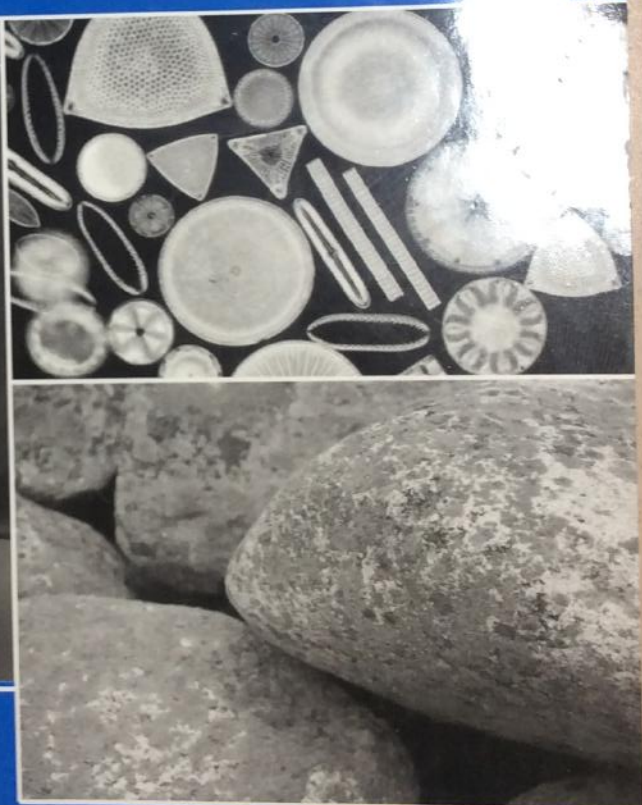




Biology

Teacher Guide
Grade 12



Federal Democratic Republic of Ethiopia
Ministry of Education

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Introduction to the Teacher's Guide

Some general aims of biology education

Biology is a life science. It enables students to develop knowledge and understanding of themselves and of the living world around them. Biology is an experimental science, so we can use it to help our students learn critical thinking, reasoning and problem solving in everyday contexts. Biology has special relevance to our students as individuals, to our society and to the growth and development of Ethiopia as a country.

A good knowledge and understanding of biology helps our students to value the natural world around them and appreciate how it works. Students of biology realise how the environment can be exploited in a sustainable way for the benefit of our whole society.

Many of the issues and problems in society – such as nutrition, health, drug abuse, agriculture, rapid population growth, environmental problems and conservation – are basically biological in nature. If we are going to deal with these problems realistically, we need young people with a good understanding of biology. Recent advances in biotechnology and genetic engineering are also going to have an impact on life in Ethiopia, and we need our young people prepared to understand how to make the most of these scientific advances.

Studying biology prepares students for employment, both by developing important general skills and as a preparation for careers that require knowledge of the subject, such as agriculture or medicine. However, a study of biology does not just mean learning facts. Biology, as with the other sciences, requires the student to develop problem-solving skills which are important in all ways of life.

The Secondary Biology curriculum takes a competency-based, active-learning approach, underpinned by three broad outcomes: knowledge, skills, and values and attitudes. The Students' Book and Teacher's Guide places emphasis on learner-centred classroom and field activities, not only to help students to acquire knowledge, but also to develop problem-solving and decision-making skills, as well as a good attitude to the natural environment.

It is very important for you, the teacher, to help your students understand that science is a dynamic activity. Biology is not a set of rules but a body of knowledge that is growing all the time and is modified by experimentation.

There are many different approaches to teaching and learning, involving a range of teaching styles, along with practical activities and field work. By using a mixture of teaching styles in every lesson you will be able to engage the interest of all your students and help them to develop their knowledge and understanding of biology. Many of these methods are summarised in the 'Teaching Methods' section below.

Objectives of this biology course

The broad competencies of the Secondary Biology course in Ethiopia are:

- **Knowledge:** students will construct their biological knowledge. They will interpret and apply their biological, technological and environmental knowledge to everyday situations.

Answers to review questions

- | | |
|------|-------|
| 1. C | 6. D |
| 2. D | 7. D |
| 3. D | 8. D |
| 4. B | 9. D |
| 5. B | 10. D |

1.2 The ecology and uses of bacteria

Learning competencies

By the end of this section students should be able to:

- Appreciate that bacteria are found in many diverse locations.
- Explain that bacteria are important disease-causing agents; are used in industrial processes and give examples of industrial processes that use bacteria; and are involved in the cycling of mineral elements such as carbon and sulphur.
- Describe the main groups of micro-organisms.
- Explain the roles of reservoirs of infection in the transmission of infectious diseases caused by bacteria.
- Explain the roles that bacteria play in every ecosystem.
- Explain how bacteria produce disease.
- Compare infectious disease with functional disease and state the germ theory.
- State the role of bacteria in recombinant DNA work.
- Define cloning and illustrate how foreign genes are inserted in bacteria plasmids, and how bacteria are used on vectors.

This section should fill approximately **10 periods** of teaching time.

Starting off

Students should be aware of the landmark work of Pasteur, Koch and Lister in establishing the germ theory of disease. Pasteur's work has already been described in some detail in grade 11 (The Nature of Science) but could be usefully revisited.

Teaching notes

Students could carry out a library search to find out more about the work of Lister in developing and using antiseptics in surgery, and Koch in identifying the organisms associated with some diseases, including the tuberculosis bacillus and the cholera vibrio. Koch's postulates should be discussed with the students to ensure they appreciate the logic of these in ensuring that a particular micro-organism causes a particular disease. The micro-organism should be:

- found in all cases of the disease examined
- capable of being prepared from the diseased organism and maintained in a pure culture

What is the role of bacteria in industrial processes? (2)	
SA	Students complete the work on their presentations.
MA	Students give presentations to the class.
CA	Teacher reviews presentations.
How are bacteria genetically modified?	
SA	Students say what they understand by the term 'genetic engineering'. Students examine that a gene is transferred from one organism to another (usually of a different species) and that the organism receiving the gene becomes a transgenic organism.
MA	Students begin by reviewing the structure of a bacterial cell, understanding the presence of DNA as: • the main non-linear strand (sometimes called the bacterial chromosome) • plasmids Students appreciate that plasmids can be moved from one bacterium to another and serve as vectors for genes. Students discuss with the teacher the main stages involved in transferring a gene into a bacterium. Give students an unlabelled diagram of the process for them to use as the basis of their notes.
CA	Students research the topic and find more examples of products that are made by genetically engineered bacteria.
How are genes transferred into plants?	
SA	Students discuss with the teacher some of the benefits of genetically engineering crop plants.
MA	Students study the methods of transferring genes into crop plants including using: • <i>Agrobacterium</i> • the gene gun Students make notes on these processes.
CA	Brief class discussion about some of the concerns about exploitation by companies who develop genetically modified crop plants. Students research this more deeply for the next lesson.
Do companies who develop genetically engineered crop plants exploit developing nations?	
SA	Students review the issues.
MA	Students collaborate to make a display.
CA	Class discuss the outcome and balance the advantages against the risks.

Answers to review questions

1. C
2. D
3. C
4. C
5. D
6. D
7. B
8. C
9. C
10. D

MA	Students carry out the activity 'Agree/disagree'. Teacher records the results for each statement.
CA	Teacher and class review the opinions that the class has displayed.
AIDS awareness campaign (1)	
SA	Students determine most significant effects HIV/AIDS has on community relations, drawing on their experience in previous lessons.
MA	Students complete the planning stage of activity 1.11.
CA	The class discusses together the different plans formulated and decides on the best one.
AIDS awareness campaign (2)	
SA	Students decide what actions they need to take to get their chosen campaign up and running.
MA	With your help, students make the resources they need to run their campaign and make relevant contacts in the community to ensure they can carry it out.
CA	Students assign team roles for the campaign and are ready to carry it out outside of school time. Students agree a method of evaluating the success of their campaign.
Are viruses living organisms?	
SA	Class to review the discussion from the 'Introducing viruses' lesson. Explain activity 1.15 and divide the students into the three groups.
MA	Students in all groups research the issues. Students carry out activity 1.15.
CA	Teacher reviews the outcome of the debate. The students should understand that viruses are an example of life that does not have all the characteristics of living organisms but is an important part of the study of biology.

