binding them
- identifying the threats to the area and implementing the necessary steps to ensure their ongoing existence
- contacting their nearest conservation office for advice and assistance.

(Source: *2000 Cape Nature Conservation*)

» Activity 3 Biomes and conservation *(Specific Aim 1)*

Learner's Book page 221

It is suggested that learners work individually on these questions, preferably as homework, over a period of a couple of days.

Teacher or group assessment may be used. Oral assessment in the form of a quiz between two teams may also be considered. In this case, divide the class into two teams, ask them questions and keep a score of the each team's correct answers.

1 a The Free State, the Eastern Cape and the Northern Cape. The Karoo semi-desert shrubs are gradually replacing the savannah (tropical grasslands). NASA has kept photographic records of this alarming trend.

b Learners may suggest pressures such as overgrazing, agricultural use, urban development.

c Tax deduction and priority access to markets could be examples of incentives to farmers to maintain pockets of natural ecosystems. Farmers can advertise their name by placing stickers containing their logo and the words 'environmentally friendly' on their produce.

2 **a** Wine farming (vineyards): Temperate evergreen woodlands (fynbos).
b Cattle farming: Temperate grasslands or savannah.
c Cereal farming: Savannah, fynbos (Renosterveld), temperate grassland, forests.

These biomes are usually not farmed in a sustainable manner. Generally, biodiversity conservation is neglected in favour of economic gain. The tendency is towards monoculture, thus removing natural diversity from the land, endangering endemic species in the process. This, in the long run, may cause the increase of pest species and a decrease of rainfall leads to the destruction of catchments and the natural sponge effect.

3 In the fynbos areas (the temperate evergreen woodland), many seeds, such as various species of *Protea* require fire to destroy the tough seed coat before germination can occur. In the grasslands, dead leaves of older shrubs and grasses are unpalatable to herbivores and also inhibit the growth of new shoots. Fire removes old plant material to make space for more palatable young shoots.

4 Open-ended answers can be expected. The quality of the learners' answers will depend on the level of research they have done, and the assessment of their answer should be based on this.

5 Yes, a relationship between average rainfall and soil fertility does exist. As average rainfall increases, so soil fertility increases. This, however, is true only up to a point. For example, in areas where rainfall exceeds 1 000 mm per annum, such as in tropical grasslands, the abundant rainfall seeps too rapidly through soil, leaching the dissolved nutrients deeper into the soil, beyond the reach of plant roots.

6 *Organelle*: Smallest organisational units of a cell, for example, chloroplast.
Cell: Organelles, plus cytoplasm, plus cell membrane (and cell wall in plant cells) make up a cell, for example, blood cells.
Tissue: A collection of cells that perform a collective function, for example, leaf epidermis.
Organ: A collection of tissues working together to perform a function, for example, the heart.
System: A number of organs working together to perform a function, for example, the digestive system.
Organism: An individual plant or animal, made up of systems, for example, you!
Population: A number of organisms that share similar characteristics and are able to interbreed, for example, a population of ants.
Community: A collection of populations that occupy the same habitat, for example, grasses, shrubs, earthworms and locusts in the garden.
Ecosystem: All the communities that interact with each other and with the non-living (abiotic) factors in a given area, to sustain living processes, for example, a pond.
Biome: Ecosystems that collectively share similar characteristics and are found in similar geographic regions of the world, for example, temperate grasslands (steppes) in Russia and savannah in Africa.
Biosphere: The total sum of all the biomes on Earth.

Activity 4 Nature reserves *(Specific Aim 3)*

Learner's Book page 222

1 Provide each learner with a copy of the Veld Types map of South Africa. The sizes of reserves are usually expressed in hectare (ha).
Example: Assegaaibosch Nature Reserve near Stellenbosch in the Western Cape. (Source: *Cape Nature Conservation* by J Barrett)
The size of the reserve is 204 ha.

2 The learners' answers will depend on the area in which they live. The answers given for questions 2 to 6 are examples of how the questions could be answered, and refer to the Assegaaibosch Nature Reserve.
The reserve is in the Jonkershoek Valley, 8 km from Stellenbosch. The access road to Stellenbosch is the R310. From Stellenbosch, take the Jonkershoek Road, which leads up into the Jonkershoek Valley. The reserve lies to the right of the road.

3 The vegetation of the Assegaaibosch Nature Reserve is predominantly mountain (highland) fynbos consisting of ericas, restioids and proteas. Forest communities are found on stream banks and the banks of the Eerste River. More than 400 plant species have been recorded.

4 Steenbok, caracal and leopard occur on the reserve and in the surrounding area, but are seldom seen because of their shy nature.
More than a hundred species of birds have been recorded, including the African goshawk, forest buzzard, olive woodpecker, paradise flycatcher, kingfisher, sunbird, sugarbird and various waterfowls.

5 An easy 2 km walk starts in the wildflower garden. It leads up the mountain and continues along a contour line, from where one has a panoramic view of the valley below.
Note: If no hiking trails are available in a reserve, one should consider the reasons for that. In some reserves there are no formal hiking trails, but hiking is permitted and should be arranged beforehand with the officer in charge. No hiking is permitted in some reserves, owing to the presence of potentially dangerous animals.

Activity Self assessment questions

1 Ecology is usually defined as the scientific study of interactions that determine the distribution and abundance of organisms.

2 A biome is a large community of organisms that form ecosystems with similar features.

3 All the Earth's ecosystems together make up the biosphere. The biosphere is the part of the Earth that contains living organisms. The biosphere is a thin layer of the Earth's surface, about 20 km thick.
The biotic components of the biosphere interact with the abiotic components. The abiotic components include:
- the soil and rocks that are on the Earth's surface, called the lithosphere
- the seas, rivers and lakes, called the hydrosphere
- the gases that surround the Earth, called the atmosphere.

4 The objectives of ecotourism are:
- to create a tourist industry that opens up opportunities for job creation and at the same time helps to relieve poverty
- to create awareness of South Africa's rich biodiversity and the importance of conserving this.

Learner's Book pages 225–251
Duration: 6 hours

UNIT 3 Living and non-living resources

TERM 3

RPA

Activity 1 Separating the components of soil *(Specific Aim 2)*

Learner's Book page 228

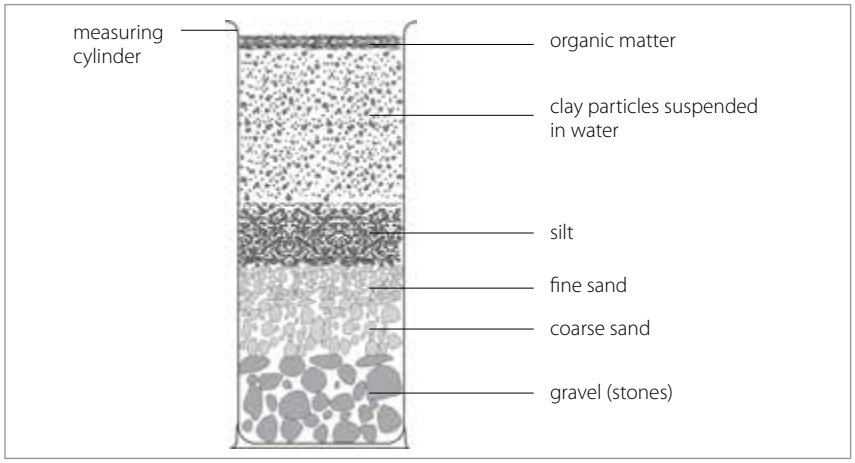
1 Soil contains air. Air is replaced by water and given off.
2 Gravel (stones). They are larger and heavier than the rest.
3 That is caused by clay particles suspended in water and too small to settle down.
4 Organic matter (humus)
5 Learners can measure the thickness of the various layers in two ways:
- direct reading from a measuring cylinder
- by using a ruler graded in mm/cm.

They must record the thickness of each layer either in mm or cm.

6 The teacher assists learners to classify their soil sample either in sand or loam or clay soil by using the following table of comparison, and then deduce the properties of their soil concerned.

Properties	Sand	Loam	Clay
1 Particle size	0,02 mm to 2,0 mm	Mixture of sand and clay	Less than 0,002 mm
2 Texture	Coarse – feels gritty	Medium – feels fairly smooth	Fine – feels smooth; sticky when wet
3 Composition	85% sand 5% silt 10% clay	50% sand 30% silt 20% clay	10% sand 20% silt 70% clay
4 Aeration (air content)	Good	Good	Poor
5 Water-retaining ability (water capacity)	Low	Good	High
6 Draining	Quick	Good	Slow
7 Temperature	Heats up and cools down quickly	Moderate	Absorbs and loses heat slowly
8 Mineral and humus content	Low	High	High
9 Cultivation	Easily	Easily	Difficult

7 Remind the learners of what is important when trying to produce good scientific drawings.



Soil particles separate according to size.

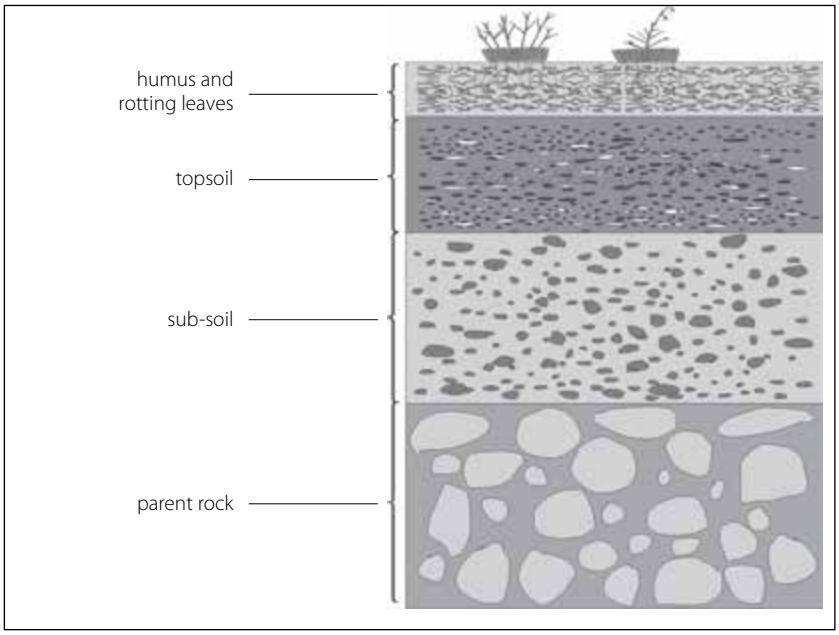
8 Learners discuss and compare their findings with another group.

Activity 2 All about soils *(Specific Aim 1)*

Learner's Book page 229

1 a A soil profile is a vertical section cut through soil to show its layers.

b



A soil profile

2 Earthworms, ants, mole-rats, termites, mongooses, ant-eaters (aardvarks), and so on.

3 Land surface of S.A. (in hectare) $= \frac{366\ 000\ 000}{3} \times 1$ hectare

$= 122\ 000\ 000$ hectare

4 Learners may refer back to the answers they gave in Activity 1, question 6 for answers. The properties of loam soil resemble the properties of a good quality soil.

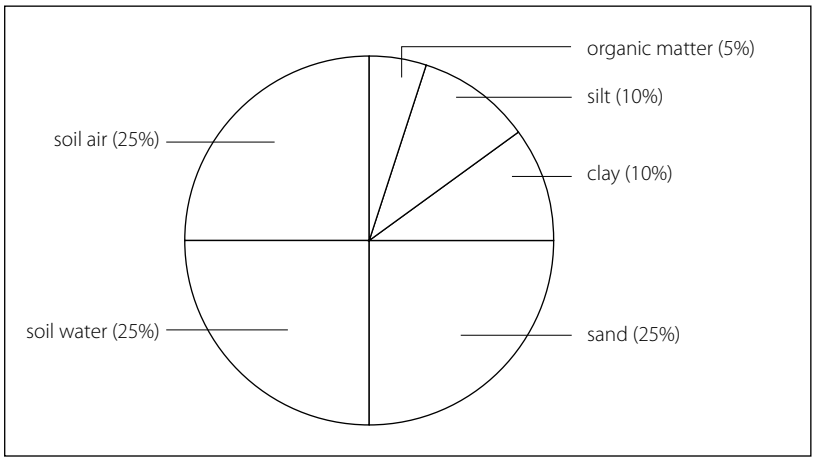
5
- Humus improves aeration by causing the soil to form crumbs.
- Humus acts as a sponge and increases the water-retaining ability of the soil.
- Humus is dark in colour and absorbs heat, thus improving the temperature of the soil.
- As it increases the water-retaining ability of soil, humus prevents the leaching out of plant nutrients (minerals) and increases the fertility of the soil.

6 Yes, it is a good-quality soil.
- The growth of the crops is not stunted (dwarfish) but, in fact, luxurious.

7 Soil temperature does not fluctuate as much as external atmospheric temperature. The temperature of soil below 30 cm is almost constant during the day.

8 Nitrogen, phosphate, potassium.

9 Learners should name the constituents of soil but allow for slight deviation regarding percentages.



Composition of good-quality soil

RPA

Activity 3 Measuring physical properties of soil *(Specific Aim 2)*

Learner's Book page 230

You must make sure that enough apparatus and materials are available and that sufficient reference books are at learners' disposal.

1 Assist learners in selecting the correct apparatus for the particular experiment. Draw their attention to observe any events that occur and monitor them continuously while they are conducting their experiments.

2 Learners briefly describe their experiments under the mentioned headings after conducting the experiments. They must pay special attention to the results obtained and conclusions reached.

3 They may refer back to question 2 dealing with the comparison of the various kinds of soil. Example: If a soil retained ±25% of the water used, you will classify such a soil as a good-quality one – water is needed by plant roots to grow and for minerals in solution to be absorbed.

4 Remind the learners what is important when trying to produce good scientific drawings.

5 Allow a learner from each group to display their completed drawing and to report back. When all the groups have reported back, allow time for the groups to write down their aims, results and conclusions of the other experiments and to make the drawings concerned.

Learner's Book page 230

1 The percentage of each soil constituent has to be calculated before a pie chart can be drawn. The soil sample consists of 25% air. The rest of the various constituents make up 75% (100 – 25). The percentage of organic matter is calculated indirectly.

clay: $\frac{3}{4} \times 12 = 9\%$

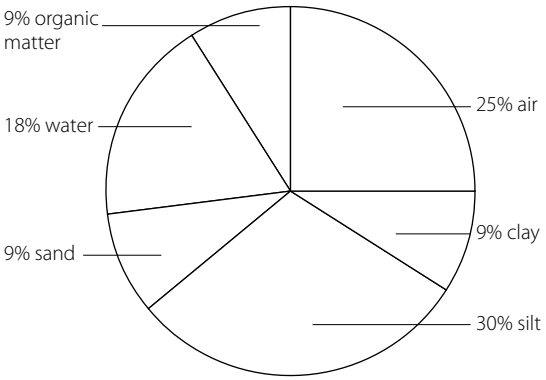
silt: $\frac{3}{4} \times 40 = 30\%$

sand: $\frac{3}{4} \times 12 = 9\%$

water: $\frac{3}{4} \times 24 = 18\%$

organic matter:

100 – (66 + 25) = 9%



2 **a** **i** R = 250 cm³ water

ii 400 – 250 cm³ = 150 cm³ soil

b **i** Volume of air present

Volume of water absorbed = volume of air displaced

(S – T) = volume of air

(400 – 350 cm³) = 50 cm³

ii Percentage of air present

$$\frac{\text{volume air}}{\text{volume soil}} \times 100\% = \frac{S - T}{S - R} \times 100\%$$

$$= \frac{400 - 350}{400 - 250} \times 100\%$$

$$= \frac{50}{150} \times 100\%$$

$$= 33{,}3\%$$

c **i** Yes

ii Sandy soil

d • For water to enter the tin from the bottom

• So that air can be driven out

Learner's Book page 232

The learners must first read the information regarding Sandile's family on their own before they form groups to answer the questions.

1 Cattle = 10 × 10 = 100 hectare
Sheep = 100 × 3 = 300 hectare
Total = 100 + 300 = 400 hectare

2 $\frac{10}{100} \times 800 = 80$ hectare

3 **a** Northern part

b Livestock: 400 hectare
Farmstead: 1
Cash crops: 4
Ecosystem: 80
485 hectare

Maize: $800 - 485 = 315 \times \frac{80}{100} = 252$ hectare

4 **a**
- Planting trees (windbreaks) on outside boundaries.
- Increasing or maintaining organic content of soil.
- Preventing overstocking and overgrazing.

Trees serve as windbreaks – they break the impact of the wind, thus reducing its ability to erode.
Organic matter binds soil particles together (they form crumbs) and plays an important part in preventing soil from being blown away.

b
- Avoiding cultivation of steep slopes.
- Ploughing across the slope and not up and down the slope.
- Introducing contour ploughing.

Any method slowing down the flow of water allows time for water to penetrate into the soil, thus reducing run-off.

