

The science of biology

Unit 1

Learning competencies for Unit 1

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

- Define science as a way of knowledge and explain it as a way of looking at and thinking about natural events.
- Describe and explain the main steps that scientists follow when they are investigating something.
- Demonstrate scientific methods by narrating how Louis Pasteur and Alexander Fleming used the scientific method to solve problems.
- Plan and conduct an experiment to investigate a particular observation.
- Write a report for a scientific experiment.
- Name and describe the function of the main pieces of apparatus that are used by biologists the world over.
- Describe how these pieces of apparatus work.
- Explain how, and under what circumstances, these pieces of apparatus would be used and demonstrate the use of some of them.
- Classify the apparatus as laboratory tools, field tools or both.
- Be aware of possible health and safety implications of using these tools.
- Explain how biological science is relevant to food production, health and disease, conservation, and control of the population.
- Explain the promise of biology in relation to genetic engineering and biotechnology.
- Explain how biologists are actively involved in the fight against AIDS.
- Describe how you can help community efforts to control AIDS.
- Describe the decisions you will need to take to help control AIDS.

This unit should fill approximately **29 periods** of teaching time.

1.1 The methods of science

Learning competencies

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

- Define science as a way of knowledge and explain it as a way of looking at and thinking about natural events.
- Describe and explain the main steps that scientists follow when they are investigating something.
- Demonstrate scientific methods by narrating how Louis Pasteur and Alexander Fleming used the scientific method to solve problems.
- Plan and conduct an experiment to investigate a particular observation.
- Write a report for a scientific experiment.

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

The nature of biology as a science

Starting off

The first section will help to establish that biology is a science and that biology and other sciences constitute an objective and logical attempt to understand the natural universe, based on observation leading to suggestions, or hypotheses, that are testable by experiment. Students will also learn that good science is an ongoing process of testing, evaluation, re-testing and re-evaluation. One of the hoped-for benefits of students taking a biology course is that they will become more familiar with the process of science.

Teaching notes

In this short theme, students should be made aware of the scope of biology. Many students have only a hazy view of the work of biologists. The examples in the book are deliberately chosen to challenge this limited view. There are many other examples, of course, and students could be encouraged to research the topic and make a display of the scope of biology.

This library search can be backed up by reference to internet sources. Please see the Further Resources section.

SA = starter activity MA = main activity CA = concluding activity	
What is the science of biology? (Activity 1.1)	
SA	Students tackle activity 1.1 to work out what they understand science and the work of scientists to be: the teacher should read out the text of the activity and encourage responses from the class.
MA	Students discuss the scope of biology and make a display of the work of biologists, incorporating some fairly 'standard' occupations and other less well appreciated ones. They will need to research this, or discuss it first.
CA	Class to compare presentations to get an overall 'feel' for the work of biologists.
What is science?	
SA	Students describe the work of Gregor Mendel, Isaac Newton (and other well-known scientists if desired).
MA	Students find common elements in their very different work. Use this to introduce the concept of the 'scientific method'.
CA	Students could also make a display or write a short essay illustrating the common elements in scientific research.
What is the scientific method?	
SA	Students discuss with the teacher the key feature behind acceptance of conclusions of scientific research. Try to elucidate the concept that, if it is to be accepted, it must establish cause and effect.
MA	Students discuss with the teacher the problems associated with assuming cause and effect from simple observations; use examples in the textbook and others to illustrate this point. Students discuss with the teacher the main elements of the scientific method as shown in figure 1.1 and table 1.1.



CA	Students carry out extension work to show how they would use the scientific method to investigate one of the problems quoted later in this book. They should include a description of the pattern of results that would support their hypothesis.
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Activities

There are a range of student activities that could be used as a follow-up to the research itself:

- Make a display of their research.
- Make a presentation to give to the rest of the class.
- Carry out a role-play interview in which one student takes the role of an interviewer and another takes the role of a particular biologist, whose work they have researched.
- Write an essay about the scope of biology.
- Present a short lesson to their classmates on the scope of biology.