Answers to review questions

1. B 3. D 5. A 7. A 9. D
2. A 4. C 6. A 8. C 10. C

Answers to end of unit questions

1.

Type of micro-organism	Example
Bacteria	<i>Streptococcus/Lactobacillus/Staphylococcus/Vibrio</i> /any suitable example
Protozoa	<i>Amoeba/Plasmodium/Paramecium</i> /any suitable example
Fungi	<i>Yeast/Penicillium/Mucor/Candida</i> /any suitable example
Viruses	HIV/cold virus/flu virus/hepatitis virus/any suitable example

2. a) The bacterial cell is smaller than the animal cell and has:
- no nucleus
 - no mitochondria
 - smaller ribosomes
 - 'circular' DNA/DNA in a loop.
- b) The bacterial cell is bigger than the virus and has:
- more DNA

- plasmids
- a cell wall
- ribosomes
- a cell membrane.

3. a) To sterilise the equipment/kill all the micro-organisms/bacteria so that any that appeared later must have entered from outside.

b)

Tube	Appearance	Reason
1	Cloudy	Broth is exposed to air; bacteria can enter
2	Clear	Cotton wool prevents bacteria from entering
3	Cloudy	Bacteria can enter through glass tube
4	Clear	Bacteria cannot enter – are caught at bottom of S-shaped tube

4. a) i) Restriction enzyme

ii) Ligase

- b) The plasmid is a vector, which carries gene into the host cell.

- c) A plasmid cannot enter plant cells.

- d) Gene gun, which fires golden pellets coated with DNA into cells.

Transgenic *Agrobacterium* bacteria carry the gene into plant cells.

5. a) Unprotected sexual intercourse, drug users sharing needles, from mother to child across the placenta.

- b) The phase when T-helper cells are replaced as fast as they are destroyed/infected; this can last for many years.

- c) They block enzymes involved in the entry phase, block reverse transcription, block protein synthesis, block assembly of virus particles (any two).

6. a) Decomposers/putrefying bacteria/ammonifying bacteria.

- b) Y – nitrate

X – nitrite

- c) i) Nitrogen-fixing bacteria use nitrogen gas/nitrogen from the air, and convert it to ammonium ions/ammonia.

- ii) Denitrifying bacteria use nitrates, and convert them to nitrogen gas.

7. a) Essays should address some of the following ideas:

Families:

- Loss of income by families – increased costs because of medical/funeral expenses.
- Children drop out of school to provide support in the home, to work in agriculture.
- Families reduce expenditure on basics.
- Increased demands on physical and mental health of carers, especially where these carers are untrained or unsupported.

Country as a whole:

- Loss of economic output because of reduction of workforce due to time taken off work or due to deaths.
- Government income also falls as less revenue from taxes.

Life skills:

- Develop a good sense of personal identity leading to self-confidence.
- A thorough understanding of AIDS and of healthy living.
- Ability to think independently, critically and creatively.
- Ability to develop good relationships.
- Ability to communicate well.
- Problem solving.
- Conflict management skills.
- Ability to make informed and responsible decisions.
- Assertiveness and self-esteem in order to drive actions needed to solve problems.

Appendix

Collecting and culturing protozoans

Teachers must ensure that there is no health and safety issue in collecting the water.

Microscopic life can be found in ponds, lakes, streams, rivers and rain puddles that have been in existence for a few days. Water samples can be collected easily using wide-mouth glass jars with tight-fitting lids. The collection jars you use should be completely clean and detergent free.

Collections from one site could include surface or bottom samples. When sampling from the bottom, include some of the bottom solid material with your sample. When sampling from the surface, include any floating material.

Upon close microscopic examination you may well see very few living things, perhaps only one protozoan per drop. Cultures can set up a short food chain, enabling the protozoans to feed and reproduce. Six different solutions that can be made easily are listed below.

Solution A – hay infusion medium

Boil one litre of pond, spring or rain water. Add a small handful of hay and boil for 10 more minutes. Allow this mixture to stand for two days. Add 25–50 cm³ of your water sample. Add a sample of this culture to a freshly prepared hay infusion every week.

Solution B – wheat infusion medium

Boil 100 cm³ of pond or spring water for 10 minutes. Cool and add five grains of wheat. Let this mixture stand in open dishes for two days, then add one tablespoon of your sample.

Solution C – rice infusion medium

Follow the instructions for Solution B, but use five grains of uncooked rice instead of the wheat.

Solution D – egg infusion medium

Hard boil an egg and grind a pinch (0.25 g) of the yolk in a bowl with a small amount of water to form a paste. Add the paste to one litre of boiled pond or spring water, allow to stand for two days before adding a tablespoon of your sample.

Solution E – powdered milk medium

Boil 250 cm³ of pond or spring water for 10 minutes. Cool and add a pinch of powdered skimmed milk. Mix thoroughly and immediately add a tablespoon of your sample.

Solution F – yeast medium

Boil 250 cm³ of pond or spring water for 10 minutes. Cool and add 2 g of dried yeast. Mix and stand in open containers for a few hours before adding a tablespoon of your sample.

Answers to end of unit crossword puzzle**Across**

- 2 genetically modified
- 6 disease
- 9 nitrification
- 13 reservoir
- 14 protozoa
- 15 cocci
- 16 CD4

Down

- 1 viruses
- 2 Gram-positive
- 3 nitrogen fixation
- 4 lysogenic
- 5 prokaryotic
- 7 spirochaetes
- 8 human induced
- 10 genetic
- 11 bacilli
- 12 algae

Further resources

http://www.qedoc.net/qqp/jnlp/TZCED_009.jnlp – quiz modules on gram positive and negative bacteria

http://www.k12station.com/k12link_library.html?subject=NST&sub_cat=105355&final=105373 – links to animations and resources on the nitrogen, carbon, sulphur and water cycles

<http://www.avert.org/aids-young-people.htm> – teaching advice and resources on HIV/AIDS

http://www.who.int/topics/hiv_aids/en/ – data and resources on HIV/AIDS

Ecology

Learning competencies

By the end of this unit students should be able to:

- Explain the need for food
- Illustrate the nutrient cycles
- Describe and diagram the phosphorus cycles.
- State that materials are recycled
- Explain what is meant by a sustainable environment
- Describe the natural environment as productive by succession
- Describe primary and secondary succession
- Give examples of primary and secondary succession
- Define the term biotic potential
- Name the major terms of ecology
- Describe the main features of an ecosystem
- Give examples of the flow of energy in an ecosystem
- Appreciate the duty of an ecologist
- biomes.
- Explain what is meant by a sustainable environment
- Appreciate the significance of biodiversity
- Explain how biodiversity is maintained
- Explain the status of an ecosystem
- Describe the principles of ecology
- Reflect a concern for the environment
- Appreciate the interdependence of organisms
- Engage in a tree-planting activity
- Express willingness to participate in a tree-planting activity
- Compare and contrast different ecosystems
- Compare intra-specific and inter-specific competition
- Describe and explain the factors affecting growth, including light, temperature, water, and nutrients
- Interpret a population graph
- Define the term carrying capacity

Students could also include in their posters information on how the following influence the cycles.

	Extra information to be included
Nutrient cycle	• Extra sources of carbon emissions
Carbon cycle	• Changing land use • Changing amounts of CO₂ in the atmosphere
Nitrogen cycle	• Effects of increased fertiliser usage • Eutrophication
Phosphorus cycle	• Effects of increased fertiliser usage • Effects of increased quarrying
Sulphur cycle	• Effects of increased burning of fossil fuels • The impact of acid rain

Project: the importance of recycling resources

Students should first consider the alternatives to recycling materials. If materials are not recycled then they could be:

- simply dumped and look unsightly as well as posing a health hazard
- used in a landfill site
- incinerated.