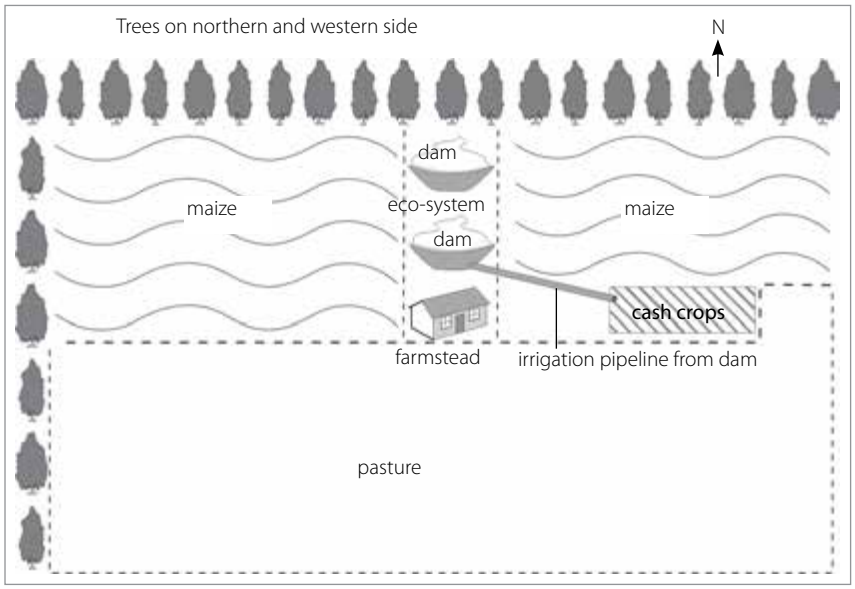
5 By building dams.

6 Potatoes, tomatoes, beans, cabbage, carrots.

7
- The best site will be in the vicinity on both sides of the named gully.
- Construct two dams, one to the northern side of the gully and the other one lower down.
- Plant indigenous trees and shrubs between the dams on both sides of the gully.
- This method will assist in reducing soil erosion.
- Parts of the gully can be filled with stones/rocks to prevent/reduce soil erosion – weirs can even be built.

8 Learners may think about what kind of fertilisers could be used and the cost involved, and what to plant when. Drought is a normal phenomenon. Minimise risk by increasing the rest period on each and every paddock. Reduce stock numbers to fit carrying capacity.

9



Proposed demarcated farm of Sandile's family

10 Learners communicate their recommendations.

11 Groups display their maps to be assessed.

Activity 5 Agricultural practices *(Specific Aims 1 and 3)*

Learner's Book page 234

It may be that some learners are not well-acquainted with the mentioned agricultural practices/concepts. For this reason it is important that the teacher should see that relevant library/reference books are at the disposal of such learners.

1 Crop rotation

Rotation means to turn round – it implies the cultivation of different crops in succession on the same piece of land. It is a good farming practice.

- It helps to control pests and diseases.
- It helps to maintain soil fertility.
- It prevents the one-sided utilisation of plant nutrients because certain crops are heavy feeders of a particular plant nutrient.
- Soil can be fully utilised if shallow-rooted crops are rotated with deep-rooted ones.
- The risk of crop failures is spread across a wider spectrum. It can be applied on the four hectares of soil where vegetables are cultivated.

2 Overgrazing

Overgrazing is when too many livestock have to compete for available food in a limited area. It is a bad farming practice.

- Too much grazing leads to destruction or killing of grass.
- Soil becomes bare and dusty.
- There is no cover for the soil and soil erosion occurs.
- There is no chance for plants to run to seed and young seedlings cannot establish themselves.
- The soil is trampled and becomes compact.
- The natural habitat is disturbed and unwanted plants such as weeds and poisonous plants increase. The southern part of the farm suitable for grazing, is subjected to this phenomenon.

3 **Monoculture (overcropping)**
Overcropping is more or less the reverse of crop rotation. This is a practice where the same crop is grown on the same piece of land year after year. This is a bad farming practice.
- It is difficult to control pests and diseases.
- It causes decline in soil fertility.
- Labour is not fully utilised and slack periods in farm activities increase. The circumstance under which monoculture would be preferred to a crop rotation system, is when a high producer price for a particular crop is fetched. The northern part of the farm allocated for maize production, is subjected to this bad farming practice.

4 **Contour ploughing**
Contour means a line on the ground that is level. When ploughing on the contour (across the slope), the furrows will lie on the level even when ploughing across the side of a hill. It is a good practice.
- Water loss is reduced – there is less run-off.
- Soil erosion by water is reduced. It can be applied to the part earmarked for maize production.

5 **Windbreaks**
A windbreak is a hedge of tall trees planted with the aim of breaking the force of strong winds. The planting of windbreaks is a good practice.
- Soil erosion by wind is reduced.
- The blowing down of fruit on fruit farms is reduced.
  Trees can be planted at the northern and western boundaries of the farm to reduce the effect of the strong north-west winds during August.

» Activity 6 Conflict around water *(Specific Aims 1 and 3)*

Learner's Book page 238

This activity shows the importance of an understanding of Life Sciences in a social context, using the shortage of water in Darfur as an example of where shortage of resources has led to conflict.

1 The farmers are the Fur and the Masalit. The nomadic peoples are Arab nomads – the Zaghawa.
2 Farmers require a constant water supply for their crops and livestock.
3 In areas with seasonal rainfall, a shorter rainy season would be likely to lead to less rain falling and so less rain available in ponds, dams, rivers and ground water sources.
4 The amount of land available for farming will decrease as the land gets drier.
5 The conflict is likely to become worse as the precious resource, water, becomes more and more scarce.

» Activity 7 Availability of water *(Specific Aim 1)*

Learner's Book page 241

Provide each learner with a blank map (photocopy) of the province concerned.

1 The learners should list at least ten daily uses of water, for example: washing, bathing, showering, brushing teeth, flushing the toilet, drinking, making coffee/tea, washing dishes, doing laundry, cooking, irrigation, washing hands.

2 **a** 97%
b 2,97%
c 0,03%

3 Learners should first decide on the names of the major rivers in their province before drawing them in on a map as accurately as possible.

4 The same as for question 3 but for dams, in this case.

5 **a** and **b** Learners must consult their local or nearest municipality or weather station to obtain the correct data.

6 Learners must consult officials in health and sanitation before answering this question.

7 The same as for question 5.

8 Chlorine is used to kill pathogens in the water. However, chlorine may react with certain industrial chemicals to produce chlorinated compounds, some of which are carcinogens.

» Activity 8 Water resources in South Africa *(Specific Aims 1 and 3)*

Learner's Book page 242

1 South Africa is a semi-arid country, where water is scarce compared to most other countries. South Africa's average rainfall is less than 500 mm (497 mm), which is well below the world average of 860 mm. The greatest part of the country receives only about 27% of South Africa's total rainfall. Due to hot, dry conditions, South Africa experiences a high evaporation rate. Evaporation exceeds rainfall, except for small areas along the coast and on certain escarpments.

2 Yes, we do need dams. About half of South Africa's annual rainfall is already stored in about 550 government dams, with a total capacity of more than 37 000 million m^3.

It should be kept in mind that dams have both positive and negative impacts. They can be beneficial in that they regulate the flow of a river, reducing flood damage and contributing to perennial rather than seasonal flow. Water leaving a dam may be cleaner than water entering it. A dam usually has a negative effect on the riverine ecosystem. Alterations in flow management (quantity of water and timing of periods of high and low flow), temperature and water quality may cause reductions in biodiversity of riverine organisms below dams.

The construction of new dams should continually be considered, because the capacity of existing dams becomes more and more reduced by the high silt load of our rivers. It should also be considered to meet the demands for the growing population. It should be emphasised that South Africa's landscape is not well suited to dams.

3 All the following lead to increased water demand, and increasing degradation of the freshwater resources of the country, which is already under stress.

- Population growth. Most of the country's rivers have been dammed to provide water for the increasing population. By the year 2020 clean water will be in short supply.
- Increased economic activity. Industrial and domestic effluents are polluting the ground- and surface-waters, and changes in habitat have affected the biotic diversity of freshwater ecosystems.
- Intensification of land-use practices. In most areas wetlands have been converted for other land-use practices, with more than 50% of South Africa's wetlands already lost.

4 Good management and sustainable utilisation of our freshwater systems and resources depend on reliable information. Everybody must help to save water, even if they live in a part of the country where there seems to be plenty of it.
- Repair or report leaking taps and toilets.
- Each day, look for ways where you can avoid wasting water.
- Collect rainwater in a water-tank/butt.
- Use "low-flush" toilets.
- Plant indigenous and, where possible, drought-tolerant shrubs and trees.
- Report any pollution in a stream or a river to your local or nearest water authority.
- Remove alien vegetation growing close to rivers or streams.

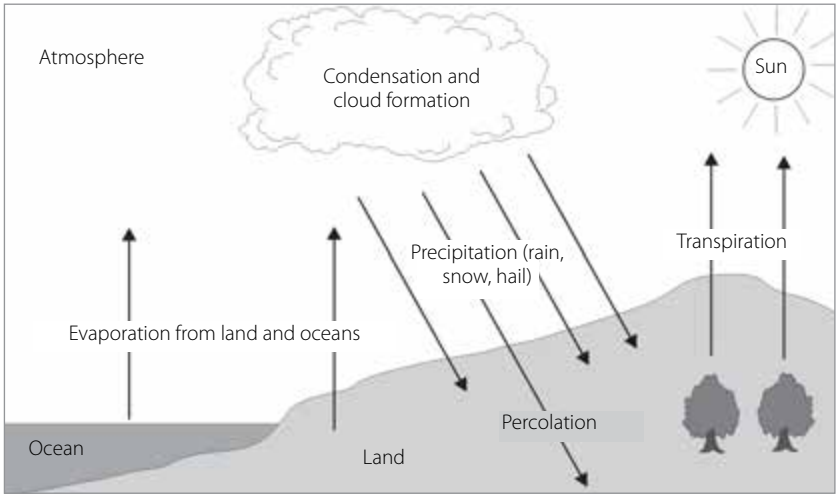
Activity 9 The water phases *(Specific Aim 1)*

Learner's Book page 244

1 Gas, liquid and solid (the answer may be in any sequence).

2 **a** evaporation **b** transpiration **c** precipitation
d evaporation **e** run off

3 **a** The learners' drawings should look something like this.



The water cycle

b Hydrogen (H) and oxygen (O).
c Oceans do not increase in size because the water is continuously evaporating.

4 **a** A rise in seawater can be caused by melting icebergs, occurring as a result of global atmospheric warming.
b From rain, snow or hail, as result of precipitation.
c Water returns to the atmosphere by evaporation from the surface of the oceans, lakes, rivers, and so on, and from the surface of plant leaves during transpiration.

5 **a** Pure water vapour, produced by evaporation, condenses and falls back to the Earth in the form of rain, hail and snow.
b The same amount of water entering the oceans, evaporates from these vast exposed surfaces back into the atmosphere.
c Sodium chloride; NaCl.

» Activity 10 A community water cycle *(Specific Aim 3)*

Learner's Book page 245

This activity could be used as a homework exercise.

Many people in South Africa obtain their water from metropolitan or regional water systems. These systems rely on one or both of two sources: reservoirs, created by damming up rivers, or from wells. Water in reservoirs is not pure and must be treated to make it safe for human consumption. After the water treatment plants purify the water, they send it out to the users. The distribution system diverts water down different pathways to homes (and businesses). Once water is used, it leaves your home (or school) as wastewater. The three parts of a wastewater treatment plant are:

a Collection. Wastewater is collected in large pipes and conveyed to the treatment plants.

b Treatment. Wastewater is treated as follows:
- primary treatment, where solid wastes are removed by bar screens and settling tanks
- secondary treatment by aeration and growth of useful bacteria and settling again
- advanced treatment, where chlorine is added to disinfect water.

c Discharge. Disinfected, cleaned water is discharged into a stream or lake from where it re-enters the natural water cycle.
Note: Some homes may have a septic system, which has a settling tank and rain field.

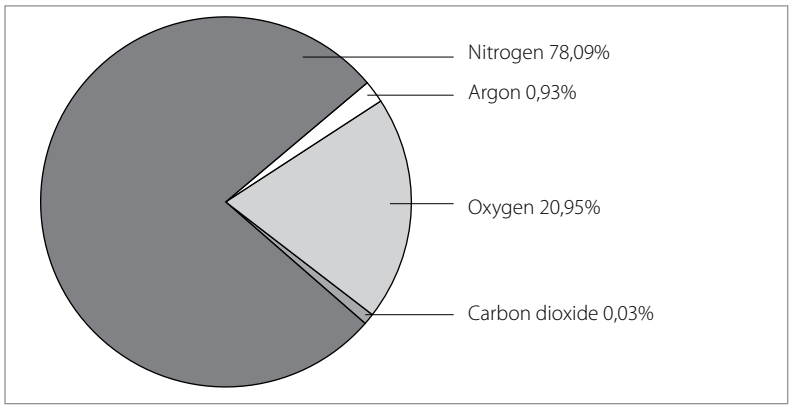
RPA

» Activity 11 The atmosphere *(Specific Aims 1 and 2)*

Learner's Book page 246

This activity could be used as a homework exercise.

1



Composition of dry atmospheric air

2 Nitrogen dilutes the other gases and is needed for protein synthesis.
Oxygen is used by living organisms during respiration.
Carbon dioxide is used by green plants during photosynthesis to produce organic food.

3 Helium, neon, argon, ozone and dust particles.

Learner's Book page 247

1 Some research work is required. Each learner in the group picks one of the named gases (SO_2, NO, CO), gains information on the disorders or ailments caused by an excess of this gas and prepares him- or herself to present it to the group. Time should be allowed for debating this issue. The group reaches consensus and makes a list of the various disorders caused by each gas.

- SO_2. Irritating lung surfaces, damaging the skin and also the surface of the eyes.
- NO. This exhaust fume contributes considerably to photochemical smog. Under conditions of temperature inversion can cause irritation to eyes and lungs.
- CO. It combines 250 times more readily with our oxygen carrier molecules, haemoglobin, in the blood. When the concentration is too high, humans can be suffocated. In lower concentrations it can cause dizziness and headaches.

2 Pollution is not just restricted to the air we breathe when we go outside. The atmosphere inside our homes may also be polluted. Some of the highest concentrations are found in rural, indoor environments. If water heaters, open fires and cookers using oil, solid fuel or gas are badly maintained, they will use fuel inefficiently and cause more pollution. These practices also give off dangerous fumes, such as carbon monoxide. It is common during winter to keep windows closed and to block up openings that might cause a draught. There is then insufficient ventilation in the room and the air becomes stagnant and stale. This phenomenon is enhanced when someone is smoking or there is an open fire. This is especially a problem for children of low-income families, who live mainly in rural areas or informal settlements with inadequate housing.

This can be rectified by:

- putting into operation an electrification programme to replace the use of coal and wood as a domestic energy source, and thus improving indoor air quality
- opening the windows to improve air ventilation
- generally improving housing design and construction, and creating larger houses with more window space
- stopping smoking in a room where children are present
- paving roads in informal settlements to improve the ambient air quality
- educating the public on the dangers of open fires inside houses, especially in poor ventilated ones.

3 Designing a poster is one of the most important things that can be done to make more people aware of how outdoor air quality in a community can be improved.

- The heading must grab the attention of the people who see it.
- Design an illustration or symbol, or cut and paste pictures or illustrations out of magazines that are relevant and essential to the message of the poster. Remember, too much information or detail is not good! A common mistake is to create a poster that is too 'busy'.
- Summarise in about 30 to 40 words some suggestions as to what can be done to improve outdoor air quality in the community. Colour and bold print has to be used.

- If there is room, include some other information such as useful addresses to contact for more information about the suggestions or problem.

4 The learners present their posters to members of another group.

Activity 13 Biotic and abiotic resources *(Specific Aim 1)*

Learner's Book page 249

This section deals with living (biotic) resources, namely plants and animals. They are living resources, since they possess characteristics such as: the need for food for growth and repair, they obtain energy by the process of cellular respiration, they grow in size through the process of mitosis, they respond to environmental stimuli, and so on.

1 The non-living (abiotic) resources dealt with are water, air and soil. These are non-living resources since they do not possess the properties of living things.

2 Figure 3.23 – plants (living); huts, soil, air (non-living).
Figure 3.24 – plants (living); windmill, air (non-living).
Figure 3.25 – people, fish (living); boat, water (non-living).
Figure 3.26 – people, shrubs (living); water, rocks (non-living).
Figure 3.27 – goats, trees (living); soil (non-living).
Figure 3.28 – grass, people, (living); vehicles soil (non-living).

3 Movement. Most animals move about, but movement from one place to another in itself is not diagnostic of life. Most plants and even some animals do not move about, while many non-living objects, such as clouds and air (wind), do move. The criterion of movement is thus neither necessary (possessed by all life) nor sufficient (possessed only by life).
Complexity. All living things, even bacteria, are complex in structure and function. However, a computer or a jet engine is also complex, but not alive. Complexity is a necessary criterion for life, but it is not sufficient in itself to identify living things, since many complex things are not alive.

4 Refer to question 4 (movement). Clouds do not possess the unique fundamental properties (the ability to feed, respire, grow, and so on) of living things.

5 No. It uses up oxygen, but it does not breathe.

Self assessment questions

1 **a** R is the best for plant growth because the soil contains adequate water and the humus content is high.

b T would most easily become waterlogged, because the water content is extremely high and the permeability to water is very low.

c S is the soil in which plants will wither quickest, because the humus content and water-retaining capacity is low and because water drains easily through and soil dries quickly.

d **i** It is important for soil to contain sufficient air, because the oxygen in air is needed by plant roots and soil organisms to breathe, air prevents poisonous substances from being formed and because it is needed for seeds to germinate.

ii Soil needs sufficient humus, because it acts as a sponge and increases the water-retaining ability of soil, it provides minerals to plants through decay and it improves the aeration of heavy soils.

2 **a** pH is a measure of the acidity or alkalinity of a solution.
b Sample B. Blue litmus paper will turn red, which indicates that the pH is less than 7.
c Sample A, because the soil is alkaline.
d When it has a pH of 7.
e Sample B. The lime neutralises and reduces soil acidity.