The scientific method

Starting off

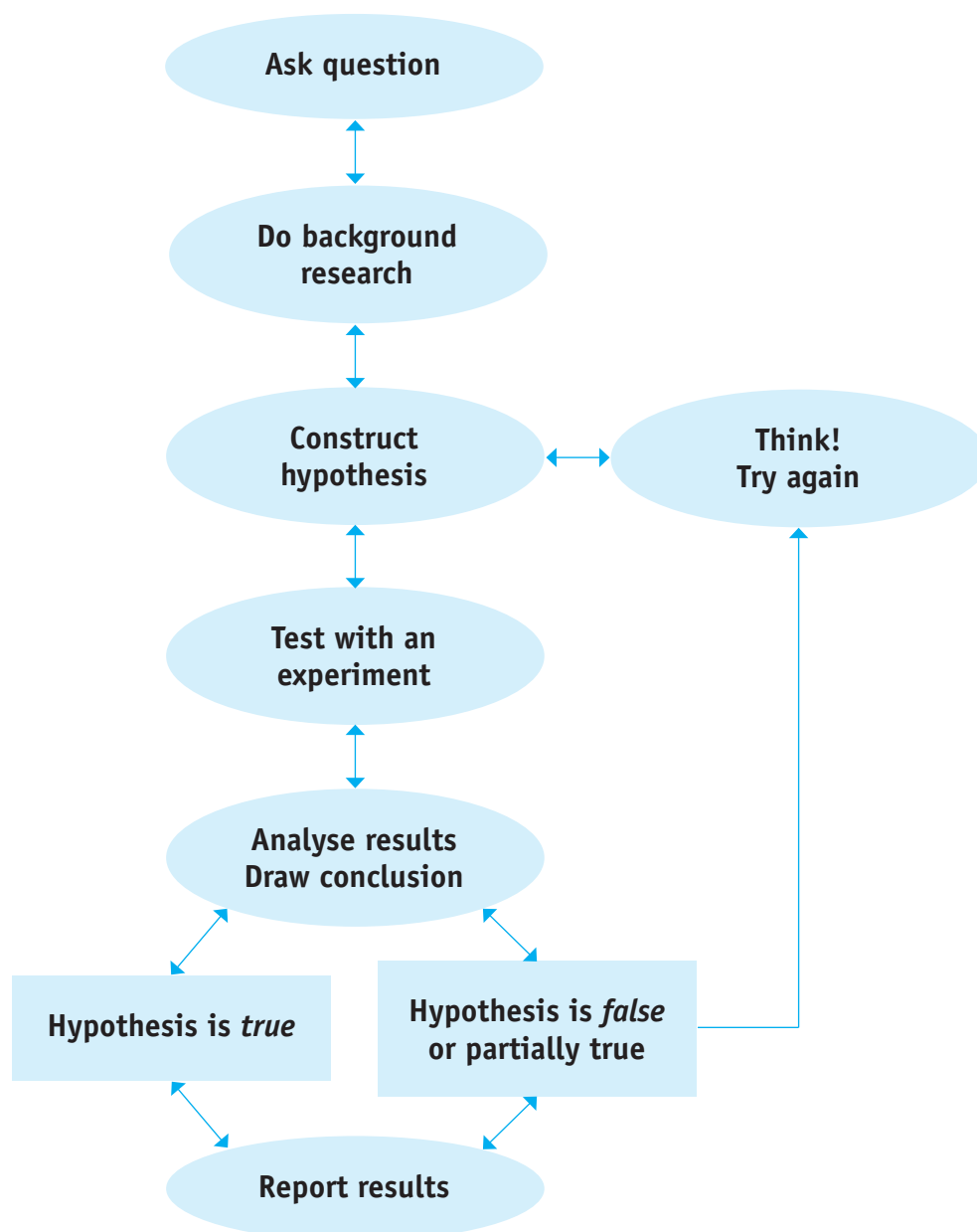
This section sets out to help students appreciate that the ‘scientific method’ is a critical logical approach to problem-solving that yields evidence to prove or disprove a hypothesis. The concept of falsifiability, first proposed by Karl Popper, is a cornerstone of the scientific method and a key way in which science differs from other ways of looking at the world. Science can only accept ideas that are supported by evidence. If an idea is couched in such terms that it can never be proved wrong, science can never accept that it is correct either; this would require an act of faith, which is not part of the scientific way of thinking.

Teaching notes

In this theme students should be made aware of the way in which the scientific method takes an observation and an idea of how to explain the observation (a hypothesis) to the status of an accepted explanation, backed up by evidence that can be confirmed or challenged by further experimentation.

Some historical background is given showing how, before the scientific method, ideas that sought to explain naturally occurring phenomena were based on observation and interpretations unsupported by any real evidence. The ‘theory’ of spontaneous generation provides an excellent example as it shows how the original idea was eventually disproved by successively more sophisticated experiments, culminating in the landmark investigations by Louis Pasteur.





The flowchart given in the Students' Book illustrates the main steps of the process. Students should discuss the various steps to gain a clear understanding of why each step is core to the whole process.