Students should research what happens in each of these situations and how this might affect the local and global populations. They could also research the cost of recycling materials and compare this with the cost of producing new products. Good examples of this include the recycling of paper, aluminium and glass.

Answers to review questions

1. B
2. C
3. C
4. B
5. D
6. A
7. D
8. D
9. C
10. D

This section should fill approximately **3 periods** of teaching time.

2.2 Ecological succession

Learning competencies

By the end of this section students should be able to:

- Explain what is meant by the term succession.
- Describe the natural process by which bare land turns out to be productive by succession.
- Describe primary and secondary succession.
- Give examples of primary and secondary successions.

Starting of

It is important ecosystems, d should also a not always ha formed from It would be u

The principle how pioneer in those cono these pionee this change h reproduce. T dominant ty allowing fur

It is importa present that

Teaching

The Student climax by p discussed; f discussed.

It is import starting poi example, th

- tropical
- deciduo
- conifer

Students sh becomes m niches for

- more c
- a great
- greater

Secondary originally, that a seco such as fir

However, least a soi survived t Secondary time, than

There are discussed

Why do different areas have different climax communities?

SA	Ask the students the obvious question 'Why don't all areas of bare ground undergo succession to rainforest?'. From this, students are to that climatic factors can limit a succession.	
MA	Students discuss other factors that can limit successions. Students produce a table to summarise the effects of these factors.	
	Factor limiting succession	How the factor limits succession
	Temperature	
	Rainfall	
	Soil type	
	Soil depth	
CA	Introduce the concept of secondary successions and how they differ from primary successions. Students construct a table (see later in this book) to compare primary and secondary successions.	

Answers to review questions

1. D
2. C
3. C
4. B
5. D

2.3 Biomes**Learning competencies**

By the end of this section students should be able to:

- Define the term biome.
- Name the major terrestrial and aquatic biomes.
- Describe the main features of each biome.
- Give examples of the flora and fauna of each biome.
- Appreciate the duty of care we have for the flora and fauna of the biomes.

This section should fill approximately **5 periods** of teaching time.

Starting off

It is well worth spending a little time at the start of this section in discussing the concept of the biosphere. Students usually have only a hazy idea of this concept and it should be firmed up in their minds as that region around the surface of the planet in which life is found. It is quite a thin region, but as the examples in the Students' Book illustrate, it is quite a lot thicker than once thought.

The biome concept does not come easily to students, and it is all too easy for them to define a biome on a geographical basis. They must be made to realise that a biome is defined very largely by temperature and precipitation. There are then

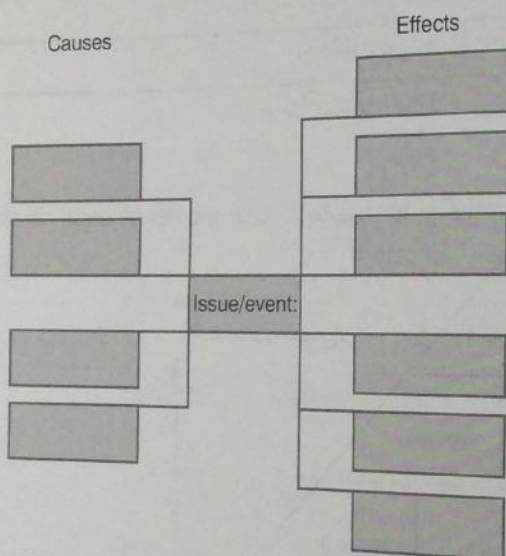
The biomes of Ethiopia – a class project and display

SA	Students discuss with the teacher the main biomes found within the country; use figure 2.18 as a basis. Provide the class with a large outline map of Ethiopia.
MA	Divide the students into groups. Each group researches one of the major biomes and produces: • a description of the biome (possibly using the pro-forma found later in this book) • pictures of some of the organisms typical of the biome.
CA	Students assemble the display with the map in the centre and the biome displays around it with pointers to regions where each is found.

Cutting the trees of Ethiopia

SA	Introduce the concept of cause and effect. Students discuss with the teacher the reason why trees are being felled in Ethiopia.
----	---

MA	Students produce cause-effect chart of tree-felling in Ethiopia, in terms of changing biomes. One possible layout is shown here.
----	--



CA	Class reviews the consequences on biomes of tree-felling in Ethiopia and writes up their notes.
----	---

Answers to review questions

1. D
2. D
3. D
4. A
5. A

2.4 Biodiversity

Learning comp

By the end of this

- Explain what
- Appreciate the
- Explain how b
- Explain the st
- Describe the
- Reflect a con
- Appreciate th
- Engage in a t
- Express willin
- locality.

Starting off

It is important tha
a list of organisms
illustrated with a s
diversity index tha
present in an area,
the success of each

Whereas the exam
merely to illustrat
or two local areas
each area.

They could:

- Estimate the m
 - Counting i
 - Using qua
 - and multip
 - to the area
- Estimate the r
 - Counting
 - Estimating
 - for the pla
 - described
- 1. Catch a sa
- 2. Mark each
- 3. Release th
- 4. Catch a se
- are marke

What is the status of biodiversity in Africa and Ethiopia in particular?

SA	Students discuss the species richness in different parts of Africa using figure 2.25 as a basis.
MA	From this, move on and students discuss the biodiversity of Ethiopia and make a display.
CA	Class reviews the displays of material and suggests possible interventions.

Is clearing forests for agriculture acceptable? – a class debate

SA	Students discuss with the teacher the structure of the debate and divide the class into groups. All groups research the material (including the 'audience').
MA	The debate takes place.
CA	Teacher reviews the arguments presented and the audience votes.

Why is biodiversity loss a concern?

SA	This section concentrates on the impact of loss of biodiversity on the individual. Get Students think about how it might impact on them. Ask for ideas. Outline the findings of the Millennium Assessment. Divide the class into groups and assign one aspect of the assessment to each group.
MA	The group then researches this aspect of the assessment and delivers a short presentation to the class.
CA	Teacher reviews the presentations and students make notes.

What can we do about it?

SA	Students discuss with the teacher the effects of doing nothing. Use the information in figures 2.28 and 2.29 as a basis for the discussion. Students examine that doing nothing is not an option.
MA	Class discussion of the concepts of: • conservation • duty of care. Students examine the basic principles of conserving wildlife. Students make notes.
CA	Students discuss with the teacher projects that they can undertake: • tree planting • non-biodegradable litter clearance. Students set up small-scale projects to achieve this, if possible. Class to discuss the medium-term implications for local biodiversity if a group of students each plant a tree each year for twenty years.

Answers to review questions

1. D
2. D
3. D
4. C
5. D
6. B
7. C
8. D
9. C
10. D

What can we do about it?

SA	Students revisit the influence of natality and mortality on population growth. Students say how each of these could slow population growth. Ask them which is the preferred option.
MA	Students discuss with the teacher some of the strategies adopted by other countries for reducing birth rates. Students make a display showing: • the strategies that could be adopted in Ethiopia • the way they would be implemented, and • the likely impact of the strategies.
CA	Class discussion on the role of government and the role of the individual in implementing the strategies.