Learner's Book pages 252–264
Duration: 6 hours

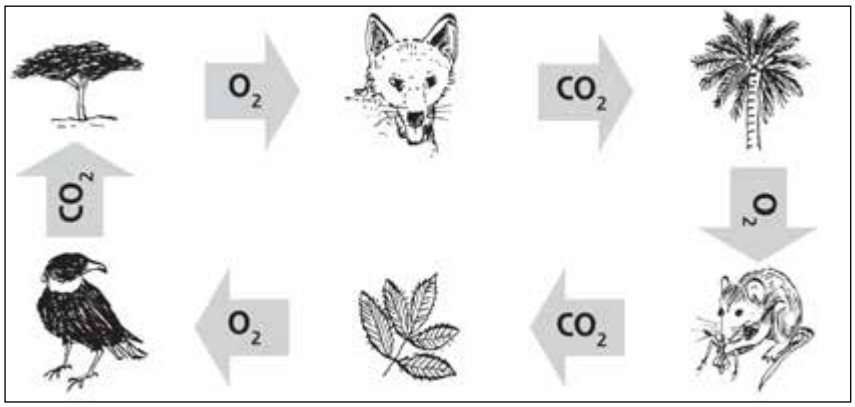
UNIT 4 Nutrient cycles and the environment

TERM 3

Activity 1 The carbon cycle *(Specific Aim 1)*

Learner's Book page 255

1 The pictures for the plant/animal gaseous exchange in a circle dance



2 The hyena story: carbon circle dance
Part of buffalo. Carbon is a very important component of living organisms, because it is an essential part of the organic compounds: carbohydrates, fats and proteins. These compounds, together with the inorganic compounds, make up the organism's body. The meat of buffalo consists mainly of carbohydrates, fats and proteins containing a lot of carbon atoms. The carbon atoms in buffalo's meat provide hyena with energy, enough so that she could hunt and kill a zebra by herself and chase away annoying vultures.
Part of hyena: Inside hyena's body, a carbon atom from buffalo's meat had become part of a cell in her hardworking leg muscles. To generate more energy, carbohydrates in hyena's muscle had to be metabolised and the carbon atom was released. When hyena's blood flowed through her muscles, this carbon atom combined with oxygen to form a carbon dioxide molecule. From the lungs the exhausted hyena breathed the carbon dioxide out into the atmosphere.
Part of acacia: A few minutes later, acacia absorbed the carbon dioxide molecule from the atmosphere into a leaf. Inside the leaf, photosynthesis took place and produced food for acacia to grow. In the leaf the carbon dioxide molecule dissociated. The liberated carbon atom and some hydrogen were used to produce a sugar molecule (food), and the oxygen from the carbon dioxide diffused back into the atmosphere.

3 High levels of carbon dioxide in the atmosphere can be reduced by "fixing" carbon in plant and animal tissues and by returning organic carbon to the soil. These stores of organic carbon are known as "carbon sinks", because they "drain" carbon dioxide from the atmosphere and hold it for a period in a form that does not contribute to global warming. Carbon sinks may be relatively temporary or permanent. For instance, grasslands are more temporary carbon sinks than forests, because the grazing and burning of grasses cause rapid turnover of organic matter. Trees, on the other hand, grow more slowly and store organic carbon for many years in woody tissues. However, they too may one day be burned as fuel or die and rot, releasing carbon dioxide into the atmosphere.
Soil is the ultimate carbon sink. It contains organic matter derived from plants, animals, fungi and bacteria. Most organic carbon in the soil occurs in a form that binds tightly to clay particles and cannot easily be dislodged. Soil enriched with organic matter is therefore a very stable carbon sink as it can store large amounts of carbon for a very long time. (Source: *Conservation farming project*, National Botanical Institute SA.)

4 Human activities add carbon to the atmosphere by burning fossil fuels, through deforestation and through the production of cement.
Burning fossil fuels. Humans have been burning huge quantities of fuel, including fossil fuels, releasing carbon dioxide into the atmosphere. Mining, transport, industry and farming contribute to that.
Deforestation. Humans have been destroying vast tracks of vegetation, including tropical rainforests. The rate of photosynthesis is reduced and less carbon dioxide is removed from the atmosphere.
Production of cement. In the production of cement from limestone, vast amounts of carbon dioxide are released into the atmosphere.

RPA

Activity 2 The nitrogen cycle *(Specific Aims 1 and 2)*

Learner's Book page 257

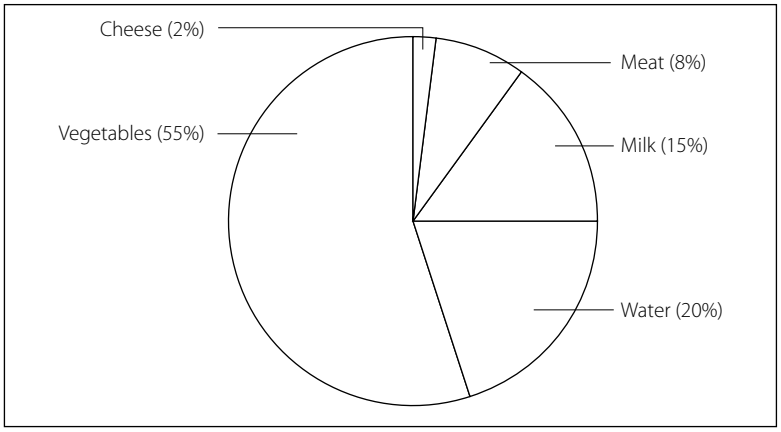
1 *Nitrification*. The process by which certain soil bacteria convert ammonia (NH_3) and nitrites (NO_2) into nitrates (NO_3). These nitrates dissolve in soil water and are absorbed by plant roots.
Denitrification. Denitrifying bacteria change nitrates back into nitrogen again in a process known as denitrification. This nitrogen escapes as a gas into the atmosphere.
Ammonification. The process by which certain soil bacteria convert plant proteins, animal proteins, urea and uric acid into ammonia.
Lightning (electrical fixation). Lightning causes some of the nitrogen gas in the atmosphere to combine with oxygen, forming nitrogen oxides. These nitrogen oxides dissolve in rain and are washed into the soil, where they form nitrates.

2 **a** 1 – Nitrates 2 – Animal protein 3 – Ammonia
b A – Nitrogen fixation B – Feeding
C – Absorption by roots D – Denitrification
c Legumes such as peas, beans, lupins and clover have root modules (small swellings) that contain nitrogen-fixing bacteria. These bacteria (*Rhizobium* sp.) use nitrogen gas from soil air and change it into nitrates. The plant uses the nitrates to produce proteins.
d These bacteria are harmful, because valuable and important nitrates needed by plants are converted into substances that cannot be used by plants. In fact, nitrates are poisonous to plants.

3 **a** Lupins are legumes and wheat not. Refer to question **2c**.

b Lupins are capable of producing their own nitrates. Some roots absorb additional nitrates from the soil solution. It may happen that an excess of nitrogen will impede absorption of other elements. The effect of this will be a decline in plant growth.

4 a



b Some vegetables (for example, beans and peas) can produce their own nitrates. All plants absorb nitrates from the soil solution. Metabolic activities in plants are relatively low and the bulk of nitrates (produced and absorbed) is used for the synthesis of plant proteins.

c Animals are active organisms and require much energy for their metabolic processes. A lot of nitrates are consumed to satisfy these processes and less are available to be converted into proteins.

d Farming practices increase with the downward flow of streams. Farmers use nitrate fertilisers in the cultivation of crops. Nitrates dissolve in irrigation water and then drain into streams and rivers.

e Invite the official concerned to address the learners regarding all aspects of municipal water.

5 To solve his nitrogen problem, Sandile could try one or more of the following ideas, all of which aim to return to the soil the nitrogen that has been depleted:

- add chemical fertiliser (which he could buy)
- add compost (which he could make himself)
- add manure (which could be provided by his livestock)
- practise crop rotation (alternating a legume crop with the current crop)
- plough unused parts of the previous crop into the soil (such as maize stalks).

» Activity 3 Climate change *(Specific Aim 3)*

Learner's Book page 259

1 The Kyoto Protocol is an agreement that requires industrialised countries to reduce their greenhouse gas emissions from 1990 levels by an average of 5% over the period 2008 to 2012. It is part of the United Nations Convention on Climate Change that requires industrial countries to stabilise their greenhouse gas emissions to 1990 levels by 2000. The USA has signed the agreement, but does not intend to ratify it. *Note*: Signing is optional, indicating intention to ratify. Ratification is the key step for a country to formally accept an international treaty.

2 Learners should indicate that they understand that developing countries such as South Africa, China and India (as examples) are industrialising rapidly and so are producing greenhouse gases, which will contribute to climate change.

3 Answer will vary, but learners should talk about coal-fired power stations, industries that use fossil fuels and use and produce fossil fuel offshoots, such as plastics, individual activities such as using cars, burning wood for fuel, using gas for fuel, failing to recycle. Learners should show evidence of research into what produces greenhouse gases.

4 Answers will vary, but learners should discuss government measures to encourage less use of fossil fuels, controls on emissions by industries and a move towards use of renewable energy resources.

5 Answers will vary. Learners should think about ways of reducing energy use, such as raising the price of conventionally produced energy and subsidising the use of renewable energy sources.

6 Learners should list solar energy, geothermal energy, wave energy, wind energy, and so on.

Self assessment questions

1 **a** The main source of carbon is the atmosphere. It is used for the synthesis of organic compounds in the form of carbon dioxide.
b Photosynthesis
c During decomposition and combustion of organic food, during respiration of living organisms, and during combustion of fossil fuels.

2 **1**: Free living nitrogen-fixing bacteria / *Azotobacter* / *Clostridium*
2: Symbiotic bacteria / *Rhizobium*
3: Plant protein
4: Animal protein
5: Urea
6: Ammonification
7: Nitrite bacteria
8: Nitrites
9: Nitrate bacteria
10: Denitrification
11: Electrical fixation
12: Absorbed by plants

Learner's Book pages 265–276
Duration: 6 hours

UNIT 5 Energy flow within an ecosystem

TERM 3

RPA

Investigation 1 Do animals prefer specific types of plants for food

(Specific Aim 2)

Learner's Book page 265

The learners of each group are responsible for their group's jars, leaves and herbivores. They should read the instructions carefully and follow the instructions in the correct sequence.

The ability to follow instructions for investigations (and experiments) and to perform specified procedures during practical work is a fundamental skill. Assess the groups while observing the learners at work. Assistance should be given where needed so that laboratory sessions are as instructive and productive as possible.

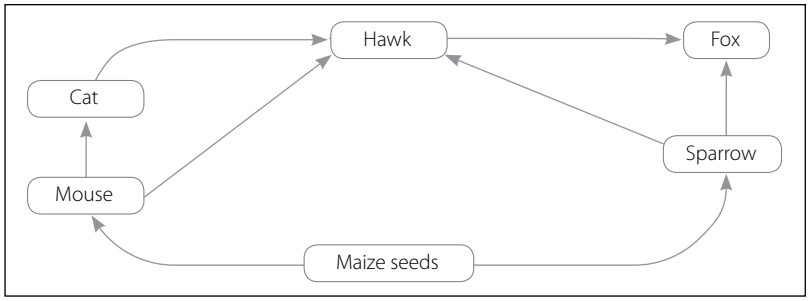
Take note that a histogram is quite like a bar graph, but there are no gaps between the columns. The columns should be of the same width and drawn with the aid of a ruler.

1 The type of plant is determined by the amount eaten.
2 It may be that the plant (leaf) does not secrete any repelling scents or flavours. The taste is palatable. The epidermis of the leaf is soft and not hairy or waxy.
3 Animals are sensitive to damaged and sick leaves. These leaves secrete substances with offensive smells.
4 For more effective verification.
5 No, there would be too much confusion in searching for the desirable leaves for food.
6 One would use a perforated lid so that:
- oxygen, needed for respiration, can enter
- carbon dioxide, as waste product of respiration, can diffuse outwards
- the animals do not suffocate and then investigation can proceed successfully.

RPA » **Activity 1 Energy flow through an ecosystem (1)** *(Specific Aims 1 and 2)*

Learner's Book page 267

1



A simple food web

2 The electricity needed to drive an electric motor is generated in coal-burning power stations. The coal used is fossil fuel. Coal developed from the remains of plants that died millions of years ago. These plants used the radiant energy from the Sun and converted it into chemical potential energy. This chemical energy is stored in organic compounds making up plant material which eventually changed into coal.

The petrol needed to drive a motor engine is derived from refined crude oil. Crude oil is also a fossil fuel. It is derived from microscopic diatoms (phytoplankton) that lived more than 300 million years ago. Phytoplankton is tiny plants that are capable of converting the energy from sunlight into chemical energy. This energy was stored in carbon compounds that eventually turned into oil droplets under great pressure and heat millions of years ago.

A racehorse is a herbivore eating plant material to obtain the energy needed for running. Plants use the radiant energy from the Sun and convert it into chemical energy. This chemical energy is stored in the organic compounds that make out the plant material.

3 **a** **i** B
ii A
b B
c C
d C
e A
f C
g B
h A
i A

4 **a** **i** Increase. If B increases there will be more B (food) to support E.
ii Decrease. If C increases, more B will be eaten so there will be less B to support E.
iii Increase. If D increases, more C will be eaten so there will be less C eating B; this will result in more B to support E.
iv Decrease. If F increases, more E will be eaten.
v Increase. If G decreases, less E will be eaten.
b **i** C and E
ii B

5 If some event interferes with a food web, all the organisms in it are affected in some way. The learners can mention various possibilities when goats and cats are introduced, for example:
Goats. Less vegetation will be available as food for rabbits. The owl population will decrease, as a result. Rats will become a pest and compete with goats for food.
Cats. Fewer rats will be available as food for foxes and owls. Foxes will start catching and killing goats for food. Due to the decrease in the population in owls, the beetle population will increase. Beetles will become a pest and compete with goats for food.

RPA

Activity 2 Energy flow through an ecosystem (2) *(Specific Aims 1 and 2)*

Learner's Book page 269

1 **a** When radiant energy from the Sun falls on grassland, about
- 20% is reflected by the vegetation into the atmosphere
- 39% is used in evaporating water from the leaves during transpiration
- 40% warms up the soil, the air and the plants
- only about 1% is left to be used in photosynthesis for production of new organic compounds by the leaves of plants.

b The transfer of energy from grass vegetation (producer) to the cow (primary consumer – herbivore) is as follows:
- the bulk (about 60%) of the grass eaten, passes through the alimentary canal undigested
- 30% is used in cellular respiration to provide energy needed for movement and other life processes
- 10% of the plant material is converted into new animal tissue to contribute to growth.

2 **a** Herbivores (primary consumer) – second trophic level
b **i** The energy content of a cauliflower can be determined from burning a known mass of this food completely in the presence of oxygen in an apparatus called a food calorimeter. The heat given off heats up a known quantity of water. From the rise in temperature of the water we can calculate the amount of energy released by the food.

ii Count the individuals per unit area. Do a few counts and calculate the average.

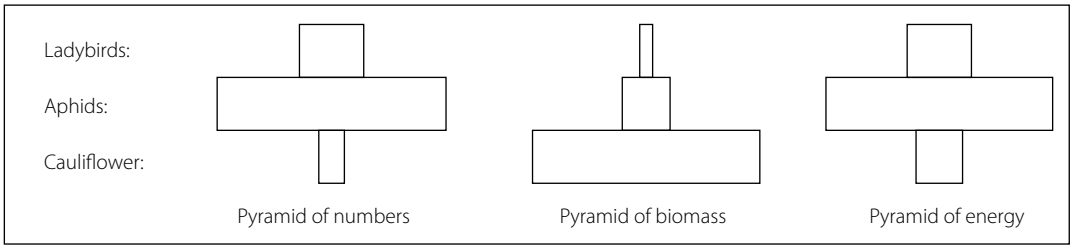
The SI unit used for measuring energy is the joule. Joules are very small units in relation to the energy used by a person.

For this reason the energy contained in food is expressed in kilojoules (kJ). 4.18 kJ is the energy required to raise the temperature of 1 kg (1 000 cm^3) of water through 1 ^{0}C (more precisely, from 14,5 ^{0}C to 15,5 ^{0}C). The joule values of most human foods are already determined. Different food substances have different joule values, i.e. they provide different quantities of energy.

c **Table 5.2**

Organism	Number per square metre	Biomass/g per square metre	Energy content/kJ per square metre
Cauliflower	10	900	15
Aphids	400	20	200
Ladybirds	20	2	40

d



e **i** In the pyramid of numbers there is a large number of primary consumers (herbivores/aphids) feeding on a few but large producers (cauliflower). The secondary consumers (ladybirds) are far less than the herbivores. In this "upside down" or "wrong shape" pyramid, a few producers support a large number of consumers. This pyramid is not a very accurate representation of feeding relationships.

The pyramid of biomass reflects the decrease in biomass at each trophic level in a food chain. The total mass of each level is smaller than that of the level below. This pyramid is a typical pyramid shape with a broad base. This is because it takes account of the relative size of organisms involved. The bar for the producers is always at the bottom of the diagram.

ii In the case of the pyramid of biomass, the shape is in the form of a pyramid because energy is lost at each trophic level, so it gets narrower towards the top. In the pyramid of energy, the producers (cauliflower) store less energy. The primary consumers are capable of storing more chemical energy in their body tissues due to their large numbers. The energy transfer from the primary to the secondary consumers is accompanied by a decrease due to the conversion of potential energy into kinetic energy and heat energy.