The book takes students through the various stages using the concrete example of 'Why do tomato seeds not grow inside the tomatoes?'. This is an easy-to-understand problem and one that can be carried out by students using a minimum of equipment. It can also be extended to investigate whether or not this phenomenon is true of other fruits and, if so, is it the same chemical involved in all cases. If this is the case, tomato extract should inhibit the germination of melon seeds or oat seeds. Students can form their own hypotheses for these experiments before carrying them out.

Students can also be given examples of problems and be asked how they would investigate them using the scientific method.

SA = starter activity MA = main activity CA = concluding activity														
The scientific method and spontaneous generation (Activity 1.2)														
SA	Students revisit the belief that rotting meat <i>produces</i> flies.													
MA	Students design an investigation to establish whether or not this belief is true. Students compare their design with the work of Francesco Redi. Students explain why Redi’s experiment was accepted as proof that rotting meat did not produce flies.													
CA	Students read the account of the work of Louis Pasteur on the souring of wine and complete activity 1.2 in class. This will reinforce their understanding of the scientific method.													
Cause and effect in science (Activity 1.3)														
SA	Students examine what is meant by cause and effect and its importance in scientific investigations. Introduce the terms independent variable and dependent variable.													
MA	Students discuss with the teacher the conditions under which an experiment could show that changes in the independent variable caused changes in the dependent variable. Introduce the concepts of: • controlled variables • confounding variables.													
CA	Students complete Activity 1.3: the teacher should ensure students know how to use a library and other resources to find information. Students research the work of Lazzaro Spallanzani and describe those elements of his work that were: • similar to Pasteur’s work • different from Pasteur’s work. Students explain the way in which Pasteur’s investigation was an improvement on Spallanzani’s investigation.													
Accuracy, reliability and validity (1) (activity 1.5)														
SA	Students write down what they understand by each of the terms.													
MA	Students discuss each concept in turn, using materials presented in the textbook and other examples. Students summarise the concepts in a table, such as the one shown.													
	<table><tr><th>Concept</th><th>Description</th><th>Example</th></tr><tr><td>Accuracy</td><td></td><td></td></tr><tr><td>Reliability</td><td></td><td></td></tr><tr><td>Validity</td><td></td><td></td></tr></table>	Concept	Description	Example	Accuracy			Reliability			Validity			
Concept	Description	Example												
Accuracy														
Reliability														
Validity														
CA	Students choose one example in activity 1.5 and plan an investigation that will establish cause and effect. The teacher should ensure that the students have read and understand the three scenarios and how to write up the investigation – it may help to draw up a sample structure on the board. Encourage the students to plan independently.													
Accuracy, reliability and validity (2) (Activities 1.4 and 1.6)														
SA	Students complete activity 1.4 and discuss their answers.													
MA	Students carry out activity 1.6 in pairs. Ask two or three of the pairs to explain their reasoning to the class and then discuss whether they are right or wrong.													
CA	Students look back at the definitions they made at the beginning of the previous lesson and discuss whether they are still sufficient, and agree on any changes.													

Activities

Suitable examples could include:

- A home wine-maker finds that when she uses the sugar lactose to make wine, the result is not as good as when she uses ordinary sucrose.
(Students could investigate the rate of fermentation of yeast using different sugars.)
- A baker uses different strains of yeast to bake his bread. Not all bakers make bread with a good texture; some is quite 'flat'.
(Students could investigate the rate of fermentation of yeast using different yeasts.)
- The distribution of [plant or small invertebrate around your school] seems to be influenced by [appropriate environmental factor].

(Students could investigate the distribution of the species by either transect or random sampling techniques, as appropriate. In carrying out an ecological investigation, students should realise that they cannot control other factors in the same way as biologists can in the laboratory. However, they can *monitor* these variables so that they can either exclude them from factors influencing the outcome or recognise that they may be exerting some effect.)

In addition, students could research key scientific investigations (other than those given in the book) and show how the scientific method was used in each. They could research:

- Charles Darwin's experiments on phototropism.
- Gregor Mendel's experiments on inheritance in pea plants.

Students could use the pro forma in the appendices to record their plans.

Scientific experiments and writing reports

Starting off

This section sets out to show students that scientific experiments are carried out in such a way as to establish cause and effect between two variables. To do this, other variables must be controlled so that they have no influence on the experiment. If, then, changing one variable (the independent variable – IV) produces changes in the variable being measured (the dependent variable – DV), then cause and effect is established and the hypothesis is proved. Students also need to appreciate that to be accepted by other scientists, experiments must be shown to be: accurate, reliable, valid; students must be able to differentiate between these three concepts. They need to learn that a standard format for writing up experiments is important so that scientists across the world can appreciate the way in which the experiment was carried out and repeat them if need be.