Answers to review questions

1. C 6. D
2. C 7. C
3. B 8. C
4. A 9. B
5. D 10. D

End of unit questions

1. a) Any four suitable examples, such as: glucose, sucrose, protein, DNA, carbon dioxide, carbon monoxide.
- b) Diagram should show each of the following correctly positioned in the cycle
 - photosynthesis
 - feeding
 - respiration
 - decomposition
 - fossilisation
 - combustion
2. a) Three of:
 - nitrogen-fixing bacteria use nitrogen gas
 - convert it into ammonium/ammonia
 - which can be oxidised to nitrate
 - they add to the total amount of nitrogen in circulation
- b) Four of:
 - nitrification involves oxidation
 - of ammonium/nitrite to nitrate
 - results in more nitrate available
 - denitrification results in less nitrate available
 - as nitrate is converted to nitrogen gas

- c) Nitrogen-containing s
acted on by decompo
releasing ammonium
3. a) Primary
Hydrosere
- b) The swampy centre w
shrubs and then by tr
- c) Three of:
become more compl
become more stable
each sere changes th
reach a climax
4. a) i) The population do
adapted and die a
ii) The population d
capacity and the
- b) Two of:
disease
predation
accumulation of to
- c) B, because it is incre
human population/
5. a) A biome is an area
similar organisms.
- b) Relevant statemen
plant species richn
- c) Six of:
nama karoo reduc
to about half curr
but range extends
succulent karoo r
grassland reduces
to about half curr
replaced by savan
6. a) Equal numbers o
years plus.
- b) Static: narrow ba
little change unti
- c) Much broader ba
age increases; fev

ted by grasses/

ses

rganisms are not

he carrying

pid increase in the
hortening period.
nd ecologically

both similar in
es richness.

ghtly

an men at 85

ner ages show

ers quickly as

7. a) Three of:
proteins

ATP

DNA

phospholipids

b) i) Three of:

death/excretion

decomposition

release of phosphate ion

from suitable example (e.g. ATP, ADP, DNA)

ii) Three of:

harvesting removes parts of plants

reduces phosphate returned to soil

by decomposition

so fertilisers have to be used

represented by X in diagram

c) i) Decomposition involved; both stored in organic molecules in living organisms.

ii) Two of:

photosynthesis

respiration

fossilisation and combustion

8. Award marks in the following categories:

Category	Marks	Descriptors
Breadth	0-2	Student involves all the main aspects of the topic in reasonable detail
Relevance	0-2	Student does not bring in irrelevant material, although some extra, related, biology is acceptable
Communication	0-2	Essay is well written and logically presented, making good use of scientific vocabulary
Biological accuracy	0-5	Biological content is not at the required level and may contain significant misconceptions
	6-10	Biological content is essentially correct and of an acceptable standard although there may be an occasional slight error
	11-15	Essay is of a high standard with no significant errors

Answers to end of unit

Across

1 photosynthesis

4 biosphere

5 deforestation

8 saprobiotic

11 interspecific

12 biome

13 hydrogen sulphide

16 extra cellular

18 rocks

20 sulphur dioxide

21 sere

23 natality

24 combustion

25 population

Further resources

<http://www.practicalbiology.org>
the carbon and nitrogen cycle

<http://www.ibc-et.org/>

<http://www.fi.edu/tfi/usa>
– US-based site offering resources for ecology

<http://www.un.org/esa/population/>
statistics, data and resources

Answers to end of unit crossword puzzle

Across

- 1 photosynthesis
- 4 biosphere
- 5 deforestation
- 8 saprobiotic
- 11 interspecific
- 12 biome
- 13 hydrogen sulphide
- 16 extra cellular
- 18 rocks
- 20 sulphur dioxide
- 21 sere
- 23 natality
- 24 combustion
- 25 population

Down

- 2 tropical rain forest
- 3 biotic
- 5 denitrifying
- 6 redox
- 7 pioneer species
- 9 biodiversity
- 10 habitats
- 14 decomposers
- 15 respiration
- 16 exponential
- 17 root nodules
- 19 succession
- 22 tundra
- 24 climax

Further resources

<http://www.practicalbiology.org/area-index-pages/environment/> – activities on the carbon and nitrogen cycles

<http://www.ibc-et.org/> – Ethiopian Institute of Biodiversity Conservation

<http://www.fi.edu/tfi/units/life/habitat/habitat.html> – the Franklin Institute – US-based site offering resources and activities related to biomes, habitats and ecology

<http://www.un.org/esa/population/> – United Nations population division, with statistics, data and resources on human populations

Answers to review questions

1. B
2. D
3. D
4. C
5. D
6. D
7. D
8. B
9. C
10. A

This section should fill approximately **6 periods** of teaching time.

3.2 Molecular genetics

Learning competencies

By the end of this section students should be able to:

- Describe the structure of a chromosome.
- Describe in detail the structure of the DNA molecule.
- Name the four nucleotides that build up the DNA molecule.
- Construct a model of DNA showing the base pair between complementary nucleotides.
- Describe the semi-conservative replication of DNA.
- Describe the significance of some of the uses of gene technology in forensic science (such as genetic fingerprinting).
- Describe how genetic fingerprints are produced.
- Define and give examples of cloning.
- Understand that genes can be cloned and explain in outline how this is achieved.
- describe, in outline, the procedures involved in genetic engineering and appreciate that whilst there are many advantages that result from the process, there are also some ethical concerns about some of the procedures.

Starting off

Again, some of this work will be a revision of material that the students covered in grade 10, but it is probably best to assume that only the basics have been memorised and to recap virtually all of that material before progressing.

The Students' Book begins unit 3 with an outline of the relationship between chromosomes, genes and DNA. This section begins with a slightly more detailed presentation of that topic. Get the students to recap their knowledge of globular proteins at the outset. Then they will be ready to appreciate just how DNA becomes wound round histone molecules to form nucleosomes. It is then probably sufficient to explain that these form sections of chromatin known as 'beads on a string', which become progressively compacted as the chromatin condenses to form a visible metaphase chromosome.

The activity of genes should be linked to the degree of condensing; genes are most active in the uncondensed chromatin and least active in the most condensed chromatin. If more detail is required, the diagram below can be used to extend the

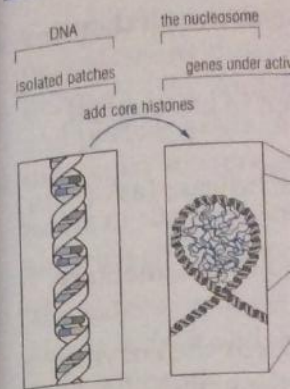


Figure 3.1

This would be an appropriate activity for eukaryotic DNA.

The basic structure of DNA should be familiar to students, but it will not hurt to review the rule, but it will not hurt to review the concept of antiparallelism once they have grasped the concept of antiparallelism. sufficient detail for the purpose of this activity.

Make sure that the students understand the structure of a DNA molecule of DNA.

The practical opportunity for students to work with DNA is explained in full in the next section reproduced here for reference.

Carry out the following activities:

1. Mix together the DNA extract and the restriction enzyme (try to produce a mixture is called a restriction digest).
2. Blend the chunky DNA extract with the restriction enzyme.
3. Add the extract to the agarose gel.
4. Set up your water bath at 100°C.
5. Stand the banana DNA extract in the water bath at the temperature of 100°C.
6. Remove the banana DNA extract from the water bath and pass it through a fine sieve or cloth to remove the greenish liquid.
7. Half fill a test tube with the banana DNA extract.
8. Pour the ice-cold ethanol into the test tube to form a transparent dense layer.
9. Where the two liquids meet, the DNA will precipitate out of the mixture, will p...
10. Remove the DNA from the Petri dish lid and place it in a test tube.
11. Test the DNA for the presence of sugar and phosphate groups.

How can gene technology be used in forensic science?

SA	Students examine the difference between conventional fingerprinting and genetic fingerprinting.	
MA	The process of genetic fingerprinting should be discussed and students could then be given a partially labelled diagram to complete and a table to complete, such as the one below, to reinforce understanding by applying the information in a slightly different way.	
	What must happen?	How is it done?
	DNA must be extracted	
	Fragments of DNA must be separated	
	Separated strands of DNA transferred to a membrane	
	Strands must be made radioactive	
	Positions of strands must be shown	
CA	Students debate the ethical and moral considerations of using gene technology.	