3
- Ladybirds as predators will kill the pests.
- They are highly selective and host-specific.
- They do not cause harm to other organisms or accumulate in food chains.
- The predators will breed in the environment and repeated follow-up operations are minimised.
- Pests do not become resistant to the predators.
- They do not harm humans.

RPA

» Investgation 2 Leaf decomposition *(Specific Aim 2)*

Learner's Book page 271

1 **a** Decomposers are organisms (for example, earthworms, bacteria and fungi) that break down the bodies and remains of dead plants and animals. They obtain their energy from dead and decaying matter of producers and consumers. During decay, chemical elements are released and can be absorbed (recycled) back from the soil by plants.

b In bag A, with mesh size of 8,0 mm.

c Bag C

d Invertebrates, for example, earthworms.

e Temperature, water, gases (O_2 and CO_2)

f **i** 70%

ii 25%

g *pH*. Most organisms require a neutral pH or slightly acidic environment. Extremes in pH limit the metabolic activities of organisms and, therefore, the decomposition of organic matter.
Oxygen. Aerobic decomposing bacteria are more effective in the presence of oxygen needed for cellular respiration.

» Activity 3 Food chains *(Specific Aim 1)*

Learner's Book page 272

1 The pyramid of numbers A represents food chain 2.
The pyramid of numbers B represents food chain 4.
The pyramid of numbers C represents food chain 1.
The pyramid of numbers D represents food chain 3.

2 The primary source is the Sun.

3 Pyramids of biomass and pyramids of energy.

» Assignment An aquatic ecosystem *(Specific Aim 1)*

Learner's Book page 272

1 October/November

2 **a** Ecosystem

b Habitat

3 Aquatic

4 Organisms interact with one another.
One organism serves as food for another.

5 Bacteria, decomposers.

6 Soil, water, gases, mineral salts, temperature, sunlight.

7 Photosynthesis

8 **a** Water plants

b tadpoles

c fish

9 Oxygen, for animals to breathe.
Carbon dioxide, for water plants to photosynthesise.

Self assessment questions *(Specific Aim 1)*

1 **a** Herbivore-predator food chain, for example:
green plants → mouse → snake → eagle

b With the transfer of energy from one organism to another,
- a large amount of potential energy is lost as heat energy
- a small amount of energy-rich organic compounds will be available to support the next trophic level
- the longer the chain, the less energy is available
- shorter chains have larger amounts of available energy.

In a food chain each consumer has only one source of food, because if one of the consumer species is destroyed all the consumers further on in the chain will die.

c In a food web each consumer may have several different sources of food. If one of the consumer species is destroyed the other consumers can still survive.

2 **a** 9

b 2, 3, 5, 6

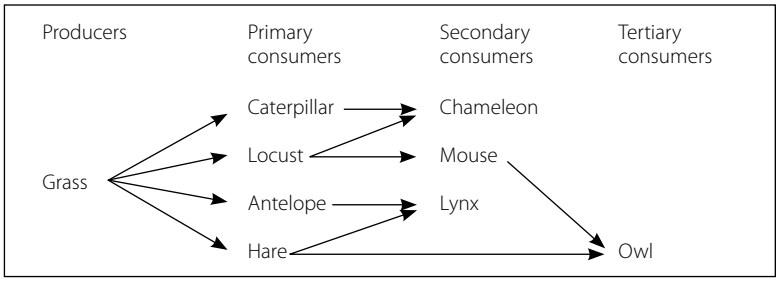
c 1, 4, 6, 7, 8

d 2, 3, 5

e 5

f 9

g



3 **a** An ecosystem is a demarcated and self-maintaining, stable area of all the different populations that interact with one another and with their non-living physical environment.

b Number 4, because herbivores are plant-eaters, such as antelopes.

c **i** Number 1
ii Number 4
iii Number 1

d A producer, because green plants produce food also for other living organisms, food is produced by the process of photosynthesis, leaves contain chlorophyll, which converts radiant energy into chemical energy, and this energy is stored in organic food, which is available for the plant and herbivores.

e **i** Number 3
ii Number 3. An omnivore is a secondary consumer, like humans. They feed on both primary consumers (animals) and producers (plants).

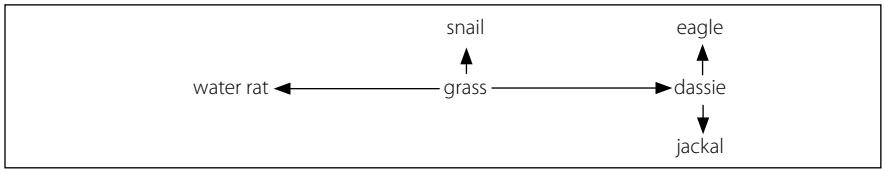
f The antelope, which is number 4, is the source of food for the lion, which is number 1. The lion will need to find another source of food or will face extinction. Vegetation (plants), which is the source of food for the antelope, will increase.

Extension activities

The activities may be done at the discretion of the teacher and if time allows.

More on ecosystems *(Specific Aim 1)*

1 Use the information in the diagram below to answer the questions that follow.



a What does this diagram represent?

b If the number of dassies increases, name the animals that might:

i increase

ii decrease.

Suggest a reason for your answer in each case.

c Who are the producers in this diagram?

2 Study the following table and answer the questions that follow.

Nutrition in animals	Fate of food		
	% not digested	% used for growth	% used for respiration
Sheep eating dry grass	70	X	20
Lion eating zebra	30	Y	60

a According to the table, who is the:

i predator?

ii herbivore?

iii carnivore?

iv producer?

b What is the value of

i X?

ii Y?

Show your calculations.

c What total percentage of the first-order consumer's food is digested and used? Why is this percentage smaller than the value for the second-order consumer?

d **i** If a sheep eats 50 kg of dry grass, how much of this is converted into mutton?

ii If a lion eats 250 kg of zebra, how much of this will be used for growth?

Show your calculations.

Memo

1 **a** A food web.

b **i** Eagles and jackals might increase, because more food will be available for secondary consumers.

ii Snails and water-rats will decrease, because more grass will be consumed by the dassies, therefore less food will be available to other herbivores.

c Grass

2 **a** **i** Lion

ii Sheep

iii Lion

iv Grass

b **i** X = 100 – (70 + 20) = 10%

ii Y = 100 – (30 + 60) = 10%

c 100 – 70 = 30%

For the second-order consumer, the lion, it is 100 – 30 = 70%.

The first-order consumer's (sheep's) diet consists mainly of cellulose. Cellulose is indigestible and dry grass is a low quality food.

d **i** $\frac{50}{1} \times \frac{10}{100} = 5$ kg

ii $\frac{250}{1} \times \frac{10}{100} = 25$ kg

STRAND 4

HISTORY OF LIFE AND BIODIVERSITY

Unit 1: Biodiversity and classification
Unit 2: History of life on Earth

Learner's Book pages 279–305
Duration: 4 hours

UNIT 1 Biodiversity and classification

TERM 4

Activity and self assessment question memos

Important note to teachers:

- According to the CAPS document, this entire unit needs to be completed in one week.
- To achieve this, you need to be totally confident, well prepared and organised so that you convey the key ideas to learners in a condensed, highly efficient manner, instead of relying on the learners to discover the content on their own.
- Thus, good old fashioned purposeful "teaching" is required to pace the rate of learning over a short time.
- If, however, despite all efforts, this unit takes longer to complete, bear in mind that you need to budget this into Unit 2's prescribed time allocation of five weeks.
- Please resist the temptation of avoiding keys! Learners always enjoy this as they do all games. More important, this is real science in action and an essential life skill. This, however, only applies if you "teach the rules" in a confident, enthusiastic and well prepared manner.

These are a few general points that need to be noted when considering this topic:

1 The singular and plural forms of the word species are the same. There is no such thing as a biological "*specie*".

2 The widely-used species definition given in the Learner's Book is far from definite and in fact there is still *no* universally accepted definition for *species* that applies across the whole spectrum of living and extinct organisms. Here are some additional points:

- Artificial hybridization between closely related species (and even genera) which is normally isolated in the wild may take place in laboratory / captivity (e.g. horse crossed with donkey → mule, which is sterile; lion crossed with tiger → tiglon or liger). This process has played an important role in agriculture (e.g. artificial selection of maize, corn).
- Many wild plant species, especially in temperate regions, are natural hybrids of closely related species, as can be shown by genetic analysis. This applies to many wind-pollinated forms, e.g. oaks, pines (wind

is a less specific pollinating agent than animals such as insects). Hybrids between South African *Protea* species commonly occur in botanical gardens.

- In practice most living species are defined by morphological characters that are considered to be significant by taxonomists who work with the group of organisms involved, rather than on breeding behaviour. Not all taxonomists will agree on what constitutes a valid species. This is a good example of the contested nature of science.
- Obviously the breeding behaviour of extinct organisms – such as most fossil "species" – cannot be tested. These are defined on the basis of morphology alone. The subdivision of evolutionary lineages of extinct organisms into successive "chronospecies" is a particular problem. In fact, it is mainly because of evolution – genetically determined morphological change through time – that discrete species cannot be universally defined and recognised. Groups that are currently evolving rapidly, such as the vygies (Family Aizoaceae), are a particular headache for taxonomists because clearly defined species and higher taxa (e.g. genera) are often difficult to recognise – they are still diverging and stabilising.

Changing formal names

Standardised binomial names give a high degree of stability to scientific nomenclature. However, even the formal names of organisms may occasionally be changed (which can be very annoying!). The main reasons for such changes include:

- An earlier formal name for the same plant exists elsewhere in the world but another name is given by scientists who are not aware of this name. This happened during the "apartheid years" when South Africa was isolated from the International Botanical Society. Keen gardeners are very aware of the numerous name changes that have occurred since 1994.
- When taxonomists transfer a species to another genus because the species is now considered more closely related to other species within that genus.
- When a genus is split up into two or more new genera, or two or more genera are combined into one

Formal names changes and disagreements between experts are regulated by internationally agreed sets of rules such as the International Code of Botanical Nomenclature and International Code of Zoological Nomenclature.

A recent, highly controversial, decision made in 2005 was to change the generic name of most African acacias (thorn trees) from *Acacia* to *Senegalia*. So, for example, *Acacia karroo* now becomes *Senegalia karroo*. The genus *Acacia* was first established in 1754 for a species of thorny tree in the pea family from Africa and Asia (*A. nilotica*). However, some 1 350 *Acacia* species have since been described worldwide. The great majority (955 spp.) grow in Australia. These are the famous thornless wattles that form the basis of a huge international timber industry. Several wattles are now important invasive aliens in South Africa. An *Acacia* species is Australia's official floral emblem and this single genus makes up some 18.5% of the entire Australian

flora. The huge old genus *Acacia* has now been split into several newly defined genera (including *Senegalia*) and it was decided to keep the genus name *Acacia* for Australian wattles because this would involve far fewer name changes overall. Naturally, many African botanists are not at all pleased.

» Activity 1 What is in a name? *(Specific Aim 1)*

Learner's Book page 283

Some popular South African field guides and relevant text in Learner's Book are required.

This activity is a 'Trivial Pursuit" game. The process of locating the origin of plant names is more important than the correct answer.

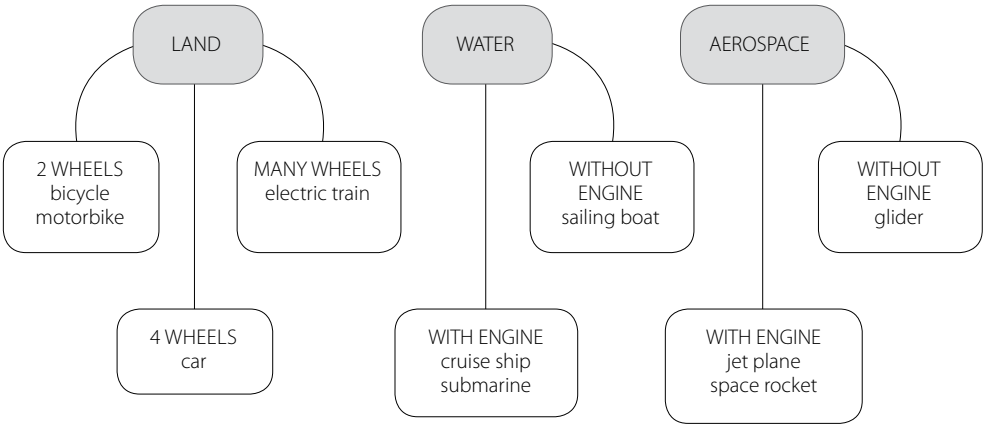
The table contains plant names taken from the index of *Guide to the Aloes of South Africa* (Briza, 2nd Edition of 2003). The following may serve as a possible "solution sheet".

1. *A. africana* – of the African continent
2. *A. arborescens* – *arbor* is Latin for tree, thus a tree aloe
3. *A. dewetii* – surname de Wet (J F de Wet discovered the plant)
4. *A. dichotoma* – from dichotomous = forked, because it has forked branches
5. *A. gariepensis* – grows along the Gariep River = Orange River
6. *A. longistyla* – long style that sticks out above the large flower sepals
7. *A. prinslooi* – surname Prinsloo. Named after G I Prinsloo who discovered it
8. *A. soutpansbergensis* – grows along the Soutpansberg mountain range
9. *A. umfoloziensis* – named after the Black- and White Umfolozi Rivers in KZN
10. *A. vryheidensis* – named after the town of Vryheid in KZN, grows nearby

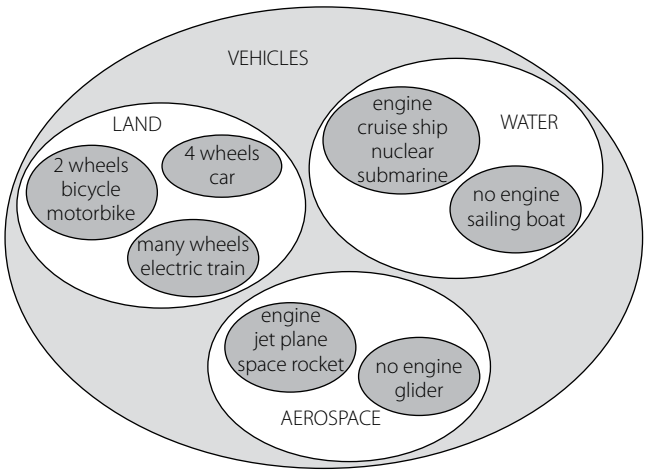
Photocopy the above "solution sheet" for self/group assessment.

Learner's Book page 286

1 Solution: Substitute the last row of classification of vehicles as follows:



2



These are some ideas for expanded exercises if learners require more experience in understanding and designing classification systems.

1 Large collections of books, journals and other printed literature are stored in schools, universities, municipal and state libraries and some private homes. In order to quickly find a particular book, or put one away, the books have to be arranged according to key features or characters. Suggest some obvious characters that might be used to classify and arrange books in a large public library. What other characters might be used for a small private library at home? Find out how books are classified in your local library (school/town, etc).
Possible answer:
- subject (biology/poetry/politics/sport/cookery)
- cover or binding (paperback/hardback)
- author
- publisher
- date of publication
- language (English/Afrikaans/Zulu)
- format (size and shape) of book
- Less useful: colour/smell/order of acquisition or reading/cost/good or bad/favourites/number of pages/popularity/type and number of illustrations

Note: Think about the Dewey-decimal system.

2 Visit a local supermarket or large store and discover how the large range of objects on sale are classified and arranged for the convenience of shoppers (and the store owner). Draw a plan.

3 Suggest practical classifications for (a) utensils in a kitchen, (b) items of clothing, (c) meals on a restaurant menu, (d) rocks and minerals, (e) weapons (f) pack of playing cards.

Note that the orientation of the branching classification is not significant. The tree can branch upwards, downwards or sideways without changing the classification.

It is also important to note that:

- Formal names of all taxa are capitalised but not italicised (informal versions are written with small initial letter: plants, spermatophytes, fabaceans, mammals, elephants).
- The category "division" used by botanists is broadly equivalent to the "phylum" used by zoologists. However, increasingly the term phylum is used by all biologists.
- In practice, many further taxonomic levels or categories are employed by taxonomists (e.g. subphyla, superorders, subfamilies, etc). Only the most important ones are given here. The Vertebrata (= Craniata) are a subphylum within the phylum Chordata, for example.
- As discussed, there is no final consensus among scientists about how organisms should be classified (e.g. the number, names and scope of the higher taxa). The taxa listed here are widely used, but there are other, perhaps more valid, alternatives.

Remember, biological classifications are evidence-based scientific hypothesis and are therefore testable.

Biological keys

A good key is practical, short and clear. Keys that involve either/or alternatives throughout are called dichotomous keys (dichotomous = two-branched). However, as long as the system is clear, three or more choices are equally valid (as occasionally used in our example). Each choice may include a single character (e.g. wings present/absent) or several characters (e.g. compound eyes plus a waist). A single choice is simpler, several characters give more confidence. Keys that are illustrated with annotated explanatory pictures are often easier to use than those that are expressed entirely in words. Humans are visual animals and, as is so often the case, "a picture is worth a thousand words".

Because all the invertebrate groups involved in the key are very large in terms of number of species as well as diverse in their adaptations to different ways of life, it is difficult to construct a simple key that is infallible. There are nearly always exceptions. For example:

- Some slugs do have a small external or internal shell (vestigial).
- The key only works for mature adults (e.g. not for larvae, pupae of insects).
- It does not apply to all castes in social insects such as ants and termites (where, for example, the sexual reproductive castes, queens/kings/drones, have two pairs of well-developed wings).
- Many beetles (a huge group) cannot fly and have lost the second pair of wings entirely (e.g. toktokkies or tenebrionids).