Teaching notes

Students should appreciate that scientific experiments seek to establish cause and effect between two variables:

- the independent variable (IV)
- the dependent variable (DV).



They should also appreciate the need to control other variables that might exert an influence on the results. For example, enzyme-controlled reactions are influenced (in particular) by:

- temperature
- pH
- substrate concentration
- enzyme concentration.

Students should appreciate that, if they are to investigate (say) the effect of temperature (IV) on enzyme action (DV), then the other factors should be controlled (not allowed to vary in the different conditions of the IV) so that the comparison of the outcomes in different conditions of the IV is a *fair test* and likely to be due only to the variation in the IV. This is illustrated in the book by reference to the tomato seed investigation used throughout the unit.

Students should also appreciate that for the results of investigations to be accepted by other biologists, these biologists need to be convinced that the investigations were:

- accurate
- reliable
- valid

These concepts are often muddled and it is important that students appreciate the nature of each and that, although related, they are distinct.

Accuracy concerns the degree of precision with which data are measured and recorded. It is concerned with the extent of error in the investigations. One aspect of this is the error involved in measuring equipment, such as pipettes and balances. As the different instruments deal with different ways of measuring, the only way of comparing is by percentage error.

Students should appreciate that the real error of a piece of graduated equipment is taken to be 0.5 of the graduation. For example, in a 20 cm³ pipette, the graduations may be 1 cm³. In this case, the real error is 0.5 cm³.

$$\frac{\text{real error} \times 100}{\text{volume measured}}$$

So, if a syringe was used to measure 15 cm³, the percentage error would be:

$$\frac{0.5 \times 100}{15} = 3.33\%$$

If the syringe was used to measure 20 cm³, the percentage error would be 2.5%.

This illustrates an important principle, that, given a certain accuracy of measurement, the percentage error is reduced by using larger volumes.

Students should be encouraged to calculate percentage errors for a given piece of apparatus, measuring different quantities to illustrate this principle.

Reliability is concerned with repeatability. If others were to try the same experiment under the same conditions, how likely is it that they would get similar results? One way of increasing the reliability of results is to repeat the investigation several times to generate mean data. Means are generally more reliable than data from individual investigations as the effects of any anomalous results are minimised in the mean.



Reliability will also be enhanced if procedures are standardised so that variation in the process of carrying out the investigation is kept to a minimum.

However, it should be emphasised that just because an experiment is reliable, doesn't mean that it is accurate. An experiment may well be repeatable but have a low level of accuracy and, if a control variable was consistently ignored, the experiment will not be valid.

Validity is about truth. It is concerned with whether an investigation is, in fact, measuring what it says it is measuring. When we report that changes in the activity of an enzyme are due to the changes in pH in our investigation, we must be sure that nothing else can be causing the changes. If we have failed to control variables adequately, then another variable could be producing the changes and our conclusions may not be valid.

Students could be encouraged to look at the key investigations cited in the book (Redi, Pasteur and Fleming) and assess how accurate, reliable and valid these investigations were.

Reporting scientific investigations needs to follow an agreed format so that biologists can instantly recognise the way in which the work of another biologist is reported. This has grown out of a need for research biologists across the world to be able to understand one another, but it is important that students realise that reporting scientific investigations is not an activity that can lend itself to freedom of expression.

SA = starter activity MA = main activity CA = concluding activity	
Writing reports on experiments (1) (Activity 1.7)	
SA	Students discuss with the teacher the purpose of a report on a scientific investigation. Try to elucidate the following: • a clear statement of the aims of the investigation (including an hypothesis) • an account of how the work was carried out • a clear summary of the results • conclusions drawn with explanations • an evaluation of the likely accuracy, reliability and validity of the procedures, results and conclusions
MA	Class to discuss the material in the textbook showing the components of a scientific report. Students examine the purpose of each component.
CA	Students draw up a rough outline of the report in activity 1.7.
Writing reports on experiments (2) (Activity 1.7)	
SA	Students plan in pairs an appropriate method for evaluating the success of the report they are about to write for activity 1.7.
MA	Students carry out activity 1.7.
CA	Students evaluate the success of their report in pairs – students take it in turns to test their reports on each other.
Developing and testing hypotheses (Activity 1.8)	
SA	Students briefly brainstorm activity 1.8 in pairs.
MA	Whole class brainstorms; write up the results at the front of the class. Students then split into pairs to complete the activity by drawing up flowcharts.
CA	each pair makes a brief presentation of their flowchart to the rest of the class.