Answers to review questions

1. C
2. B
3. A
4. A
5. C
6. A
7. D
8. D

3.3 Protein synthesis**Learning competencies**

By the end of this section students should be able to:

- Describe how the flow of information in a cell starts from the code on DNA and ends with proteins being synthesised.
- Understand the nature of the genetic code.
- Describe the roles of DNA, mRNA, tRNA and ribosomes in protein synthesis and understand the processes of transcription, translation and gene expression.
- Understand that protein synthesis depends on having a supply of amino acids which, in animals, come from the food they eat.
- Understand the different roles proteins have in cells and in the body.

This section should fill approximately **5 periods** of teaching time.

Starting off

It is as well at the outset to give students an overview of the whole process of protein synthesis. In the Students' Book, figure 3.45 and the accompanying

What happens to the proteins synthesised?

SA	Students recall some of the functions of proteins. In particular, that nearly all enzymes are proteins.
MA	Students recall that all metabolic pathways are controlled by enzymes. Students research metabolic pathways to show how enzymes are involved in: - controlling pathways such as respiration and photosynthesis - controlling the manufacture of structural proteins such as haemoglobin. Students produce charts to show the flow of information in a cell leading to the activation of specific metabolic pathways. They could follow the general format: Gene → mRNA → protein → catalyses reaction → product/stage in metabolic process activated
CA	Class to review protein synthesis from gene through to product formed.

What controls gene expression?

SA	Tell students that all their cells have the gene that determines their eye colour. So why aren't their toes the same colour?
MA	Question and answer to establish the concepts of activating genes and inhibiting genes. Class to discuss transcription factors and gene silencing as methods whereby this is achieved. Students make notes.
CA	Student produce a small display on how gene silencing might cure AIDS or cancer.

Answers to review questions

1. B
2. D
3. D
4. A
5. B
7. C
8. D
9. D
10. D

3.4 Mutations**Learning competencies**

By the end of this section students should be able to:

- Explain what is meant by the term mutation.
- Describe some of the different types of mutations.
- Describe and explain some of the causes of mutations.
- State the spontaneity of a mutation.
- Describe and explain some of the consequences of mutations.
- Give examples of inheritable mutations.

This section should fill approximately **5 periods** of teaching time.

What about chromosome mutations?

SA	Students recall that mutations are any alterations in the DNA and explain that this can involve whole chromosomes or sections of chromosomes.
MA	Students learn that many of the errors that occur to give rise to point mutations (inversions, deletions, duplications) can also occur on a larger scale. Class to discuss the impact of these chromosomal mutations and students make notes.
CA	Class to review all types of mutations.

Mutations: summary

SA	Students suggest, discuss and agree on single sentence definitions of the different types of mutations they have learnt about and these are written up at the front of the classroom.
MA	Students complete activity 3.14.
CA	Students present their posters to the class with brief explanations.

Answers to review questions

1. C
2. C
3. D
4. D
5. A

Answers to end of unit questions

1. a) The DNA molecule is:
 - double stranded
 - arranged in a double helix
 - each strand made of nucleotides
 - nucleotide made of sugar, base and phosphate
 - two strands joined by hydrogen bonds
 - complementary base pairing of A-T and C-G
 - link between phosphate and sugar in nucleotides in a strand

Note: all need to be clearly labelled if only a diagram is used.
- b) Three of:
 - mRNA is shorter than DNA
 - mRNA is single stranded whereas DNA is double stranded
 - mRNA contains uracil whereas DNA contains thymine
 - mRNA contains ribose whereas DNA contains deoxyribose
- c) Two of:
 - tRNA is looped/hairpin shape whereas mRNA is straight
 - tRNA has base pairing whereas mRNA does not
 - tRNA has an amino acid attachment site whereas mRNA does not

2. a) UAA GG
Perfectly
- b) i) Delet
base
ii) Addi
3. a) Four of:
DNA s
free RN
assembl
comple
by RNA
Ignore n
- b) In a pro
transcr
transcr
no pos
4. a) A gene
specifi
An all
Domin
- b) Breed
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5. a) Four
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evid
- b) Four
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2. a) UAA GGG CGA UUU GUC

Perfectly correct = 2 marks, 1 error = 1 mark.

b) i) Deletion removes a base from a sequence (sequence redrawn with a base missing).

ii) Addition adds a base to a sequence (sequence redrawn with base added).

3. a) Four of:

DNA strands in region of gene separate/unzip
free RNA nucleotides used

assembled into a strand

complementary to sequence on DNA

by RNA polymerase

Ignore references to post-transcriptional modification.

b) In a prokaryotic cell:

transcription and translation are coupled

transcription takes place in cytoplasm

no post-transcriptional modification occurs

4. a) A gene is a section of DNA that codes for a specific protein/determines a specific feature.

An allele is a specific 'version' of a gene.

Dominant refers to an allele that is expressed in the heterozygote.

b) Breed the plant with a white-flowered plant.

If the parent plants were homozygous for white alleles, the offspring would be pp.

If the parent plants were homozygous – all offspring Pp.

If parent plant was heterozygous, some/half of the offspring would be Pp and some would be pp.

5. a) Four of:

controlled by a pair of alleles

'black' allele and 'white' allele

show incomplete dominance

evidence – when black and white alleles together, get blue

evidence – crossing two blues/heterozygotes gives 1:2:1 ratio

b) Four of:

blue and white offspring

1 : 1 ratio

Parents	Bb	x	bb
Gametes	B	b	b
Offspring	Bb		bb

6. a) i) All affected individuals are male; it skips a generation.

ii) Two of:

two unaffected parents can produce an affected child
so parents carry the allele but do not express it
not possible if allele is dominant
only possible if allele is recessive

- b) Any of: 4, 8, 9, 10, 23, 25, 26

Plus two marks for suitable logic:

either

father was affected

must pass his affected X chromosome to daughter

or

son is affected

must have inherited affected X chromosome from mother

- c) Sons – X^bY

All X chromosomes of parents are X^b /are affected

Daughters X^bX^b

All X chromosomes of parents are affected so must inherit two affected X chromosomes

7. a) Prophase – chromosomes condense and crossing over occurs
nuclear membrane disappears and spindle forms.

Metaphase – homologous chromosomes align opposite each other.

Anaphase – homologous chromosome pulled to opposite poles.

Telophase – two haploid nuclei form at the poles.

- b) i) If not linked:

would expect a 1:1:1:1 ratio

due to independent assortment of alleles

four gametes possible in heterozygote/Cs Cs cs cs possible

only one gamete from homozygous recessive/cs

If linked:

two gametes from heterozygote/Cs cs

still only one type from homozygous recessive / cs

only two types predicted coloured smooth and colourless wrinkled
other types are recombinants

- ii) Parents

Gametes

Offspring

50% c

8. a) i) Low level
then sudden

continues

with diploid

- ii) Mutation

as some re

sharp increase

in 1993 (s

gives resistance

survive and

- b) Conjugation

Transduction

Transformation

9. a) Incubate DNA
the fragment

transfer the f

prepare a radio

called a DNA

- b) Yes. All the f

Mary, some

child.

10. a) i) 153/156;

ii) Gene for

ribosome

- b) i) A gene is

extracted

enzymes

bacteria.

- ii) Any two sui

point) and s

ii) Parents	CScs	x	CScs
Gametes	CS	cs	CS
Offspring	CSCS	CScs	CScs
	50% coloured smooth	50% colourless wrinkled	

8. a) i) Low level until 1994
then sudden/sharp/great increase
continues to remain high/to increase slowly/steadily
with dip in 1997-1998
- ii) Mutation giving resistance always present/occurs several times
as some resistant bacteria always present
sharp increase in use of penicillin
in 1993 (some time just before sharp increase in numbers)
gives resistant types a survival/selective advantage
survive and reproduce in greater numbers than others
- b) Conjugation
Transduction
Transformation
9. a) Incubate DNA with a restriction enzyme to cut it into fragments; separate the fragments by gel electrophoresis; carry out Southern blotting to transfer the fragments to a membrane; add a radioactive DNA probe; prepare a radiograph of the membrane. This reveals a pattern of fragments called a DNA fingerprint.
- b) Yes. All the fragments in the child's fingerprint are common with Larry or Mary, some are only found in Larry; some of Bob's are not found in the child.
10. a) i) 153/156; 3 bases per amino acid/3 bases per amino acid plus stop code.
- ii) Gene for insulin is transcribed to give mRNA, which travels to ribosomes and is translated to insulin protein/polypeptide.
- b) i) A gene is cut from DNA using restriction enzymes; plasmids are extracted from bacteria and cut open with the same restriction enzymes; the plasmids have sticky ends; the plasmids inserted into bacteria.
- ii) Any two suitable concerns (use the list in the Students' Book as starting point) and suitable methods of addressing these concerns.