These exceptions can usually be handled by making the key more complex or explicit.

PPA

Activity 3 Using a biological key to identify common invertebrates *(Specific Aim 2)*

Learner's Book page 287

It is suggested that you circulate frequently among the pairs of working groups to guide where necessary. If, after Part 2 of this activity, you think that learners require more practice in using biological keys, then it is important to look for or adapt simple keys from available field guides and give these to the learners so that they can refine their skills in using keys correctly and systematically to identify the biological characteristics that are used in keys.

However, most learners will almost certainly develop a good grasp of the value and process of constructing biological keys once they have completed the five tasks given in Activity 4.

Note: A user-friendly key, a bit different to that of Activity 3, can be found in a field guide to trees: *Common Trees*, *Struik Pocket-Guide for Southern Africa*, by Eugene Moll, Glen Moll and Mici Page. ISBN 1-86825-001-6. Learners enjoy using this book and the key at the back of the guide.

RPA

Activity 4 Poster - diversity of the animal kingdom *(Specific Aims 1 and 2)*

Learner's Book page 301

Each group is to select a subgroup that is shown in the Venn diagram in the Learner's Book.

Each group is required to research the selected subgroup along specified guidelines, outlined in the Learner's Book.

Since rubrics offer such a convenient way of assessing posters, the following might be helpful:

4	3	2	1
Systematically and accurately collected all relevant data	Systematically and accurately collected nearly all relevant data	Data collection still requires more skill development	Skill of collecting relevant data has not as yet developed
Appropriate data are all presented in a concise and attractive manner (poster)	Appropriate data are mostly presented in a concise and attractive manner	Appropriate data are rather scant and masked by mostly irrelevant information	Still has to acquire the skill of selecting and presenting relevant data for a poster display
Displayed all information in a logical flow and sequence	Displayed most information in a logical flow and sequence	Displayed some information in a logical flow and sequence	Displayed is jumbled and without any logical flow and sequence
All detail displayed is clearly visible from a one metre distance	Most of display is clearly visible from a one metre distance	Limited aspects of display is visible from a one metre distance	Display is either overcrowded, partly done or not done at all

Activity 5 Interpretation of a cladogram *(Specific Aim 1)*

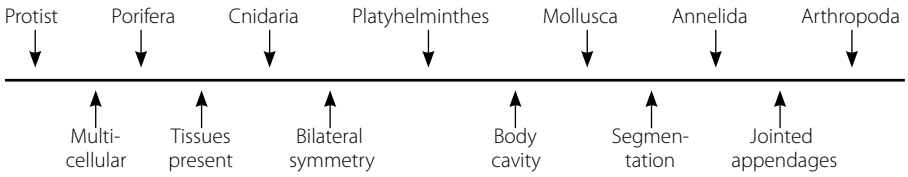
Learner's Book page 302

Learners need to study the data given in Figure 1.22 and Table 1.6.

Suggested answer to the questions:

1 The presence of a notochord in all representative groups gave rise to the phylum name Chordata.
2 No. The lamprey does not have a vertebral column, so it is not grouped as a vertebrate.
3 Yes – this is true.

Some additional information:
Note: if we were to draw up a rough cladogram of invertebrates, it may reflect the following data:



PPA

Activity 6 Exploring animal diversity *(Specific Aims 1 and 2) (Formal Assessment Task)*

Learner's Book page 303

1 **a** Platyhelminthes
b Annelida
c Arachnida
d Diptera
e Smaller insect order (Siphonaptera)

2 **a** Mammals
b Hymenoptera
c Cnidaria
d Arachnida
e Mollusca
f Echinodermata

3 **a** Mammalia
b Minor Phyla
c Mammalia
d Lepidoptera
e and f Other chordates

4 **a** Most abundant group = Coleoptera with 290 000 out of a total of 1 032 000 species. Thus:

$$\frac{290\,000}{1\,032\,000} \times 100 \text{ (for \%)} = 28{,}1\%$$

b Most abundant, most diverse insect Order, vary a great deal in size, structure, colour and habits. One pair of leathery protective wings usually cover delicate flying wings. About 18 000 species in South Africa, e.g. ground beetles, tiger beetles, water beetles, fruit chafer beetles, dung beetles, jewel beetles, click beetles, fire-flies, maize beetles, ladybird beetles, tortoise beetles, toktokkie beetles, mealworm beetles, blister beetles, CMR beetles, longhorn beetles, tree borers, weevils.

c Success probably due to their ability to adapt to changing environments, as shown by their wide range of habits, habitats, food preferences, ecological roles and structures. The strong exoskeleton must also play an important role in their survival.

5 **a** List of rank order from largest (Coleoptera) to smallest (Mammalia) groups.

b The two median groups are: Molluscs at 50 000 and Other Chordates at 38 000.

6 Research on SA Amphibian Red Data species should include: the Fynbos Micro Frog and the Grassland Giant Bullfrog. The Desert Rain Frog from the Succulent Karoo could also be considered but bear in mind that its numbers are still unknown, thus its Red Data Status is still unknown.
OR
IKS stories or statements should be backed by explanations and references.

Possible criteria for assessment:

4	3	2	1
High level of competence in manipulating statistical data.	Satisfactory level of competence in manipulating statistical data.	Somewhat competent in manipulating statistical data.	Little or no competence in manipulating statistical data.
Skilled in accessing information from field guides and other resources.	Fairly skilled in accessing information from field guide, etc.	Somewhat skilled in accessing information from field guide, etc.	Not yet skilled in accessing information from field guide, etc.
Competent in evaluating the impact of modern society on natural resources.	Fairly competent in evaluating the impact of modern society on natural resources.	Some competence in evaluating the impact of modern society on natural resources.	Not yet competent in evaluating the impact of modern society on natural resources.

Self assessment questions

1 Over time, with the advent of microscopy, scientists discovered micro-organisms such as bacteria, fungi, algae and protozoans. These had more common characteristics among members of their own kind than they had with plants or animals. Thus, the necessity to expand the kingdoms, to accommodate bacteria, protists and fungi in addition to plants and animals.

2 **i** Prokaryotes do not have a distinct nucleus (no membrane around chromosomes).
Eukaryotes have a distinct nucleus with chromosomes enclosed in a nuclear membrane.

ii Prokaryotes = bacteria. Eukaryotes = Protista, Plantae, Fungi and Animalia.

3 Learners must compare their resulting diagram with that of the textbook. Were they able to draw and label all components?

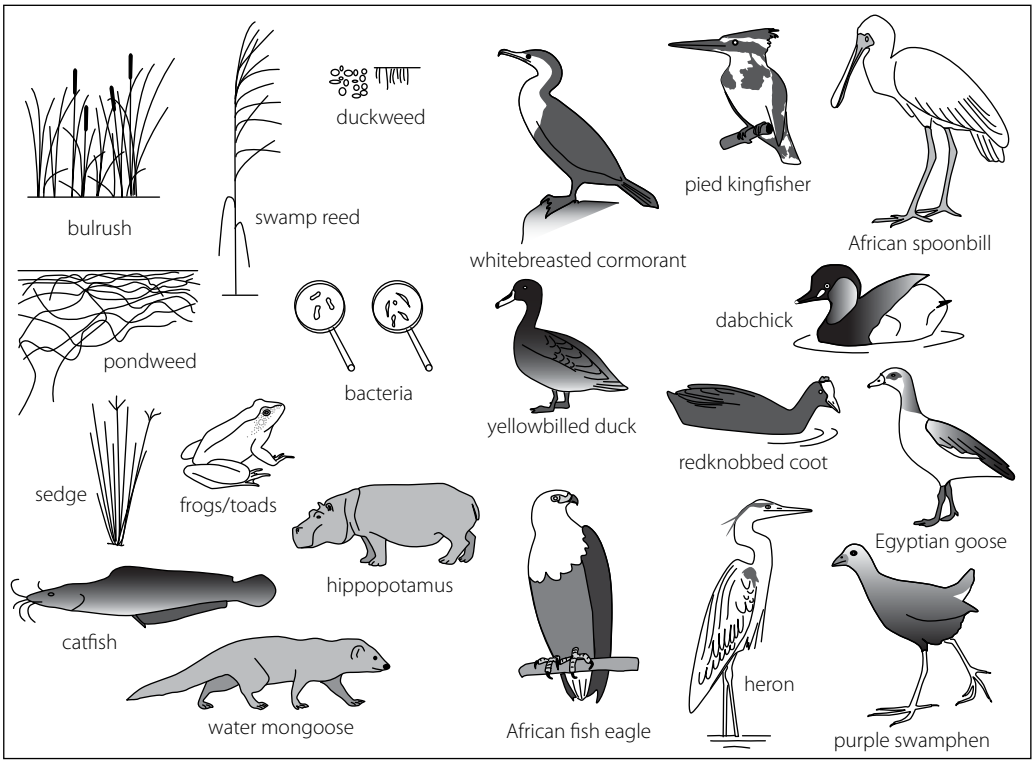
4 **a** Flagella
b Pilus and slimy capsule (sticky)
c Chromosomes and plasmids
d Cell membrane
e Ribosomes

Extension activities and worksheets

Because of the time constraint conferred by CAPS (teaching this unit in one week), only five activities were given in the Learner's Book. There are, however, several revision questions at the end of the unit, given as self-assessment. As a teacher, you might decide to give a few at a time, appropriate to the sections dealt with over the next pages, so the learners may consolidate the theory. When given as homework, this may save on classroom contact time. Four additional (optional) activities are also included in this guide. Also find a note on the latest classification system developments.

» Activity Complexity of classification systems – expanded *(Specific Aim 2)*

1 Study the organisms that are commonly found in a wetland ecosystem in South Africa, as shown in the figure below.



Follow the steps (**a**–**d**) to classify the organisms shown.

a Use an A4 sheet placed sideways to construct either a branching tree diagram or a Venn diagram to show the classification.

b Clearly indicate the highest ranking (largest) order. In this case it will be "Common Wetland Organisms".

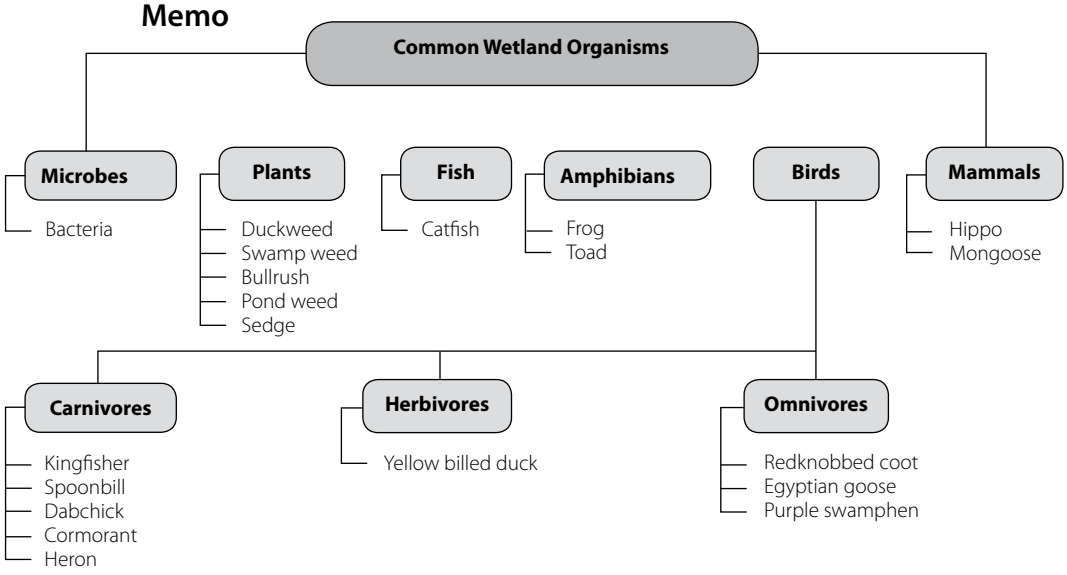
c Now select the organisms that fit best into the following groups:
- **i** microbes (microscopic organisms)
- **ii** plants
- **iii** fish
- **iv** amphibians
- **v** birds
- **vi** mammals.

Create new sub-groups for each.

d Finally, subdivide the largest group (birds) into the following sub-groups: A carnivores B herbivores and C filter-feeders. Work out the way that they feed by studying the beak and other structures. If you are still unsure, consult field guides on birds to find out how each type of bird feeds.

Compare your classification systems with that of neighbouring groups.

Memo



Activity Invertebrates *(Specific Aims 1 and 2)*

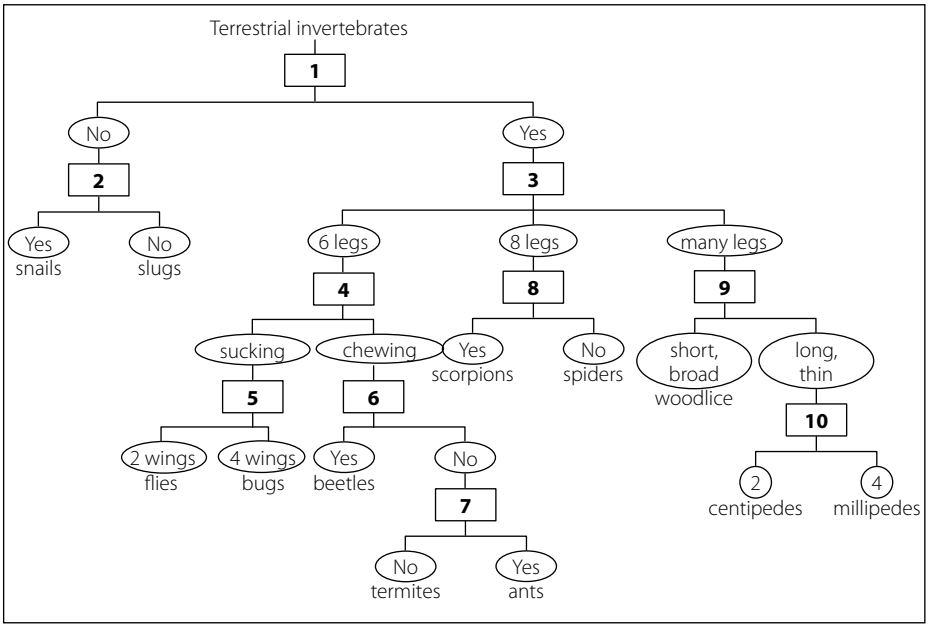
You will need a cool head and an adventurous scientific spirit to complete the following four tasks.

You will also need good general references or field guides on invertebrates.

1 Convert the invertebrate key of Activity 3 on page 288 of the Learner's Book into:
- **a** a branching tree diagram
- **b** a set or Venn diagram.

Which of the three systems (which includes the key) do you find quickest and easiest to use?

2 Look at the alternative tree diagram on the next page, which is designed to distinguish between and identify the same set of twelve invertebrate groups. Which YES/NO (for presence/absence) or other character choices or questions might be placed in the numbered empty boxes?



3 Once you have filled in all the boxes in this diagram, proceed to convert the tree diagram to a written key like the one given on page 289 of the Learner's Book in Activity *3*.

Memo

2 Suggested "key phrases" for inserting into blocks 1–10 of the tree diagram above (accept any alternative phrases, provided they fit and are logical):

1 Segmented walking legs present?
2 Shell present?
3 Number of walking legs per body?
4 Chewing or sucking mouthparts?
5 Number of delicate wings present?
6 Wings present ?
7 Compound eyes present?
8 Sting in tail present?
9 Similar segments throughout body.
10 Number of legs per body segment.

3 Accept any logical variation along this theme – remember, it is the process skill rather than the product that is important in this activity.

1	Segmented walking legs present?	Go to *3*
	Segmented walking legs absent?	Go to 2
2	Calcareous shell present?	Snails
	Calcareous shell absent?	Slugs
3	Six walking legs present per body?	Go to 4
	Eight walking legs present per body?	Go to 8
	More than eight legs per body?	Go to 9
4	Sucking mouthparts present?	Go to *5*
	Chewing mouthparts present?	Go to 6
5	One pair of delicate wings present?	Flies
	Two pairs of delicate wings present?	True bugs
6	Wings absent	Go to 7
	One pair of wings are tough and leathery	Beetles
7	Compound eyes present?	Ants
	Compound eyes absent?	Termites

8	Tail ends in a poisonous sting	Scorpions
	No tail, poisonous fangs instead	Spiders
9	Short, broad body with similar segments	Woodlice
	Long, thin body with similar segments	Go to 10
10	Two walking legs per body segment	Centipedes
	Four walking legs per body segment	Millipedes

Or, an alternative simpler, shorter version of terrestrial invertebrate key shown above:

1	One large slimy foot present	Slugs and snails
	Segmented walking legs present	Go to 2
2	Six pair of walking legs per body	Go to 3
	More than six pairs of walking legs present	Go to 4
3	Sucking mouthparts and delicate wings	Go to 5
	Chewing mouthparts and tough, leathery wings	Beetles
	Chewing mouthparts but without wings	Ants and termites
4	Single pair of segmented walking legs	Scorpions and spiders
	More than eight pair of legs	Go to 6
5	Only a single pair of delicate wings	Flies
	Two pairs of delicate wings	True bugs
6	Body is short and broad	Woodlouse
	Body is long and thin	Go to 7
7	One pair of legs per body segment	Centipede
	Two pairs of legs per body segment	Millipede

Activity Essay – the medical, ecological and economic importance of fungi *(Specific Aims 1 and 3)*

You will need suitable references. Old biology textbooks and the Internet are useful resources.