Activity

Students could also evaluate actual scientific research in terms of the scientific method. The link below produces an interesting account of an investigation into the effect of pH on yeast activity:

sophia.smith.edu/~lrizzo/writing/lab6.ppt

The account includes results together with an analysis of the results and an evaluation of limitations of the procedure, and possible errors that may have limited the validity of the investigation.

Answers to review questions

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

1.2 The tools of a biologist

Learning competencies

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

- Name and describe the function of the main pieces of apparatus that are used by biologists the world over.
- Describe how these pieces of apparatus work.
- Explain how, and under what circumstances, these pieces of apparatus would be used and demonstrate the use of some of them.
- Classify the apparatus as laboratory tools, field tools or both.
- Be aware of possible health and safety implications of using these tools.

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

Starting off

This section sets out to help students learn about the range of equipment that biologists across the world would recognise as being the 'tools of the biologist'. These include laboratory equipment such as optical microscope, electron microscope, balance, pipette, Petri dish, dissecting instruments, centrifuge, as well as field equipment such as quadrat, insect net, trap, altimeter, plant press, CPS.

Teaching notes

It is recognised that students may well have used many of these pieces of equipment already in their biology course. However, this section seeks to formalise their knowledge and to make students aware of some of the different ways in which some pieces of apparatus can be used.



Students will already be familiar with many of the measuring devices listed (syringes, measuring cylinders, pipettes, balances, etc.) but they should now be made aware again of the ways in which these pieces of equipment should be used to gain readings that are as accurate and reliable as possible.

Techniques to be stressed include:

- reading the level of a liquid in such a way as to avoid parallax errors;
- always measuring the level of a liquid by reading the lowest level of the meniscus;
- not reading any digital equipment until the reading has stabilised.

SA = starter activity MA = main activity CA = concluding activity	
Equipment used to take measurements	
SA	Students discuss with the teacher the sorts of measurements that a biologist might wish to make, include measurements of: • length • volume • mass • time
MA	Students make a list of the different apparatus that could be used for each and the occasions when each might be used (relate the precision of the equipment used to that needed by the investigation).
CA	Students could carry out the experiment shown in figure 1.9. They could use the equipment shown, but also use a balance to measure the loss in mass (due to loss of oxygen produced) during the reaction. Write up briefly explaining the role of measuring equipment.
Equipment used to aid observation	
SA	Students examine the point that such equipment includes anything that will make observation easier.
MA	Students discuss the ways in which observation can be made easier. Include: • magnification (lenses and microscopes) • removing overlying structures (dissecting equipment) • Petri dishes containing culture media (allow growth/reproduction of micro-organisms and so observation of colonies formed).
CA	Students describe how each of the above contribute to making more meaningful observations.
Microscopes (1)	
SA	Students carry out a simple activity that involves making a temporary mount for an optical microscope (such as making a slide of onion epidermis). Students discuss with the teacher how an optical microscope produces a magnified image.
MA	Give students an electron micrograph of a plant cell to compare with their image of onion cells from their slide. Students examine that an electron microscope uses beams of electrons rather than light. Introduce the concept of resolution and describe the differing resolutions of optical and electron microscopes. Students examine how this has allowed details of cellular structure to be elucidated. Students could now carry out Activity 1.10: in this very brief activity the teacher should ask the question at the front of the class and then invite students to discuss their opinions.
CA	Students make notes on optical and electron microscopes.

Microscopes (2)	
SA	Students recap the differences between optical and electron microscopes as preparation for the visit.
MA	Visit a higher education institution and see the sophistication of optical microscopes used and electron microscopes in use, if possible. Students make notes on the way in which the microscopes are used.
CA	Students write up notes on the way the two different types of microscopes are used in education and research.
Field equipment (1)	
SA	Students discuss with the teacher the types of investigations that biologists carry out in the field.
MA	Students study the commonly used field apparatus. Students read through Activity 1.11 to assist their understanding: this could be done as homework later on. The teacher should explain – or demonstrate if possible – how a plant press works and how a simple one can be made.
CA	Students design investigations into: • what factors influence the distribution of an organism in the local environment • the abundance of one or more organisms in the local environment. Students examine that they should make clear: • the field equipment they will use • how they will use it • how they would interpret any results. The teacher will need to check these plans and comment on suitability and suggest revisions where necessary.
Field equipment (2)	
SA	Students discuss the revised investigations with the teacher.
MA	Get students to carry out their investigations (this may take more than one session).
CA	Students write up the results of their investigations explaining: • how they used the equipment to obtain the results • any conclusions they draw from their results. Students could also carry out Activity 1.12 if there is time, and complete for homework. The teacher should explain that this is a summary exercise, and check all the tables the students produce to ensure they have understood.