Evolution

Learning competencies

By the end of this lesson, you should be able to:

- Explain what is meant by 'evolution'.
- Describe and explain the origin of life and the generation of biochemical diversity.
- Describe some of the evidence for evolution, including the fossil record.
- Appreciate the role of natural selection in evolution.
- Appreciate the role of genetic drift in evolution.
- Describe the role of mutation in evolution.
- Describe the role of gene flow in evolution.
- Compare the role of natural selection and genetic drift in evolution.
- Explain how natural selection has modified the environment.
- State the need for a common ancestor in evolution.
- Explain how the fossil record supports the theory of evolution (the fossil record is comparative).
- Describe examples of evolution.
- Define natural selection.
- Explain the role of natural selection, speciation, and evolution.
- List, describe, and explain natural selection.
- Explain how natural selection works.
- Construct a phylogenetic tree.
- Explain the role of phylogenetic trees in evolution.
- Discuss some of the challenges to the theory of evolution.

Unit 4: Evolution

CA	Students examine that modern 'weak panspermia' theories have some evidence to back them: many eminent scientists believe that organic molecules could have arrived with comets.
How does the biochemical theory seek to explain the origin of life on earth?	
SA	Question and answer to establish that for life to originate in this way: • appropriate organic molecules would need to be formed • these would need to come together in some cell-like structure • the structure would need to be capable of reproduction.
MA	Students study the essentials of the Oparin/Haldane hypothesis and Miller's experiments providing supporting evidence.
CA	Carry out activity: Class discussion 'The origin of life'.
How did autotrophs evolve on the earth?	
SA	Students review what autotrophs are and explain the different types of autotrophs (photo-autotrophs, chemo-autotrophs).
MA	Students discuss with the students the likely evolution of the major groups of organisms using figure 4.13 and the text as a basis. Students make notes.
CA	Activities 4.3 and 4.4 – Debating and class discussion on the origin of life. Because students may have diverse religious backgrounds these must be handled sensitively, the students must respect each others' opinions. Some notes on the aims behind these activities are given in the teaching notes; the teacher must manage the debate carefully and sensitively, and with a keen respect for students' backgrounds.

Answers to review questions

1. D 6. A
2. C 7. D
3. D 8. D
4. B 9. D
5. D 10. D

This section should fill approximately **5 periods** of teaching time.

4.2 Theories of evolution

Learning competencies

By the end of this section students should be able to:

- Appreciate that there have been several attempts to explain how evolution takes place.
- Describe the theory proposed by Jean-Baptiste Lamarck.
- Describe the theory proposed by Charles Darwin.
- Compare these two theories.
- Explain how our knowledge of genetics, behaviour and molecular biology has modified Darwin's ideas into a form called neo-Darwinism.
- State the neo-Darwinian ideas of evolution

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Analys

Breeding and natural selection

SA	Students discuss in pairs what they remember about breeding from earlier in the course.
MA	Students move into small groups and complete activity 4.5.
CA	Students present their lists to the rest of the class and discuss.

What is neo-Darwinism?

SA	Students recap Darwin's theory, especially the date and the date of Mendel's publications. Elicit that Darwin could not have known anything about genetics.
MA	Students discuss with the teacher aspects of an organism's phenotype other than physical features that might give it a survival advantage. Let the students then discuss that all these features are determined by genes. This then should lead to an appreciation of a modification of Darwin's theory that selects for advantageous genes/alleles.
CA	Students produce flow chart to show how natural selection alters gene frequencies.

Answers to review questions

1. C 6. D
2. C 7. D
3. D 8. A
4. C 9. D
5. D 10. C

4.3 The evidence for evolution**Learning competencies**

By the end of this section students should be able to:

- Explain how the following support the theory of evolution: palaeontology (the fossil record), comparative anatomy, comparative embryology, comparative biochemistry, plant and animal breeding experiments.
- Describe examples of each of these types of evidence.

This section should fill approximately **5 periods** of teaching time.

Starting off

To introduce this unit it is a worthwhile exercise to get the students to 'think outside the box' a little. Ask them to think of trying to prove that any event in history (recent or ancient) actually happened. Get them to think about what might constitute supporting evidence.

- Were there any witnesses?
- Is there any artefact surviving that would fit with the event happening; can the artefact be reliably said to have come from that time?
- Is there anything that happens now that could be a consequence of the event and would be less likely to happen if the event had not occurred?

How does palaeontology support the theory of evolution? (2)

SA	Students review the process of fossil formation and analyse the formation of a dinosaur fossil (figure 4.19) to consolidate learning.
MA	Students discuss how fossils can be dated: • Stratigraphy • Radiocarbon dating • Potassium-argon dating Students examine the limitations of each method and how using more than one technique is often necessary.
CA	Students carry out activity on dating fossils.

How do comparative anatomy and embryology support the theory of evolution?

SA	Introduce the concept of homologous structures and class to discuss the likelihood of these structures evolving independently. Also discuss the way in which vertebrate embryos develop can reflect closeness of evolutionary relationship.
MA	Students discuss examples of comparative anatomy (paying special emphasis on pentadactyl limb) and comparative embryology.
CA	Students make notes on both.

How do comparative biochemistry and plant and animal breeding support the theory of evolution?

SA	Question and answer to re-establish that proteins are determined by genes and so the more similar proteins are, the more similar genes must be.
MA	Students discuss with the teacher the techniques of DNA hybridisation and amino acid sequencing as methods of assessing similarities of molecules. Students discuss the dendrograms shown in the text and how they represent evolutionary relationships. Students make notes.
CA	Class to discuss how plant and animal breeding show how the process of evolution could occur (rather than actual hard evidence for its occurrence).

Reviewing the evidence for evolution

SA	Teacher reviews the main lines of evidence with the class and divides the class into five groups.
MA	Students carry out activity 4.8 – The evidence for evolution
CA	Group posters are assembled into a class display.

Answers to review questions

1. B
2. D
3. D
4. D
5. C
6. B
7. A
8. C
9. D
10. C

4.4

4.4 Th

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Answers to review questions

1. D 6. B
2. B 7. C
3. A 8. D
4. A 9. D
5. B 10. A

This section should fill approximately **5 periods** of teaching time.

4.5 The evolution of humans

Learning competencies

By the end of this section students should be able to:

- Explain how humans have evolved.
- Construct an evolutionary tree of human evolution.
- Explain the importance of Lucy and Ardi in the study of human evolution.
- Discuss some of the controversies surrounding human evolution.

Starting off

This topic needs to be set in context at the outset. Human evolution needs to be seen not as a separate process from the rest of evolution, but as a continuation of one line of evolution that is not finished simply because we have the ability to recognise that it has happened. Also, students must appreciate that two key events in the evolution of humans have been the increase in size of the brain and the evolution of true bipedalism. These two features, in particular, separate us from other apes and primates.

Teaching notes

It is important at the start to introduce the concept of the 'common ancestor' and for students to appreciate that this term is not exclusive to the common ancestor of chimpanzees and humans. Figure 4.39 should help with this.

Next, we jump straight into the idea of 'other humans before us'. Students should realise that if a fossil can be classified as belonging to the genus '*Homo*' then it is some kind of human. There is scope here for students to research the main *Homo* species that existed before us and make displays of the main features of each one. It is probably best to limit this to *H. habilis*, *H. erectus* and *H. neanderthalensis*.