1. Access information on the various uses by, and effects of fungi on humans. Group this information into the following three main groups:
   - Medicinal. Include medical drugs such as antibiotics, other treatments and diseases.
   - Ecological. You will also find some relevant information in this unit.
   - Economic. Think of all the types of foods and manufacture of other products that are dependant on fungi. Also consider harmful effects on foodstuffs and agricultural diseases.
2. Plan your essay outline so that it has a logical and coherent flow.
3. Write the essay. It should not be longer than two pages.

Memo

1. Encourage learners to plan the essay structure. A few essential ideas are included below – not in any specific order of importance.
   Fungi as a group are of enormous medicinal, ecological and economic importance, especially in terrestrial ecosystems. For example:
   Medicinal
   - Fungal parasites cause human diseases. This includes athlete's foot, ringworm, opportunistic infections of the vagina and soft palate (*Candida*), as well as serious lung infections.
   - Very dangerous toxins are produced by some moulds, such as the carcinogenic aflatoxins produced by the mould *Aspergillus*.
   - Important antibiotics are taken from cultures of moulds, e.g. penicillin from *Penicillium*.

- The yeast *Saccharomyces* is widely studied in research into cell biology since it is thought to be more closely related to the cells of humans than most other microbes studied in great detail.

Ecological

- They decompose dead plant and animal material to recycle nutrients. Without them, we would be knee-deep in leaf litter and corpses!
- Fungal rots and moulds destroy our valuable resources (foods, timber, leather, paper, etc.).

Economic

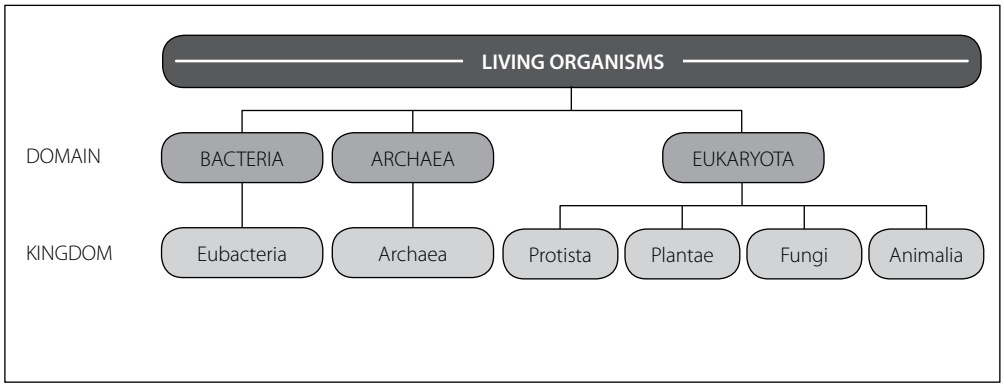
- Fungal parasites cause many important plant diseases (e.g. rusts and smuts on tomato and cereal crops, *Botrytis*, which has had an effect on the wine industry in South Africa)
- Larger fungi such as mushrooms and toadstools are an important supplementary food source for many humans and other animals. Some, like the subterranean truffles and the huge toadstools growing on termite mounds in southern Africa, are highly prized.
- Yeasts are used in the fermentation of alcohol and bread-making worldwide Several moulds are used in cheese-making (e.g. the blue veins in blue cheese are injected streaks of fungi).

Additional information

About recent classification systems

The latest CAPS policy statement requires that we follow the five-kingdom system. It is however, important to note that more advanced systems are used at higher education colleges and universities. This could be brought to the attention of learners who may proceed to follow studies in the Life Sciences at HE level.

For your interest, the classification system that has replaced the five-kingdom system, is shown in the figure below:



The six-kingdom system, developed by Carl Woese, based on new discoveries of nucleic acid sequences (DNA and RNA) and macromolecules such as proteins.

The three-domain system, also developed by Carl Woese. More recent microbiological discoveries, particularly on bacteria, revealed that organisms are best grouped into three domains, as shown above. Research on bacteria such as extremophiles contributed largely to the domain grouping of kingdoms.

As the diagram on the three domains of life shows, prokaryotic organisms (Monera) do not form a natural group, although you might encounter the term in older textbooks. The term was used for an artificial grouping of bacteria, based on shared primitive features such as the absence of a nucleus.

Prokaryotes

Kingdom: Bacteria

Pathogenic bacteria always crop up in classroom discussions, so, for your interest, here are some of the better known examples:

Disease	Bacteria species	Common host	Shape
Tuberculosis (TB)	*Mycobacterium tuberculosis*	humans	filamentous
Anthrax	*Bacillus anthracis*	antelope (buck)	rod shape
Tetanus	*Clostridium tetani*	humans	rod shape
Cholera	*Vibrio cholerae*	humans	vibrio (bent rod)
Sore throats (pharyngitis)	Most common are *Streptococcus* spp.	humans	coccus, chain of spheres

Although bacteria multiply, by mitosis, on average, every 20 minutes or so, their population numbers are kept in check because ideal living conditions for reproduction such as optimal temperature, sufficient food and enough moisture and darkness are limited in host bodies or elsewhere in the environment. In addition to limited life-supporting conditions, the toxins given off as metabolic waste by the bacteria also become too concentrated and can kill off bacteria.

Worksheet

Activity Amazing life forms in a drop of water *(Specific Aims 1 and 2)*

The following activity is time-consuming if done as a formal exercise in class, hence given here as an optional activity. Alternatively, slides or a DVD may be used to show the diversity of micro-organisms.

Apparatus:

- pond water
- a compound microscope
- apparatus to make wet mounts
- reference books to identify protists found in the wet mounts.

PART 1: Practical investigation

1. Scoop a thin layer of pond scum from the bottom of a fairly shallow pond. Also scoop some drifting bits of scum from the upper surface of the pond water.
2. Prepare a wet mount from a drop of pond water. Lower the cover slip very gently and slowly so that you do not shock the tiny creatures. Shock makes them contract into motionless "blobs" or may kill them. This can make it very difficult for you to identify the creature.
   (Precaution: Do not use the artificial light of microscopes – this will kill species like *Amoeba*. Use natural light instead.)
3. Mount the slide on the microscope stage and view under low power. Scan across the slide sideways as well as up and down until you find something that moves. If you find a creature, carefully switch to medium and high power if necessary.
4. Identify the species that you find, using suitable references.

5 If you find a protist, record it by means of a labelled drawing. Give your drawing a title and state the magnification used.
Remember, you are looking for protozoans such as amoebae, zooflagellates, ciliates, euglenoids, *Paramaecium*, *Vorticella*, and so on; algae such as *Chlorella*, *Spirogyra*, *Volvox*, *Scenedesmus*, etc; and also possible slime moulds or even bacteria.

PART 2: Questions

1 The following sporozoans, e.g. *Plasmodium* and *Trypanosoma*, are human parasites. Name the disease caused by each sporozoan.
2 Where will you find members of multicellular algae? What important role do they perform in the ecosystem that you mentioned?
3 When fish die, their bodies become covered in a white mat of growing slime mould. What important role do slime moulds play in an aquatic ecosystem?
4 Do bacteria play a role in the life cycles of organisms in pond water? Explain your answer.

Memo

PART 1: Practical investigation

It is seriously recommended that you test the sample of water for the presence of living organisms – to avoid a period of useless search by the learners. There is also an alternative source:

- A few weeks before the activity is scheduled, a hay infusion can be prepared by adding hay and a few grains of corn, rice or wheat to a litre of water in an empty glass bowl or fish tank. Boil the mixture first, then placed the cooled mixture in the container, ensuring that the depth of water is about 5 cm. Now add some sediment from the bottom of a dam or pond. This culture will remain viable for a month or so, topping up the water to compensate for evaporation.
- Since this activity requires patience, it will be a good idea to run the session over two periods or over a period that includes a break-time.
- It is assumed that all learners have mastered the skill of preparing wet mounts.
- It is also advisable to reinforce the precautions included in the instructions of this activity.
- Photocopied and laminated illustrations from reference sources are recommended so that these are available for years to come, as part of the classroom resource base.
- Protozoans such as amoebae, zooflagellates, ciliates, euglenoids, *Paramaecium*, *Vorticella*, and algae such as *Chlorella*, *Spirogyra*, *Volvox* and *Scenedesmus* are usually abundant in hay infusions.

PART 2: Questions

1 *Plasmodium* causes malaria and *Trypanosoma* causes sleeping sickness.
2 Mostly in the oceans, especially along sea shores and reefs. A few species of fresh water algae can also be found in rivers and wetland areas. They are the essential producers in aquatic ecosystems.
3 The slime moulds decompose the dead corpses of animals (and algae) so that the nutrients from their tissues can be recycled in the ecosystem.
4 Many different answers are possible – look out for the ecological links and evaluate these as being valid or not.

Activity and self assessment question memos and additional learning material

This unit contains a number of new and potentially difficult new terms that may make it more difficult for learners to understand the concepts contained in this unit. It is recommended that you make sure that learners understand these terms as you progress through the sections.

It is also imperative that the school's media centre, and you as educator, invest in appropriate references on South Africa palaeontology. With this in mind, a number of known references (also suitable for Grade 12) are given below. This list is not complete, thus continue to search for more and especially new books that might soon appear in bookshops.

Some recommended media centre and teacher references:

	Title	Author / Editor	Publisher	Year
1	*Life Etched in Stone*. Fossils of South Africa	Colin MacRae	Geological Society of South Africa	1999
2	*Towards Gondwana Alive* Vol 1	John M Anderson	National Botanical Institute (now SANBI)	1999
3	*Field Guide to the Cradle of Humankind*	Brett Hilton-Barber & Dr Lee Berger	Struik	2002
4	*Langebaanweg. A record of past life.*	QB Hendey	SA Museum C.Town, now Iziko	1982
5	*Fossil Reptiles of the SA Karoo*	MA Cluver	SA Museum C.Town, now Iziko	1978
6	*Die Groot Avontuur Wondere van die Lewe op Aarde*	Leon Rousseau	Human & Rousseau	2006
7	*Evolusie*	PAJ Ryke	Universiteit van Potchefstroom	1987
8	*Famous Dinosaurs of Africa*	Anusuya Chinsamy-Turan	Struik	2008
9	*The Story of Life on Earth*	Terence McCarthy and Bruce Rubidge	Struik, Kumba Resources	2005
10	*The Complete World of Human Evolution* (focus mainly on Europe but fairly good inset on African origins)	Chris Stinger and Peter Andrews	Thames and Hudson	2008

The cosmic timeline, Earth timeline and fossil timeline is briefly dealt with so that learners develop the concept of the immense time passage of Earth's history to date. You might want to pace a straight line in the school grounds with roll of toilet paper. Let each segment of the toilet roll represent a million years. Let learners mark off Earth time and then insert the Periods on the segments. Don't bother with cosmic time – you will need a lorry load of toilet paper for this! However, let the learners imagine how long the strip would have to be.

The geological time scale

It will be imperative to guide learners every step of the way, with the following activity on the Earth's Timeline. It is the actual piecing together of all the components, as per guidelines given, that allows concepts to develop. Photostat copies from books or the Internet are absolutely unacceptable and will defy the science skills that need to be refined in this compulsory activity, as prescribed in the CAPS document.

Note: Since this activity spans the content of this entire unit, you may set the learners in motion at this stage but only demand the completed poster by a given date towards the end of this unit. In fact, this is highly recommended as an excellent approach to allow learners to place this difficult content in context. It will also give them the required time to develop an appreciation for the enormous time intervals of events. As you and I know, it takes time and continuous interaction with the content, time-intervals and biological events, to become familiar with deep time concepts like these. This will also allow learners to really enjoy the activity, without undue pressure. Do, however, ensure that stragglers do not leave this to the last minute! Regular progress reports (verbal and/or visual) are recommended to overcome the problem of those learners who consistently leave things to the last minute.

Here is a skeleton outline of the geological time scale, which is a conglomerate of the detail sourced from recently published reference books, to provide you with a quick and easy reference.

Note: The Tertiary period is sub-divided into two Epochs: Neogene and Palaeogene. Epochs become relevant especially when dealing with the evolution of hominins, but it is not recommended to burden the learners with Epochs as well. Also note that there are two earlier Eons: Proterozoic (before life) Eon [680–542 Ma = Precambrian] and the Archaean Eon [2 500–680 Ma = before life], but again, this is just for interest.

Geological time scale that ranges from 680 Ma to the present

<table>
<tr><th>Time (Ma)</th><th>Eon</th><th>Era</th><th>Period</th></tr>
<tr><td>0,01
1,75</td><td rowspan="13">PHANEROZOIC</td><td rowspan="2">Caenozoic
(Recent life)</td><td>Quaternary</td></tr>
<tr><td>24
65</td><td>“Tertiary” = 2 epochs:
• Neogene
• Palaeogene</td></tr>
<tr><td>125</td><td rowspan="3">Mesozoic
(Middle life)</td><td>Cretaceous</td></tr>
<tr><td>203</td><td>Jurassic</td></tr>
<tr><td>251</td><td>Triassic</td></tr>
<tr><td>295</td><td rowspan="6">Palaeozoic
Ancient life)</td><td>Permian</td></tr>
<tr><td>355</td><td>Carboniferous</td></tr>
<tr><td>410</td><td>Devonian</td></tr>
<tr><td>440</td><td>Silurian</td></tr>
<tr><td>500</td><td>Ordovician</td></tr>
<tr><td>545</td><td>Cambrian</td></tr>
<tr><td>680</td><td>PROTEROZOIC</td><td colspan="2" rowspan="2">Precambrian</td></tr>
<tr><td>2500</td><td>ARCHAEAN</td></tr>
</table>

Activity 1 Earth's time line – from earliest times to modern life forms *(Specific Aims 1 and 2)*

Learner's Book page 312

Learners will find much of the required information in different formats in the text but it is also a good idea to have additional references available for them to consult.

Note: Learners are only required to memorise the three Eras, but the more familiar they become with the Periods (ten for our purpose), the easier it becomes for them to "anchor" Earth and biological events in context with time.

The questions that follow in this activity may be staggered so that each is done as soon as the relevant information has been dealt with in the text. They may even be given as homework tasks.

Question memo

1 **a** Cyanobacteria and archaebacteria.

b The encrusted mounds formed by these bacteria are called stromatolites.

c These ancient bacteria lived in the shallow shorelines of ancient seas. They extracted CO_2 from dissolved carbon compounds in the water. With time, layers of bacteria were buried in layers of calcium carbonate. These deposits built up into large mounds of bacteria alternating with layers of chalk or calcite, now hardened and compacted into fossils.

d Precambrian

e The type of ecosystem that supported these organisms comprised shallow sea-beds with established but very primitive food webs. Nutrients were recycled via herbivores, e.g. molluscs that fed on the algae, decomposers such as bacteria and fungi that fed on decaying matter and filter feeders that fed on small particles of matter from all these organisms. Algae and photosynthetic bacteria were the producers that formed the base of the food webs, as well as increasing the concentration of oxygen in the water and atmosphere, whilst reducing the carbon dioxide concentration through photosynthesis.

2 During the Cambrian Explosion (an interval of only 10–20 million years), multicellular animals of different lineages evolved rapidly into a variety of species. When compared to the rate of adaptive radiation of other time intervals, this particular phase shows a remarkably fast rate of evolution into new species – hence the term "explosion".
Note: When one species evolves into several new species, we call this adaptive radiation.

3 The series of ice ages during the Precambrian interval caused the extinction of many species, thus leaving many vacant niches for new species to occupy; the oxygen level in the oceans and atmosphere was increasing, thus a greater variety of aerobic species could be supported and this meant that many anaerobic species evolved into several aerobic species; plankton and nekton in the oceans produced abundant organic waste as a food source for more filter feeding species; macrophagy (engulfing food particles with pseudopodia) allowed more rapid ingestion of food particles (faster than simple diffusion), thus new species that were larger and more active were now able to evolve.

4 Laurasia was experiencing warm tropical climates since it was positioned across the equator at the time. These warmer climates could sustain a large variety of species. Gondwana, on the other hand, was moving across the icy South Polar Region at the time. Only hardy species able to survive extremely cold conditions were found in this region.

Plants and animals invade the land

Emphasise the reason why ancient fossils from tropical forests are far more abundant in Europe, Asia and North America than in Africa.

The first land plants

Relate this to the plant kingdoms dealt with in Unit 1. Obtain some examples of horse tail, liverwort, lycopods, *Selaginella* (primitive club-moss fern-moss link), etc. Take them to class and explain that their ancestors were almost as large as tree ferns in the tropical swamp forests of the ancient northern hemisphere. Also mention that the well known ancient gymnosperm produced spores, not seeds like modern gymnosperms, and that is proof of the evolution of gymnosperms from the adaptive radiation of ferns. Artistic impressions of these swamp forests are also readily available to use as illustrations. Local museums are good sources of illustrations. Ask why the descendants of the plants are now so reduced in size and distribution (reinforce the concept of adaptations to changing environments).

Mass extinctions

Exploit the natural curiosity of learners for these events. Plenty of BBC and National Geographic videos/DVDs exist, especially on the two extinctions highlighted in the text. Consider showing at least one, followed by a brief classroom discussion.

» Activity 2 What caused the cretaceous extinction? *(Specific Aim 1)*

Learner's Book page 318

It is recommended that you do the necessary research independently. Unless this is done, a fair assessment of the learner's work is not possible. Scientific evidence of this extinction is readily available on the Internet and in many journals and reference books.

Use the summary in Table 2.1 and the supporting text in this unit as a departure point but keep in mind that this information is not cast in stone. Since ongoing new research brings new insights, the latest hypotheses may change from time to time.