Activities

To check understanding of the nature of the equipment, students could be asked to give a brief outline and a sketch of the assembled equipment they would use to investigate a particular problem. Although only a brief account is needed, students should still list any variables they would need to control and describe any control experiments they would carry out.

Some examples could be:

- using a gas syringe to measure the rate of respiration in yeast
- using a digital balance to measure the effect of different concentrations of sucrose on water gain or loss by potato (or other root vegetable)
- using a gas syringe to measure the rate of photosynthesis of a water plant under different environmental conditions
- using a measuring cylinder to measure the rate of evolution of oxygen gas when yeast decomposes hydrogen peroxide.

Students could be made aware of how a simple piece of equipment such as a Petri dish can be used in many different ways. Its use requires little additional equipment and can be used in the following ways:

- to culture micro-organisms from different places using a basic nutrient agar in the Petri dishes
- by using a Petri dish with gridded lid (as shown on page 18 of the Students' Book), recording the percentage of the Petri dish covered in micro-organisms each day and plotting a graph to estimate growth rates
- by using different antibiotic discs, the effect of each on microbial growth can be observed
- by using starch agar with wells punched in it using cork-borers, the rate of digestion of starch by different concentrations of the enzyme amylase can be estimated.

There is no tool quite as synonymous with biologists as the microscope. Students should revisit the basic structure and functioning of a basic optical microscope, first met in grade 9, and try to improve their technique of:

- slide making
- using the microscope at different levels of magnification
- making drawings from microscope slides.

They should be reminded of the concepts of magnification and resolution and how it is resolution that is the real key to producing detailed images.

They should also be made aware that some optical microscopes are anything but simple and produce an image that is projected onto a screen after being computer-enhanced to improve resolution. If possible, a visit to a higher education or research institute would reinforce this.

They should also be reminded of the greater resolution produced by an electron microscope and the benefit this has been to biologists in elucidating the structure of cells.

Field investigations require a different set of equipment and a slightly different approach. Students should appreciate that, often, we want to establish an estimate of numbers of a particular organism in an area or the way in which the numbers of an organism change across an area. They should be reminded that to investigate numbers in an area we need to use a random sampling technique to avoid bias. To investigate changes across an area, a transect with a systematic sampling technique is required. This is not random and does have bias, but it makes it less likely that key areas in the transect will be omitted.

In their investigations in the field it is not possible to control variables in the same way as in the laboratory, so they must monitor them so that they can be taken into account when considering the results.

Activity

To check understanding of the nature of the equipment, students could be asked to give a brief outline of how they would investigate:

- the numbers of [*a small plant or small invertebrate common in your area*]
- the change in numbers of [*small plants or small invertebrates common in your area*].

Although only a brief account is needed, students should still list any variables they would need to monitor and how they would go about this.



Answers to review questions

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

1.3 The relevance and promise of biological science

Learning competencies

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

- Explain how biological science is relevant to food production, health and disease, conservation and control of the population
- Explain the promise of biology in relation to genetic engineering and biotechnology.

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

Starting off

This section sets out to help students appreciate that biology is relevant to our lives at many different levels. It offers answers to many 'deep' questions that students will all ask themselves at some time. It explains how our bodies work and how we depend on other organisms in all manner of different ways. It offers an answer to the questions: 'Where did we come from?' and 'How did we get here?'

Teaching notes

The focus of this section is the students carrying out searches and finding information through interviews. It is a research section of the syllabus.

The Students' Book gives some examples of how biological science is relevant and something of the promise of biotechnology in particular, but this is intended to be indicative and in no way prescriptive. There is no reason for the students to confine themselves to this area in their searches.

SA = starter activity MA = main activity CA = concluding activity														
Questions that biologists try to answer														
SA	Students discuss with the teacher some areas of biological research. They need not all be large-scale examples, but some areas such as: • how can we develop a vaccine against HIV? • how can we improve the yields of crop plants? • what causes migraine? • How did modern humans evolve? are useful examples.													
MA	Students carry out activity 1.14. Give students credit for their own questions.													
CA	Students summarise their research in a table such as the one shown below.													
	<table> <tr> <th>Biological question</th><th>Current research</th><th>My view on the research</th></tr> <tr> <td></td><td></td><td></td></tr> <tr> <td></td><td></td><td></td></tr> <tr> <td></td><td></td><td></td></tr> </table>	Biological question	Current research	My view on the research										
Biological question	Current research	My view on the research												
The promise of biology in agriculture, medicine, the environment and specifically in Ethiopia														
SA	Assign students or groups of students a specific research project based on one of the areas above.													
MA	Students carry out Activity 1.16. Again the teacher should ensure that students know how to use research resources, and suggest they use the library but also look for other sources of information. This is likely to take more than one session and may be partly done as homework.													
CA	Students make a presentation or display of their research. This could easily take one full session.													