The significance of Lucy in establishing that bipedalism evolved before brain size had increased significantly is discussed in the Students' Book, as is the significance of Ardi, the most recently discovered fossil human, in establishing that the common ancestor of humans and chimpanzees was also probably bipedal. This means considerable rethinking of earlier ideas that the common ancestor was more like a chimpanzee than a human. A bipedal common ancestor has clearly evolved along two different lines with both lines showing significant change.

Apes to humans

SA	Students review the evolutionary line that led from apes to humans.
MA	Students prepare to carry out activity 4.10 'Apes to humans' to understand and that mankind has evolved alongside other great apes. In this period, they research their assigned topic and begin to prepare their presentations. Some useful websites are given in the textbook as starters, but expect students to go beyond these.
CA	Teacher reviews progress and advises on what must be completed for next lesson.

Apes to humans

SA	Remind students of the protocol for presentations.
MA	Groups make their presentations. Allow the others to question each group about details for a few minutes.
CA	Teacher reviews the presentations and the topic of human evolution.

Answers to review questions

1. C 7. D
2. C 8. D
3. B 9. D
4. D 10. C
5. C

Answers to end of unit questions

1. Allow any suitable points. Those given are examples only.

Theory	Point(s) in favour of theory	Point(s) against theory
Special creation	Does not require proof of feasibility	Cannot be proved or disproved
Spontaneous generation	Accounted for observable facts before scientific method	Experiments have disproved this theory
Eternity of life	Does not require any special creation	Cannot be proved or disproved
Cosmic origin	Some evidence for biological molecules in meteorites	Presence of these molecules does not account for origin of life
Biochemical	Shows all the major steps to creating cells from materials in Earth's atmosphere are possible	Requires a large number of chance events to take place

2. a) i) Evolution – genetic change in a population over time, leading to the formation of new species.
ii) Convergent evolution – evolution of functionally similar structures in different organisms/that develop differently.

iii) Divergent evolution – evolution of functionally different structures/ types from one common structure/type.

b) provides evidence of life in the past; can show how forms have changed over geological time; can be dated.

3. a)

Aspect of evolution	Lamarck's explanation	Darwin's explanation
How differences emerge	Through use and disuse	Variation occurs naturally in the population
Inheritance of features	Acquired features inherited	Those with advantageous traits survive in greater numbers
Why certain types survive	Development of new feature in order to survive	Natural selection acts in favour of the best adapted

b) Neo-Darwinism takes account of: genetics of an individual, including mutations; population genetics/gene pool; behavioural traits/ethology.

4. a) i) Two distinct ranges of numbers of nettle hairs; offspring numbers of hairs the same as parents; suggests a controlling allele being passed on.

ii) In areas where deer graze, more stinging hairs confers a selective advantage; these plants reproduce in greater numbers; advantageous alleles passed on in greater numbers; increase in frequency of advantageous alleles; increase in frequency of individuals with more stinging hairs.

b) Interbreeding is still possible; there is no reproductive isolation; differences cannot accumulate.

5. a)

Section	Selection pressure	Best-adapted type	Marks
(i)	Hunting by lions	Fastest runners	2
(ii)	Use of penicillin	Resistant types	2
(iii)	Low light intensity	Largest leaved types	2

b) i) Both involve an isolating mechanism; to prevent mixing of genes/ alleles/mutations.

ii) Allopatric involves geographic isolation; sympatric involves temporal/ seasonal/behavioural isolation.

6. a) Group of similar organisms, which can interbreed to produce fertile offspring.

b) i) Mutation that was not harmful, so retained in population.

ii) Breed king cheetahs with ordinary cheetahs; breed their offspring with other cheetahs; if they produce offspring, then they are fertile, so the king cheetah is the same species as the other cheetahs.

7. a) Completely correct = 4 marks
Deduct one mark per error.
- b) It is part of the electron transport chain in respiration, so is present in most organisms.
- c) DNA hybridisation provides a measure of the similarity of two types of DNA because hybridisation only occurs in regions where the base sequences are complementary; more hybridisation means more similarity between the types of DNA; DNA determines all traits, so the more similar the DNA, the more traits in common, so more closely related.

8. a)

Aspect of speciation	Marking points	Marks
Isolation of populations	Prevents interbreeding Allows genetic differences to build up Exposes to different selection pressures	3
Mutation	Produces new genes Produces new traits	2
Selection pressures	Select for specific traits/alleles Different in different areas Change in population over time	2(max)
Reproductive isolation	If cannot interbreed then are different species	1

- b) Increase in body hair traps a layer of warm air near to surface of skin; shorter squatter shape reduces surface area/volume ratio; increased layer of adipose tissue beneath skin reduces heat loss.
9. a) Both carried out controlled experiments; isolating the independent and dependent variables; controlling other variables.
Up to two marks for a description of Redi's experiment.
Up to two marks for a description of Pasteur's experiment.
- b) i) Life is created from inorganic molecules existing in the Earth's primitive atmosphere using electrical energy from lightning; first creating organic molecules such as amino acids/lipids/sugars; these dissolve in the water and form pre-biotic soup; some molecules form pre-cells/coacervates and evolve into cells.
- ii) Results of Miller's experiment – formation of sugars/amino acids; spontaneous formation of coacervates; polymerisation has been shown to be possible.

10. Award marks i

Category

Breadth

Relevance

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Biological acc

Answers to e

Across

- 1 isolating
- 3 neo-darwinis
- 5 eternity of life
- 7 oparin
- 12 palaeontolog
- 16 special creati
- 21 stratigraphy
- 22 lamarck
- 23 cosmozoan
- 24 homo sapien

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10. Award marks in the following categories:

Unit 4: Evolution

Category	Marks	Descriptors
Breadth	0–2	Student involves all the main aspects of the topic in reasonable detail
Relevance	0–2	Student does not bring in irrelevant material, although some extra, related, biology is acceptable
Communication	0–2	Essay is well written and logically presented, making good use of scientific vocabulary
Biological accuracy	0–5	Biological content is not at the required level and may contain significant misconceptions
	6–10	Biological content is essentially correct and of an acceptable standard although there may be an occasional slight error
	11–15	Essay is of a high standard with no significant errors

Answers to end of unit crossword puzzle

Across

- 1 isolating
- 3 neo-darwinism
- 5 eternity of life
- 7 oparin
- 12 palaeontology
- 16 special creationism
- 21 stratigraphy
- 22 lamarck
- 23 cosmozoan
- 24 homo sapiens

Down

- 2 spontaneous generation
- 3 natural selection
- 4 convergent
- 6 lucy
- 8 ardi
- 9 adaptive radiation
- 10 biochemistry
- 11 intelligent design
- 13 homologous
- 14 directional
- 15 speciation
- 17 coacervation
- 18 embryology
- 19 evolution
- 20 genepool

Further resources

- <http://www.practicalbiology.org/area-index-pages/evolution/> – resources for modelling natural selection
- http://www.christs.cam.ac.uk/darwin200/pages/index.php?page_id=k4 – collection of information and resources on Darwin
- <http://evolution.berkeley.edu/> – large collection of resources, lesson plans, news stories and videos on evolution
- <http://www.biomedcentral.com/bmcevolbiol/> – open access journal with peer-reviewed articles on evolution

How do plants and simple animals respond to stimuli?

SA	Question and answer to establish a range of plant responses (such as the responses of shoots and roots to light and to gravity). Also, get the students to give some examples of behaviour by small invertebrates. Classify these as: • kinesis – responses to changes in intensity of a stimulus that lead to a change in the rate of movement • taxis – responses to changes in direction of a stimulus that lead to a change in the direction of the response.
MA	Students discuss the mechanisms of: • phototropism • photo-kinesis in woodlice. Students explain these by making behaviour flow diagram models in their notes detailing the components involved in each. Students carry out activity 5.1 and activity 5.3, if time.
CA	Students write up activities 5.1 and 5.3. Class reviews examples of non-human behaviour and how they also fit the behaviour flow diagram model.
Why is it important to study behaviour?	
SA	Ask students the question 'Why should we bother to study behaviour in other organisms?' Try to elicit as many reasons as possible.
MA	Students research reasons for studying behaviour in other organisms and make a display.
CA	Class reviews reasons for studying behaviour in non-human organisms.