Construct a skeleton memo of the key points required for each of the three questions, to assess learners' comprehension. This task also provides perfect opportunities to identify and assist or guide any learners who are still struggling to select relevant information and appropriate sources; struggle to remain focused on the required task; are still unable to analyse and evaluate data or still unable to express their findings in a logical, scientific manner. Since this task is to be done individually, these potential problems ought to be easy to identify and solve before these learners move on to Grades 11 and 12, when there will be little, if any time to address the development of such fundamental cognitive skills.

The sixth mass extinction is upon us – human influences on biodiversity

The statistics shown in Table 2.2 are alarming. Equally alarming are comparisons of similar tables at ten year intervals in the recent past. The rapid rates of increase of the number of species that are threatened, endangered or extinct are shockingly evident in such comparisons. You might want to source a few of these tables from the past three or four decades as the basis for a data-response question for a test or examination paper. Link this section with relevant sections from Strand 3, e.g. habitat destruction, hunting, global warming, etc.

RPA

Activity 3 The sixth extinction – a poster presentation *(Specific Aims 1 and 2)*

Learner's Book page 319

Learners need to find information relevant to the particular task which you assign to each group. The group is expected to construct a poster on this particular cause by following the guidelines outlined for this task

Allow adequate time for learners to access, select and process all required information.

Consider selecting the best posters for display at the local municipal library to spread awareness to the greater public. It is also a valuable opportunity to showcase the good and relevant work being done by the school which the public supports.

What are fossils?

Various museums in the country have taken the initiative to sell plaster casts of well known fossils, for use at schools and colleges. It will be a good idea to build up such a collection. Again, a reminder that the collecting of authentic fossils is a legal offence, and it should be so to protect our amazing natural heritage.

RPA

Activity 4 How are fossils formed? *(Specific Aim 2)*

Learner's Book page 322

PART 1: Orientation exercise (10 min) "My body as a future possible fossil?"
Here are some key ideas that are expected to be part of the learners findings:

1 Burial must be rapid, under layers of fine mud, sand and clay, in an area with little or no microbial activity, nor any plant growth. The best location will be the sediment found in shallow seas. (Definitely not a burial in a coffin or cremation!)

2 Bony parts of skeleton and teeth.

3 **a** Sedimentary rock

b Igneous rocks solidify from moulten magma or lava at 750–1 200 °C. At this temperature, all parts of the fossil will be incinerated. Metamorphic rock forms under high pressure and extreme pressure conditions that also destroy fossil remains.

PART 2: Comparative table of fossil formation
Learners are to refer to the text to provide summary notes on the key concepts shown in the bullet points. Make sure that each bullet point is fully covered in their notes.

Final result of questions 1 and 3 – the table may be similar to this:

Category of fossil	Conditions required for formation	Distinguishing features
1 Unaltered	Usually no undue temperature or pressure changes, Also usually in younger fossil remains.	Resemble original structure most closely.
2 Permineralisation	Minerals in soil solution seep into porous parts of fossil and harden into rock.	In some fossils the cell structure can still be identified.
3 Replacement (also called petrification)	Some original material is removed and replaced by new minerals that harden into rock.	Original fine structures are still visible, e.g. annual growth rings in petrified tree trunks.
4 Compression (also called carbonisation)	Extreme pressure and high temperatures to cook off moisture and change organic material into a carbon layer.	Flattened fossils, e.g. plant leaves that remain as black deposits amongst layers of sedimentary rock.
5 Moulds and casts	Internal tissue is removed by acid ground water and the spaces are refilled with sedimentary mud.	Mould – if the space is not filled with sediments. Casts – if the space is filled with sediments.
6 Trace fossils	Quick solidification of, e.g. footprints in mud, burrows or animal droppings (faeces) or depressions on exposed ancient ocean beds of, e.g. sea life.	Does not resemble organism but gives valuable information on animal behaviour, diet, habitats, etc.
May also include micro-fossils, e.g. plankton, spores, pollen grains, etc.		

RPA

Activity 5 Identifying fossils *(Specific Aim 2)*

Learner's Book page 323

Educators should perhaps approach this as a rather informal activity. It is the reasoning, while applying their insight that is of significance here.

	Fossil identified as:	Type (category) of fossil
A	Cast of crinoids (sea lily)	Fossil shells
B	Skeleton of *Moschops* (a therapsid)	Permineralised bones
C	Fossil tree trunk	Petrified wood
D	Planktonic alga	Microfossil
E	Starfish depressions	Trace fossil
F	Dendrites (mineral growth)	Pseudofossil

Fossils and geological time

The popular approach among geologists and palaeontologists is to use both biostratigraphic correlation and radiometric dating since the one approach may confirm the findings of the other. In some places, e.g. the Cradle of Humankind, relative dating techniques are very unreliable because of the reshuffling of sedimentary layers during Earth crust upliftment or subsidence. This means that the top layers may not be the youngest layers, because older layers have been moved to the top during this reshuffling process. In this case, scientists from the Cradle of Humankind usually compare their fossil finds with fossils from areas where sedimentary layers experienced less disturbance, e.g. in the African Rift valley in Ethiopia, Kenya and Tanzania.

Also note that archeologists use the carbon-dating as a form of radiometric dating. Carbon-14 dating is useful but since ^{14}C has a short half-life of only 5 730 years, there is almost no parent isotope left after 40–50 000 years. This method is therefore not suitable for dating most rocks which are usually millions of years old.

Note: Consider starting the time-consuming Activity 11 that is found at the end of this unit now rather than later in the term. For further detail, refer to the recommendations given at this activity in this Teacher's Guide. This is an important Formal Assessment Task.

RPA

Activity 6 About determining the age of fossils *(Specific Aims 1 and 2)*

Learner's Book page 326

1 Zone fossils usually represent well known species that are selected by palaeontologists and geologists to indicate the relative age of rocks in which they are found. The most useful zone fossils represent species that were relatively short lived (few million years or so) but widespread, e.g. the many species of Trilobites and Ammonites.

2 **a** Ammonite-Cretaceous Period (203–125 Ma) but in other areas, e.g. on the shores of Lake St. Lucia, another species lived during the late Triassic and Jurassic (280–145 Ma).
b Lycopsids – Late Devonian – Carboniferous Periods (410–350 Ma)
c Spores from *Glossopteris* – Early Permian – Early Triassic (280 Ma)

3

Relative dating	Biometric dating
Relative dating of fossils or rocks in relation to other similar fossils, rocks and rock strata (layers) found elsewhere on Earth.	Absolute dating of fossils or rocks based on known half-life of selected isotopes present. Can be measured by calculations done on the percentage of radioactive isotope still present in the rock or fossil.
• Biometric dating is more accurate since it can be measured by calculations based on known data (half-life of isotopes). The results of such calculations are considered accurate to the nearest million years or so. (In geological terms, this is very accurate). • Relative biostratigraphic dating may be out by several million years since it is based on comparisons with similar rocks and fossils. This can be, at best, only an estimate of age. • In practice, geologists and palaeontologists tend to use both these, as well as other techniques to establish the age of rocks and fossils.	

4 **a** 700 million years
b 1 400 million years
c 2 100 million years
d 2 800 million years

A note about dating zircon crystals:
When igneous rocks such as granites weather on land, zircon crystals within them are released. The zircons are transported away by water, wind or ice and are eventually deposited within new sedimentary rocks such as sandstones elsewhere. Radiometric dating of the zircons (provided that they have not been chemically altered) gives a crystallisation age of the parent granite as well as a *maximum* age for the sediment (since the sediment was formed *after* the granite).

Key fossil areas in South Africa

Learners should appreciate the fact that in South Africa, in the Barberton Mountains, there are rocks that contain some of the oldest Precambrian fossils on Earth – fossil bacteria that contributed to the Earth's oxygen supply. The only other places on Earth that can boast a small patch of bacterial fossils that are a bit older than the Barberton fossils is a tiny region in Greenland and some other isolated very small samples elsewhere.

Also find out whether there are any stromatolites nearby for a possible excursion.

Note: The richest fossil records of Gondwana are found in the drier parts of the subcontinent. This is mainly because:

- The lack of water prevented excessive weathering so that the fossils are not covered by thick soil or dense vegetation and hence more easily exposed.
- The African continent has been repeatedly uplifted by several hundred metres in the recent geological past. This uplift has rejuvenated river systems that eroded deeply into the bedrock to expose ancient fossil-bearing rocks.

These advantages are not shared to the same extent by other Gondwana continents. For example, fossil rich rocks in Antarctica are hidden beneath thick ice sheets, Australia is mostly very flat and lacks good rock exposures, while much of India and South America have experienced deep subtropical to tropical weathering, which destroys fossils.

Primitive forests and coal deposits

It is recommended that you find good outline maps to show the size and position of the Ecca Karoo inland Sea, as well as the major rivers that flowed from it to the oceans. This will help learners to understand why, e.g. fish fossils are found near Grahamstown, and so many lampshell (Brachiopods) and Trilobites are found in the Little Karoo.

Activity 7 Difference between the Devonian and Permian ecosystems *(Specific Aim 1)*

Learner's Book page 331

1 Guidelines for comparing vegetation of the Devonian and Permian Periods can be found in the following table.

Devonian Period	Permian Period
Early Devonian: Gondwana moving over South Pole, icy cold climate with little if any seasonal changes. Atmosphere is dry, surface water largely frozen. First land plants appear – required adaptations for cold dry climate: • Primitive vascular tissue to transport water, minerals and organic nutrients and to support plant in upright position (no true xylem as yet) • Cuticle (waterproof) to reduce desiccation • Stomata to allow gaseous exchange in and out of waterproof surface • Plants remained predominantly small, e.g. club mosses such as Lycopods Late Devonian. Climate somewhat warmer. More seasonality. Air less dry. • First trees appear • First forests become established • Mycorrhiza is common so that fungi assist tree roots to absorb sufficient water and minerals • Archaeopteris, a fern-like gymnosperm tree, as dominant vegetation – reproduce by spores (no seeds yet) • Leaves falling from trees create a humus rich forest soil	Gondwana gradually moving North towards the equator. Warmer climate with slightly more distinct seasons. Melting ice creates large and abundant swamps towards the end of the Permian Period. • Vascular plants still rather primitive but gymnosperms have developed true roots and leaves • True xylem in vascular bundles, for transport and support • Also a cuticle (waterproof) to reduce desiccation • Also stomata to allow gaseous exchange in and out of waterproof surface • Dense forests with tall gymnosperm trees around swamps • Permian swamps gave rise to the rich coal deposits of South Africa • Primitive woody gymnosperm species, *Glossopteris* as dominant vegetation

2 The abiotic factors that influenced the biodiversity and distribution of animals that lived in the Devonian and Permian Periods are climate change and continental drift.

From the first tetrapods to the much later evolution of birds

The animals discussed in the following section are mostly foreign to the learners and their complicated names do not make it easy to get to know them. In North America and Europe, children will rattle off the names of most of their dinosaurs. Sadly, some of our South African youngsters also know these exotic dinosaurs (e.g *T. rex*) but are clueless about our own equivalent species. Let us rectify this by posting diagrams of our own prehistoric animals and plants on the classroom walls, with their names and the period in which they lived added to each. This will help to make learning more relevant and fun. Also, stress that while Eurasia and North America boast the larger diversity of dinosaurs, we in South Africa can boast in the same way about our therapsids. We even have a dinosaur with an isiXhosa-derived name: *Ngwebasaurus*! In learner-speak, how "cool" is that?

A recently published, beautifully illustrated and not expensive source of reference is highly recommended:
Famous Dinosaurs of Africa by Anusuya Chinsamy-Turan, (2008), Struik.
It even includes a stunning poster that shows the distribution of fossil finds across Africa and Madagascar.

PPA

» Activity 8 The fish-amphibian connection *(Specific Aim 2)*

Learner's Book page 333

The discovery of *Tiktaalik*, the "fishapod" is of great significance to palaeontologists and zoologists because it represents the perfect "missing link" between the fishy panerichthyids and early tetrapods like *Acanthostega*. *Tiktaalik* still had fish characteristics, such as scales and gills, but it also shows tetrapod features such as a rib cage. A flexible neck and moveable wrist joints are present. Hence *Tiktaalik's* nickname "fishapod", meaning fish with legs.

Please note: The coelacanth is not the "missing link" between fish and amphibians. This misconception that is still so popular must be corrected with the information on *Tiktaalik*.

Homework: Coelacanth activity
If, as teacher, you would rather rework this into an essay or any other form, please do so. The cartoon approach was suggested because this overcomes the problem of plagiarism from the internet or elsewhere. Moreover, it is impossible for any learner to tackle a series of cartoons without having done the required research and thus having the required insight. If time is tight, you may even decide to give them a photostat copy of the story to use as a basis for the cartoon series,

Either way, please do not skip this activity. Knowledge about this "proudly South African" story is an essential and prescribed portion of the CAPS document.

Mammals and their therapsid ancestors in the ancient Karoo

Because of space constraints in the Learner's Book, only the gorgons were discussed in some detail. However, this may create the impression that therapsids were exclusively predators and this is far from the truth. Large plant-eating tetrapods – the megaherbivores – first appeared in the Late Permian Period. Before then, land plants were mainly eaten by arthropods such as insects, mites and millipedes. The most important group of therapsid megaherbivores in the ancient Karoo Basin was the dicynodonts (or "two-tuskers"). Instead of normal front and cheek teeth, they had a sharp-edged horny beak like a tortoise as well as two large canine tusks in the upper jaw. They were stocky animals, with a barrel-shaped trunk, slightly splayed-out front legs, more erect back legs and a short tail. Dicynodonts ranged in size from small, rodent-like species to monsters up to three metres long, and included browsers and grazers as well as underground foragers. Dicynodonts ate leaves and twigs, roots, tubers, nutritious seeds and fruit-like reproductive structures of trees like *Glossopteris*. Powerful jaw muscles were attached to the sides of the very large temporal openings at the back of the skull to facilitate the chewing of tough plant material. The large tusks were used for defence against predators, also for digging burrows, bulbs and roots.

Well-preserved fossil trackways of several dicynodonts were recently discovered in the Great Karoo near Graaff-Reinet. They were made by a small herd of dicynodonts moving in the same direction. They walked with a slightly waddling gait because the front legs were held out slightly to the side of the body. The trackways were probably made by a species called *Aulacephalodon*, while moving through a muddy area around a water hole. Fossil remains of *Aulacephalodon* were found nearby.

PPA

Activity 9 *Archaeopteryx* – the "missing link" between dinosaurs and birds *(Specific Aim 2)*

Learner's Book page 340

This is a prescribed activity.

Guidelines for the comparison:

Dinosaur	*Archaeopteryx*	Pigeon
Sharp serrated teeth in jaws	Spiky, blade-like teeth in jaws	Toothless – horny beak instead of teeth
Fused hip girdle	Fused hip girdle	Fused hip girdle
Pubic bone slopes forwards	Pubic bone slopes downwards	Pubic bone slopes backwards
Very long bony tail	Bony tail of intermediate length	Very short bony tail fused into "parson's nose".
Collar bones fused into "wishbone"	Collar bones fused into "wishbone"	Collar bones fused into "wishbone"
Sternum (breastbone) without strong keel	Sternum without strong keel	Sternum enlarged into a deep ventral keel for attachment of powerful flight muscles
Long hind limbs with fused bones to give extra strength	Long hind limbs with fused bones to give extra strength	Long hind limbs with fused bones to give extra strength
Three toes forward and one elevated reversed toe	Three toes forward and one elevated reversed toe	Three toes forward and one reversed toe on the ground
Ankle has a hinge joint	Ankle has a hinge joint	Ankle has a hinge joint
Forelimbs are grasping arms	Forelimbs are intermediate between arms and wings	Forelimbs are fully developed wings
Wrist bones are flexible and not fused	Wrist bones are reduced and more compact	Wrist bones are totally fused
Three clawed hand with flexible, long fingers	Three very elongated, flexible fingers (digits)	Three fused digits at the tips of wings
Elongated trunk with several vertebrae	Elongated trunk with several vertebrae	Short trunk with only a few vertebrae
Elongated skull; cranium not highly swollen	Skull intermediate between dinosaur and bird	Large rounded skull (swollen cranium)

Activity 10 All the different hominins *(Specific Aim 1)*

Learner's Book page 343

Homework exercise.

Do not be tempted to give any additional information to the learners since they need to practice the required skill to access relevant information from the text and to convert this into a flow diagram which will serve as a valuable memory aid when it comes to preparing for tests and examinations. Good comprehension of the limited examples mentioned in Grade 10 will go a long way towards a good foundation for the much more detailed study of hominin evolution in Grade 12.

The famous Mrs Ples skull of *Australopithecus africanus* collected by Robert Broom from Sterkfontein (probably a subadult male)

Well-preserved specimens of *Paranthropus robustus* collected recently from Drimolen, showing huge cheek teeth

PPA

Activity 11 Fossil tourism – a source of employment? *(Specific Aims 1, 2 and 3) (Formal Assessment Task)*

Learner's Book page 344

Learners are required to research the economic potential of a fossil site in their province.

This is a very important task for assessment and will be very time-consuming. It is thus recommended that you consider giving the task to learners half-way through this unit so that they have sufficient time to complete it.

An in depth revision of all the necessary steps regarding hypothesis testing will be essential to ensure that learners approach this task in a scientific manner.

It is suggested that the assessment be done in stages so that learners can benefit from constructive formative assessment feedback. Such assessment is recommended at the end of each of the following stages:

- Collect background information required for the investigation and formulate a hypothesis on the viability of this fossil site as an income generator.
- Consider the possible variables and plan the investigation and research instruments.