Activity

They may wish to look at the promise offered by research into:

- stem cells
- transplant surgery
- vaccines for AIDS
- protection of the environment

Whatever they choose, it is important that their search has a focus from the outset and they do not just try to research ‘the promise of biology’.

Answers to review questions

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



1.4 Biology and HIV/AIDS

Learning competencies

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

- Explain how biologists are actively involved in the fight against AIDS.
- Describe how you can help community efforts to control AIDS.
- Describe the decisions you will need to take to help control AIDS.

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

Starting off

This section sets out to help students appreciate the following:

- Biologists are actively involved in the fight against AIDS by:
 - carrying out research to develop a vaccine against HIV
 - developing new and better anti-retroviral drugs to combat HIV.
- People can help in the fight against AIDS by:
 - working to change attitudes
 - developing the life skills that will allow them to solve problems related to AIDS in the community and take difficult decisions regarding their social interactions
 - adopting responsible practices.

Teaching notes

It is worthwhile beginning this section with a brief outline of the nature of the human immuno deficiency virus and the disease AIDS. The Students' Book gives an account sufficient for this discussion, together with a description of the extent of AIDS. This will naturally be slightly out of date by the time this book is read and it is preferable to use up-to-date figures. The methods of transmission of AIDS are also restated.

At this point strongly emphasise the point that any way of breaking the transmission pathway will be effective in reducing the spread of AIDS. This should be thoroughly discussed – the main methods are listed in the book, but listing them is simple. The students must discuss ways of actually achieving them. This will entail a discussion of social attitudes and taboos that must change if the spread of AIDS is to be controlled.

The Students' Book then considers the role of anti-retroviral drugs in combating AIDS. These drugs combat the replication of HIV in the T-helper cells. Different drugs combat different stages of the cycle of replication.

HIV mutates and can acquire resistance to one or more drugs because its replication cycle becomes slightly altered. However, by using the drugs in combination (Highly Active Anti-Retroviral Treatment or HAART), it is much more likely that the virus will be controlled.



SA = starter activity MA = main activity CA = concluding activity															
The nature of AIDS															
SA	Students discuss with the teacher the distinction between AIDS and HIV.														
MA	Students recap with the teacher: • reasons for AIDS being a killer disease • the life cycle of HIV.														
CA	Students summarise AIDS in a table such as the one below. <table border="1"> <thead> <tr> <th>Feature of AIDS</th><th>Description</th></tr> </thead> <tbody> <tr> <td>What fraction of the world's AIDS cases are in Ethiopia?</td><td></td></tr> <tr> <td>What causes AIDS?</td><td></td></tr> <tr> <td>How is HIV transmitted?</td><td></td></tr> <tr> <td>Which cells does HIV infect?</td><td></td></tr> <tr> <td>What is the consequence of infecting these cells?</td><td></td></tr> <tr> <td>Why is AIDS nearly always fatal?</td><td></td></tr> </tbody> </table>	Feature of AIDS	Description	What fraction of the world's AIDS cases are in Ethiopia?		What causes AIDS?		How is HIV transmitted?		Which cells does HIV infect?		What is the consequence of infecting these cells?		Why is AIDS nearly always fatal?	
Feature of AIDS	Description														
What fraction of the world's AIDS cases are in Ethiopia?															
What causes AIDS?															
How is HIV transmitted?															
Which cells does HIV infect?															
What is the consequence of infecting these cells?															
Why is AIDS nearly always fatal?															
Breaking the transmission pathway															
SA	Students recall the ways in which AIDS can be transmitted.														
MA	Students carry out activity 1.18. Ensure the students respect each other's opinions as this could be a sensitive topic: some guidance on the topic is given in the teaching notes.														
CA	Teacher and class review the posters produced by each of the groups.														
The basis of drug therapy															
SA	Students discuss with the teacher the difference between drug therapy that is available and a true vaccine.														
MA	Students examine the life cycle of a retrovirus such as HIV (use figure 1.35 as a basis for this). Students examine that any drug that prevents any stage of this cycle from taking place will effectively break the life cycle of the virus. Students examine the basis of HAART (Highly Active Anti-Retroviral Therapy).														
CA	Students include in their notes: • a diagram to summarise the life cycle of HIV • the basis of HAART.														
Our role in the fight against AIDS (1)															
SA	Students discuss with the teacher where individuals can influence the transmission pathway and where this is not possible.														
MA	Students discuss with the teacher how individuals can: • show tolerance, support, compassion and understanding to sufferers • change our social behaviour patterns to minimise the risk of infection.														
CA	Students write a short 'essay' on 'My role in preventing the spread of AIDS'.														
Our role in the fight against AIDS (2)															
SA	Students recap the social behaviour patterns they identified in the previous session.														
MA	Students carry out activity 1.20. Ensure the students understand that this is a role-play exercise where they need to represent the allocated position, and that everyone understands this is not necessarily their own opinion: be sensitive when allocating the roles of 'good friend' and 'bad friend'. This could be an embarrassing exercise for some students so it will need to be monitored carefully.														
CA	Teacher summarises the presentations.														
Our role in the fight against AIDS (3)															
SA	Again, students review the social behaviour patterns that lead to AIDS transmission.														