Answers to review questions

1. D
2. C
3. D
4. C
5. D

This section should fill approximately **5 periods** of teaching time.

5.2 Innate behaviour**Learning competencies**

By the end of this section students should be able to:

- Explain what is meant by innate behaviour.
- Describe and explain the characteristics of innate behaviour.
- Describe and give examples of different types of innate behaviour.
- Describe reflex behaviour in humans.
- Describe instinctive behaviour in non-human animals.
- Describe and explain biological clocks in non-human animals.

Unit 5: Behaviour

MA

List the key features of all instinctive behaviours; students make notes. Students analyse the examples of instinctive behaviour given in the textbook to discover the key stimulus, innate releasing mechanism and the fixed action pattern response. Students research three other examples of instinctive behaviour and summarise them in a table like the one below.

Example of instinctive behaviour	Key stimulus	Fixed action pattern response	How the behaviour is adaptive
1.			
2.			
3.			

CA

Class reviews the features of instinctive behaviour.

Innate and instinctive behaviour; review

SA

Students discuss key features of instinctive and innate behaviours; list them at the front of the class.

MA

Students split into groups and prepare a poster presentation comparing instinctive and innate behaviours.

CA

Students highlight key features of their posters to the rest of the class and display them around the classroom.

Answers to review questions

1. C 6. B
2. B 7. D
3. A 8. B
4. D 9. D
5. C 10. D

This section should fill approximately **10 periods** of teaching time.

5.3 Learned behaviour

Learning competencies

By the end of this section students should be able to:

- List the different types of learned behaviour.
- Explain how the learning process takes place in each type.
- Describe examples of each type of learning (habituation, classical conditioning, operant conditioning, imprinting, insight learning and latent learning).
- Compare innate and learned behaviour patterns.

Answers to review questions

1. A
2. D
3. C
4. D
5. C
6. D
7. C
8. B
9. C
10. D

5.4 Examples of behaviour patterns

Learning competencies

By the end of this section students should be able to:

- Describe and explain courtship, territorial and social patterns of behaviour.
- Give examples of each type of behaviour.

This section should fill approximately **7 periods** of teaching time.

Teaching notes

The three types of behaviour are discussed in some detail in the Students' Book together with illustrative examples.

Courtship behaviour is likely to be associated with elaborate ritual in the students' minds. Discuss the generally accepted definition of courtship behaviour with them – *courtship behaviour is any activity that precedes and results in mating and reproduction* – before discussing other, simpler examples of courtship behaviour that clearly fit this definition.

It is worth pointing out that, often, seemingly elaborate courtship behaviour consists of a set of fixed action patterns in which one FAP response by one animal becomes the key stimulus for another FAP in the courtship behaviour by the other organism. This is illustrated by the courtship behaviour in zebra fish, shown in figure 5.26 and analysed in figure 5.27.

Territorial behaviour will be appreciated by the students as a means of defending a territory. However, it should be pointed out that it also includes actually defining the territory. Possessing a territory has several advantages to the owner, such as access to foraging areas, mates, nesting areas, etc., that a non-owner would not have.

The Students' Book does not differentiate between different types of territories, for example, between those used for foraging, mating and rearing compared with those just used for mating. A good account of different types of territory (together with examples of associated behaviour) can be found at:

<http://people.eku.edu/ritchisong/birdterritories.html>

Students should appreciate that territorial defence expends a great deal of energy on the part of the owner and this is a measure of the benefit of owning a territory. They should also appreciate that, through natural selection, defence of a territory has been reduced to rituals that replace actual fighting and are ended as soon as one animal retreats. This is adaptive, as it reduces energy

Eusocial behaviour in other insects – a research project

Unit 5: Behaviour

Students discuss with the teacher other examples of social insects – any of the ones below would make suitable examples.		
Insect	Specifics	Example Species
Ants	All ants are eusocial. They have morphologically distinct workers and queens. In some ants, the workers do not even have ovaries. Other workers can lay male eggs.	Fire ants, <i>Solenopsis invicta</i> Pharaohs ants, <i>Monomorium minimum</i> Carpenter ants, <i>Camponotus</i> <i>Pseudomyrmex</i> in acacia galls Leaf-cutter ants, <i>Atta</i>
Bees	Many bees are not social at all.	Sweatbees, <i>Lasioglossum</i> Bumblebees, <i>Bombus</i> Honeybees, <i>Apis mellifera</i> Carpenter bees, <i>Xylocopa</i>
Wasps	Some wasps are eusocial, but many are not.	Paper wasps, <i>Polistes</i> Yellowjackets, <i>Vespula</i> Stenogastrine wasps Tropical wasps, <i>Epiponines</i> , <i>Polybia</i>
Termites	All termites are social. They have male and female workers and, unlike most social insects, are diploid rather than haplodiploid. Often they have a king and a queen.	
Aphids and thrips	Some aphids and thrips are eusocial. When they form a gall, some soldiers will not reproduce. This form of eusociality tends to be restricted to a few soldiers, because the sterile forms only defend and do not care for the young.	
MA	Students research one of the social insects and make a display.	
CA	Class reviews displays.	

Answers to review questions

1. D
2. D
3. D
4. D
5. C
6. A
7. C
8. D
9. C
10. B

Answers to end of unit questions

1. a) Co-ordinated response to change in external or internal conditions (plus two suitable examples).
b) Three of:
impact on human society
impact on neurosciences
impact on environment/resource management
impact on animal welfare
impact on science education
three marks for examples + three for suitable qualifications
2. a) Two suitable examples of somatic reflexes, and two suitable examples of autonomic reflexes.
b) i) They are both automatic/do not involve conscious thought; they are both actioned by reflex arcs.
ii) Origin of stimulus (external/internal); nature of effector (skeletal muscle/internal organ).
3. a) i) The orange spot on the beak stimulates FAP.
ii) Pecking is carried out in response to the orange spot/key stimulus.
b) i) At the start, 50% pecking of both models; the herring gull pecking increases with time in the nest; the laughing gull pecking decreases with time in nest, more sharply after 4 days.
ii) No initial learning is required; fully functional on hatching.
iii) Herring gull pecking increases; have associated this with experience in nest (pecking at real herring gull gives food).
4. a) Operant conditioning/shaping: correct behaviour is rewarded/reinforced.
b) Habituation: response to harmless stimulus is diminished.
c) Sensitisation: reduced stimulation produces same response.
d) Habituation: response to a harmless stimulation is reduced.
e) Latent learning: skill is acquired without reinforcement.
5. a) Access to food/foraging; access to mates; defence against predators (each one further qualified).
b) Marking a territory; vocalisations; ritual displays; ritual fighting.
6. a) First set up a box to deliver food on any press of a lever; this establishes pressing behaviour; then food is delivered with any light flashing; associates food with light; then food is delivered with only the red light flashing; electric shock given when green light flashes; teaches discrimination between lights.
b) Any aspect of behaviour that is represented in final behaviour is rewarded; then only more closely matching behaviours are rewarded; successive approximations become more precise (with two suitable examples).

7. (i) No as not i
- b) i) Insig
- ii) Insig

8. Award mar

Category

Breadth

Relevance

Commun

Biologic
accurac

Answer

Across

- 1 insight
- 3 reflex
- 6 learned
- 8 latent
- 10 classifi
- 11 recep
- 13 circa
- 14 insti
- 16 cour
- 17 beha
- 18 stim
- 20 hab
- 21 pho
- 22 eth

Grade