- Carry out the investigation and collect all relevant data.
- Organise and manipulate the data.
- Analyse the processed data and draw conclusions.
- Summarise the investigation (all the steps) in a concise scientific report that includes an explanation of findings, with some ideas to refine the investigation towards more reliable data.

Self assessment questions

1 Palaeozoic: 488–251 Ma; Mesozoic: 251–65 Ma; Caenozoic: 65 Ma–present

2 Palaeontologists and geologists divide the millions of years of Earth's time into smaller units for easy reference. These are called geological time units and each lasted tens or hundreds of millions of years. These geological time units are used to track the history of life on Earth.

3 Most groups (phyla) of multicellular animals first appear in the fossil record during the early part of the Cambrian Period. Abundant fossils of many different animal groups, such as arthropods, molluscs and echinoderms, suddenly appeared with most of their characteristic features already fully developed within a time interval lasting as little as ten to fifteen million years. Remember this event followed over three billion years of nothing except microbes. This really busy period of multicellular (metazoan) evolution from 542 Ma onwards is called the Cambrian Explosion. This marks the beginning of the Phanerozoic Eon, which means in Ancient Greek the "Period of obvious life".

4 Learners should list all of the five mass extinctions that are known as "the big five" and write a sentence on the most probable causes of each of these – drawing on Table 2.1 in the text.

5 Learners describe fossils as the remains of extinct plants and animals and write a short paragraph on the formation of fossils within beds of mud that were later subjected to enormous pressures to form solid rock and explain that the organic remains were gradually altered by physical processes, resulting in fossils becoming enclosed in sedimentary rocks.

6 A therapsid is a mammal-like reptile.

7 Learners refer to the text in the unit and Australopithecine species and *Homo* species.

Additional questions

Here are some additional questions that learners can tackle as homework exercises if time allows.

1 Which major biological event marks the start of each one of the eras mentioned in the answer to Question 1 above? Name each era again and next to each, write down the name of the event that changed the nature of biodiversity at the start of that era.
Answer:
Palaeozoic – Cambrian explosion
Mesozoic – Permian mass extinction
Caenozoic – Cretaceous mass extinction

2 Name the three super continents that were present during ancient times and explain why these do not resemble the continents that we are familiar with today. Also state the approximate interval of time when they existed.
Answer:

- Pangaea – approximately 237 Ma (Early Triassic Period), during Mesozoic Era
- Laurasia (northern hemisphere) – Late Triassic, approximately 200 Ma
- Gondwana (southern hemisphere) – Late Cretaceous/Early Tertiary, start of Caenozoic Era, approximately 65 Ma.

The continents look different now because the tectonic plates have shifted.

3 Adaptive radiation of many multicellular organisms occurred between 550 and 530 Ma.

a What possible change in climate may have initiated this adaptive radiation?
b What atmospheric condition may have contributed?
c What ecological changes in the oceans may have encouraged it?
d What physiological break-through in the mode of nutrition, especially amongst animals, may have contributed?

Answer:

a Global Ice Age with extensive glaciation across the globe
b Increase in oxygen concentration and decrease in carbon dioxide
c Increase in plankton, nekton and other organic remains of organisms (detritus = humus in the oceans) provided more food sources than before
d Macrophagy – the ability to engulf whole particles of food, to then be digested inside cells

4 Where in southern Africa will you go to see Precambrian fossils? What may you find there?

Answer:

Barberton Mountains – cyanobacteria and stromatolites
Northern Cape – soft bodied multicellular animals (Vendobionts)
Namibia – also soft bodied multicellular animals (Vendobionts)
Note: These soft bodied organisms were weird, yet unclassified creatures and scientists are still not sure whether they were plants or animals! They are also referred to as Ediacaran biota in some reference books. (Research you might want to tackle if you become a Palaeontologist.)

5 Why are late Palaeozoic and early Mesozoic fossils more abundant in Europe, the United States of America, Canada, Greenland and Asian countries than in South Africa? Provide a brief explanation, with reference to climate and geographical locations.

Answer:

During this time interval the current northern hemisphere (Laurasian part of Pangaea) was positioned in the tropics, i.e. on or close to the equator, thus environmental conditions were conducive to sustaining energy rich ecosystems with abundant life forms.
South Africa, on the other hand, being more or less in the centre of the Gondwana part of Pangaea, was gliding across the South Pole region, in the grips of icy, glacial conditions and thus could only sustain the most hardy and very limited range of organisms.

6 State the time interval when:

a Fish evolved in the oceans
b Tetrapods invaded land (terrestrial habitats)
c Primitive plants established ecosystems on land
d Therapsids became extinct in the Great Karoo
e Dinosaurs ruled the Earth as the dominant animal group of animals
f Mammals evolved
g *Glossopteris* was abundant across the continents in the southern hemisphere

h Coal formation started in Europe
i Coal formation started in South Africa

Answer:

a Devonian: 417–354 Ma
b Late Devonian: approximately 350–354 Ma
c Devonian: 417–354 Ma
d Late Triassic: approximately 200 Ma
e Triassic, Jurassic and Cretaceous: 248–65 Ma
f Jurassic: approximately 206 Ma
g Permian: 290 Ma
h Carboniferous: 354 Ma
i Permian: 290 Ma

7 Study the graph (Figure 2.21) that shows the radio-active decay of uranium to lead shown earlier in the text of this unit.

a What does the term "half-life" of a radioactive element mean?
b How long is the half life of uranium?
c How long does it take for uranium 235 (an isotope with atomic mass of 235) to totally decay into lead?
d How does the characteristic decay of this isotope help geologists to determine the age of rocks?
e Is this a reliable scientific method to age rocks? Explain your answer.
f If there is 25% uranium and 75% lead found in a sample of rock, how old is the rock?
g Carbon dating is a popular form used by anthropologists to date, e.g. the age of Late Stone Age ostrich shell beads found near prehistoric caves. The half life of the ^{14}C is approximately 5 730 years and it takes roughly 40 000 years for this C isotope to decay completely. Can palaeontologists use this carbon isotope instead of uranium to date the strata in which Therapsids are found in the Great Karoo? Explain your answer.
h Memorise, in detail, the graph showing the radioactive decay of uranium. Now close your textbook and draw it. Are all the details shown in your version? Is it perfectly correct? If not, repeat until you can do it. This will help you to gain the required insight for possible future questions on radiometric dating.

Note to teachers: Uranium-dating is a very expensive and highly complicated method and most suitable for oldest rock. It is also quite a dangerous technique due to the radioactive nature of uranium. For dating younger (but still very old rocks) scientists often use the more economical element potassium, which decays into argon (an inert element that poses no danger). Thus, the percentage potassium compared to the percentage argon found in relatively younger rocks can tell their age.

Answer:

a This is the time (or rate) that it takes for half of the mass of the unstable isotope of an element to decay into a more stable element.
b In the case of uranium, a radioactive element, it takes 700 million years for half of the isotope uranium-235 to decay into lead-207. Thus the half-life of ^{235}U is 700 million years. Another uranium isotope, ^{238}U, has a half life of 4.5 billion years! It also breaks down into lead.
c 4 200 million years
d By determining the percentage of ^{235}U to the percentage of its daughter element, lead, that formed from the decay of the uranium

isotope, scientists can use this difference in ratio to tell the age of a rock or fossil.

e By palaeontological standards, it is regarded to be a very reliable method since the time error may, at the most, be only one million years.

f 1 400 million years. (Add another 700 million years to the first half-life time period.)

g No. The ^{14}C isotope has a half-life of only 5 729 years. Therapsids lived during the Permian period, i.e. 290 – 248 million years ago.

h If you did this as told, you will not have to waste time during tests to analyse, e.g. a new format of graph – you will recognise the data much more quickly.

8 Is radiometric dating the only way in which geologists and palaeontologists can determine the age of fossils? Explain your answer.

Answer:

No. Long before radiometric techniques became known, scientists had to rely on relative dating, also called biostratigraphic correlation. In this technique, scientists compare the nature of a sedimentary layer and its fossils with that of a similar layer found elsewhere. If the new layer shows the same physical, chemical and biological characteristics of the rock of a known age, then it can be assumed that the two sets of sedimentary layers are the same age. This method is much less reliable than radiometric dating.

9 Summarise the step-by step formation of a *Massospondylus* dinosaur fossil that probably died in a flash flood in a river bed in the Golden Gate area of the Free State.

Answer:

Step 1. After *Massospondylus* died, its body was rapidly covered by the flood waters bearing loads of mud and silt. This sediment settled out on the corpse and rapidly coated it so that scavengers could not have access and decomposers could not decompose the bony parts once the mud dried up.

Step 2. The sediments that buried the carcass and the minerals in the carcass changed gradually due to chemical processes and physical processes such as pressure from overlying sediment. This took thousands of years.

Step 3. Slowly the skeleton and the mudstone in which it was buried turned into hard rock.

10 Provide the most appropriate scientific term for each one of the following:

a A geological event that often lasts for thousands of years, causing the demise of a large number of species

b A collective term for mammal-like reptiles

c A collective term used to refer to all four-legged terrestrial animals

d The large inland body of water that spanned across much of South Africa, surrounded by dense swamp forests that transformed into underground coal seams

e Scientists who study the nature, origin and all other facts related to fossils

f The phenomena in which a large number of new species evolved over a relatively short time, following an intense ice age

g The large continental land mass that stretched from pole to pole around 400 Ma

h The genus to which early bipedal hominins, often called the "Southern Apes" belong

i The genus and species name for early modern humans
j Early humans who left Africa to populate the rest of the world

Answer:

a Mass extinction
b Therapsids
c Tetrapods
d Ecca Karoo Sea
e Palaeontologists
f Cambrian explosion
g Pangaea
h *Australopithecus*
i *Homo sapiens*
j *Homo erectus*

11 Match the ancestors in Column A with the descendants that evolved from them in Column B.

A	B
1 Therapsids	a Reptiles
2 Fish	b Therapsids and dinosaurs
3 Amphibians	c Mammals, including humans
4 Reptiles	d Birds
5 Dinosaurs	e Amphibians

Answer:

1 c **2** e **3** a **4** b **5** d

12 Mention two popular hypotheses that are attempting to explain the cause(s) of the mass extinction around 65 Ma.

Answer:

- The massive volcanic eruptions in India caused long and severe environmental changes that caused mass extinction of numerous species across the globe.
- A massive asteroid impact at Chicxulub in the region of Mexico caused long and severe environmental changes that caused mass extinction of numerous species across the globe.
- Or a combination of these two, which is currently the most popular hypothesis.

13 Explain why coal often shows distinct lighter bands and some types emit sulphur smells when burnt.

Answer:

The black to brown alternating layers represent compressed organic matter (dead plants and animals) layered with brown compressed sediments of silt or clay. The sulphur smell comes from the burning organic remains that contain traces of sulphur compounds left behind by ancient anaerobic bacteria.

14 Mention the provinces in South Africa where coal is mined. State the palaeo-geological reason for this distribution of coal. (palaeo = ancient; geological = earth surface)

Answer:

Free State, Gauteng, KwaZulu-Natal and Mpumalanga Provinces. During the late Carboniferous Period and especially during the early Permian Period, glaciers from the recent Ice Age melted and filled up the Karoo Basin, so that a shallow sea resulted, more or less stretching over the central part of South Africa. Several large rivers flowed from the shallow Ecca Sea towards the ocean either side of the southern part of Africa. Along these rivers and around the basin, a large number of deltas existed,

with dense swamp forests of primitive mosses, ferns and gymnosperms. Plant litter accumulated in thick layers on the forest floor. This was continuously flooded with mud and silt to form a bog-like peat. Over several thousands of years such layers became compressed and buried deep below the soil surface, compacting into the black rock seams that we now call the Ecca Coal Measures, stretching over several kilometres where the ancient Gondwana swamp forests existed.

15 Explain why the coelacanth:

a is often referred to as a living fossil

b cannot be regarded as the missing link between fishes and amphibians

c is often nick-named a "fishapod" or "old four legs".

Answer:

a Because the currently living coelacanth closely resembles the coelacanth ancestors that are recorded in the fossil record and lived in large numbers all over the oceans during the Devonian Period, some 300 Ma. Before their discovery, they were all thought to have vanished during the fifth mass extinction.

b They were not the direct ancestors of tetrapods such as amphibians because their features are not sufficiently intermediate in structure. It is *Tiktaalik*, recently discovered, that best fits the intermediate structures to be considered the ancestral missing link.

c This is due to its pelvic and pectoral fins that evolved into lobes, resembling "legs" and "arms" (pods or poda).

16 Briefly summarise the main historical events regarding the discovery of the modern coelacanth in the late 1930s. Use the cartoons that you drew for homework during Activity 8 as a basis for your summary.

Answer:

- In December 1938, off the Chalumna River Mouth near East London, the first coelacanth was caught by a local fisherman.
- Up to this time, scientists assumed that coelacanths were all extinct, due to the discovery of 70 000 year old fossils of Coelacanths species in the Grahamstown area (and elsewhere).
- The curator of the East London Museum, Marjory Courtney-Latimer, spotted the fish with the fisherman and instantly realised this was a unique find. She preserved it, with great difficulty, until Professor JLB Smith arrived days later, to identify it as a coelacanth. She was rewarded for her natural scientific curiosity and her pivotal role in securing such an important part of our prehistoric heritage, by scientists giving the newly found species the name of Latimeria.
- A lengthy search for more coelacanths followed until finally, another was discovered at the Comores Islands, north of Madagascar, fourteen years later. Now Professor Smith was able to confirm his previous evaluations and analytical research on a fresh specimen.
- Since then, many specimens have been seen in additional places in the Indian Ocean, such as in the Mozambique Channel, at Sodwana Bay near Lake St. Lucia and also around Indonesia.
- Coelacanth research is still ongoing. Because these fish live in very deep parts of the ocean, researchers have gained a great deal of knowledge and insight regarding deep marine ecosystems by diving and researching at depths where no one has gone before.
- The world famous Dr Hans Fricke, with his team of scientists and the submersible called Jago, have been pioneers in the study of such ecosystems and this is now proving valuable in current attempts to manage the looming disaster of dwindling marine fish resources.

17 The answers to this task are easy. All you need to do is to read all the text again from the start of the section on The South African Fossil Record.

Question: Where in southern and East Africa were the following fossils found?

a Precambrian cyanobacteria that added oxygen to the oceans and atmosphere.
b Soft bodied Precambrian organisms collectively called Vendobionts
c Petrified lycopods, a fern relative that grew into medium-sized trees.
d *Archaeopteris*, a petrified gymnosperm.
e Placoderms, i.e. primitive fishes with armour-plates on their skulls.
f *Glossopteris*
g Devonian fossilised coelacanths
h Permian fossilised coelacanths
i Mounted specimen of a modern coelacanth (think!)
j Examples of the missing link between reptiles and mammals
k Cynodonts e.g. the "dog-toothed" or "sabre-toothed" therapsids
l *Thrinaxodon*, the small mongoose-like cynodont that lived in burrows
m *Lystrosaurus*, a herbivorous dicynodont (therapsid) that survived the Permian extinction event
n *Megazostrodon*, a tiny shrew-like mammal
o Dinosaur teeth and scattered dinosaur bones
p *Massospondylus* (dinosaur) eggs still in their nest
q *Euskelosaurus* skeletons with dried skin still attached
r Taung child [*Australopithecus africanus*]
s Mrs Ples's skull [*Australopithecus africanus*]
t Little Foot (still an unidentified *Australopithecus* species)
u *Australopithecus sediba*
v *Homo erectus* (several fossils in the same region)
w Turkana Boy [*Homo erectus*]
x Saldanha Man [*Homo erectus*]
y Florisbad Man [*Homo erectus*]
z Early modern humans [*Homo sapiens*]

Answer:

a Barberton mountains
b Namibia
c Grahamstown
d Grahamstown
e Grahamstown
f Escourt and Mooi River (and other scattered places across the country)
g Grahamstown
h Great Karoo
i East London Museum
j Great Karoo
k Great Karoo
l Great Karoo
m Great Karoo
n Great Karoo
o Drakensberg and Lesotho
p Golden Gate Highlands National Park, Free State
q Ladybrand, Free State
r Taung, North West Province
s Sterkfontein Caves, Cradle of Humankind, Gauteng
t Sterkfontein Caves, Cradle of Humankind, Gauteng
u Gladysvale, Cradle of Humankind, Gauteng
v Swartkrans and Drimolen, Cradle of Humankind, Gauteng
w Great African Rift Valley, Kenya
x Saldanha, Cape West Coast
y Florisbad, near Bloemfontein, Free State

z Border Cave in KZN, Klasies River Mouth near Humansdorp; Springbok Flats, Limpopo

18 Where do the following two traces of early *Homo sapiens* existence occur?

a Trace fossils of footprints (two places in South Africa)

b Caves that contain artefacts of Middle Stone Age Culture (several places)

Answer: (any two of)

a Nahoon near East London, E. Cape; Langebaan, W. Cape

b Blombos near Still Bay (Western Cape); Diepkloof near Elands Bay (W. Cape)

c Wonderwerk Cave (Northern Cape); Apollo 11 Cave in Namibia.

SECTION E

PHOTOCOPIABLE SHEETS

The assessment grids on the following pages may be photocopied for use with the Life Sciences Grade 10 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: _____

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 assisstance	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			
Any 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

This section is for you to file the Curriculum and Assessment Policy Statement (CAPS) for Life Sciences. You may add any other documents you receive in this section and list them here for easy reference.

_____

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Grade 10

Study & Master

Life Sciences

Study & Master Life Sciences Grade 10 has been especially developed by an experienced author team for the Curriculum and Assessment Policy Statement (CAPS). This new and 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 throughout 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.

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