MA	Students carry out activity 1.19. Ensure that students know what a poem is, and suggest to any student who is unsure that a short story would suffice instead. The students will need peace and quiet to think and carry out this activity.
CA	Students read their poems to another member of the class, or the whole class if they are not too daunted by this. As mentioned, ensure the students respect each other's opinions. Other member/the class comments on the issues raised in the poem.
Our role in the fight against AIDS (4)	
SA	Students discuss with the teacher the possibilities of engaging with healthcare professionals or with PLWHA and decide on either a visit or inviting a speaker to the school.
MA	Students take the opportunity to question the speaker about issues that concern them.
CA	Students report on if/how the discussion has changed their views.

Activity

Finally, the focus of the section again cannot be dealt with adequately in a textbook as it involves students discussing the problems and challenging attitudes. Role-play work would be particularly useful here and it is often productive to get students to adopt a role whose views they would not normally agree with.

They should discuss the attitudes such as prejudice and stigma that are associated with AIDS and how these can be challenged.

Answers to review questions

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

Answers to end of unit questions

1. Step	What is involved
Ask a question	From observations, identify a problem to be solved: identify what may be the independent variable (IV) and the dependent variable (DV).
Background research	Find out what is already known about the problem so that you do not have to start from scratch.
Hypothesis	Think of the way you expect the IV to influence the DV and frame this as a statement.
Experiment	Think of a suitable way of changing the IV and measuring the DV. Keep other variables that might influence the outcome controlled. Repeat the investigation for greater reliability.
Analyse results and draw conclusions	Look for trends and patterns in the results and try to explain these trends and patterns in terms of the influence of the IV on the DV.



7. a) Anti-retroviral drugs break the replication cycle of HIV in cells.

Some block:

- the entry phase
- the reverse-transcription to DNA phase
- incorporation into host cell DNA
- viral protein synthesis stage

b) i) Almost half the treatments are in Addis Ababa

Most of the rest are in cities/towns

Fewest in rural areas

(ii) Greatest concentration of population in cities

Problems with getting information to rural areas

Problems with getting treatments to rural areas

Answers to end of unit crossword puzzle

Across

2 fair test

8 spontaneous generation

10 DV

13 HAART

14 AIDS

16 reliability

18 validity

Down

1 microscope

3 accuracy

4 hypothesis

5 Francesco Redi

6 Louis Pasteur

7 Petri dish

9 scientific method

11 experiment

12 prediction

15 HIV

17 IV

Further resources

www.the-aps.org/education/k-12misc/careers.htm – careers in biology'

http://www.sciencebuddies.org/science-fair-projects/project_scientific_method.Shtml – the scientific method

<http://biotech.einnews.com/> – biotechnology resources

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

<http://www.sciberbrain.org/> – genetic engineering activities

<http://www.apositivelife.com/forasos/biology-of-hiv.html> – information on HIV/AIDS

<http://www.avert.org/> – information on HIV/AIDS prevention

<http://www.unaids.org/en/> – UN HIV/AIDS campaign





Appendix: Pro forma for developing plans for investigations

Title	
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Step of scientific method	Application to your plan	
Background research		
Hypothesis		
Experimental investigation	Independent variable	
	Dependent variable	
	Other variables to be controlled or monitored	
	List of apparatus	Procedure to be followed





Record your results in the space below

Step of scientific method	Application to plan	
Analysis of results	Trends	Explanation of trends using biological knowledge
Accept or reject hypothesis	Accept or reject	Reason(s)
Evaluation	Source of error	Possible improvement

