NUCLEUS

ENGLISH FOR SCIENCE AND TECHNOLOGY

BIOLOGY

Teacher's Notes

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Longman

Longman Group Limited
London

Associated companies, branches and representatives throughout the world

First published 1977

ISBN 0 582 55354 7

Printed in Great Britain by
Lowe & Brydone (Printers) Ltd, Thetford, Norfolk

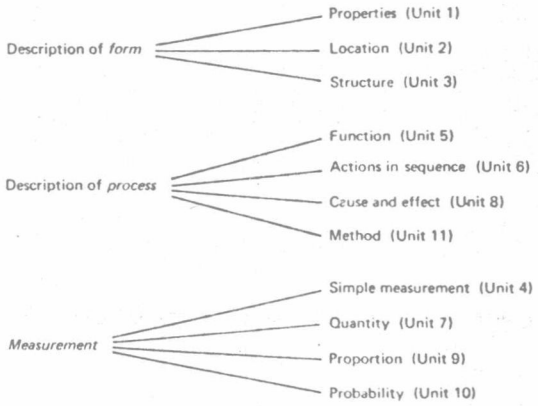
Introduction to the Series

Nucleus introduces the language learner to uses of English which are essential to scientific and technological communication. It is intended for students with some knowledge of general English, who need to reactivate this knowledge and apply it to the comprehension of written and spoken discourse.

The series consists of two parts. The General Science course presents and practises language which is shared by the various branches of science and technology, including semi-technical lexical items like *diameter*, *ratio*, etc., and items of general use such as *consist*, *adjust*, *depend*, etc., together with essential grammatical items such as the passive, sentence connectives, modal verbs, etc. The other books in the series, catering for specific subjects, present these shared items in combination with specialised language uses and in the context of reading and listening passages related to the subjects. In the General Science course the emphasis is on motivating the student and engaging him actively in the use of English. The exercises are set in familiar contexts, drawn from general knowledge and elementary science, and are intended to be both relevant to the learner's field of study and interesting in themselves. With the latter consideration in mind, considerable use is made of activities involving problem-solving and the transfer of information from diagrams to written and spoken texts.

The other books in the series consist of exercises in the comprehension of written and spoken texts about the student's subject. Each unit begins with various productive language activities, supported by diagrams, tables, etc., through which the student is presented with and manipulates the new language items, gaining confidence in their use before going on to handle them in the context of continuous discourse. As with the General Science book, the comprehensive exercises draw on basic concepts and reasoning processes which the student needs to develop in the study of his subject.

The texts and exercises demonstrate ways in which the scientist and technologist describe the phenomena and processes which they are concerned with. Each unit of each book is based on an aspect of the world which the scientist or technologist describes, together with language items associated with it. Together they form three conceptual groups, which are interwoven in the course, for the sake of variety.

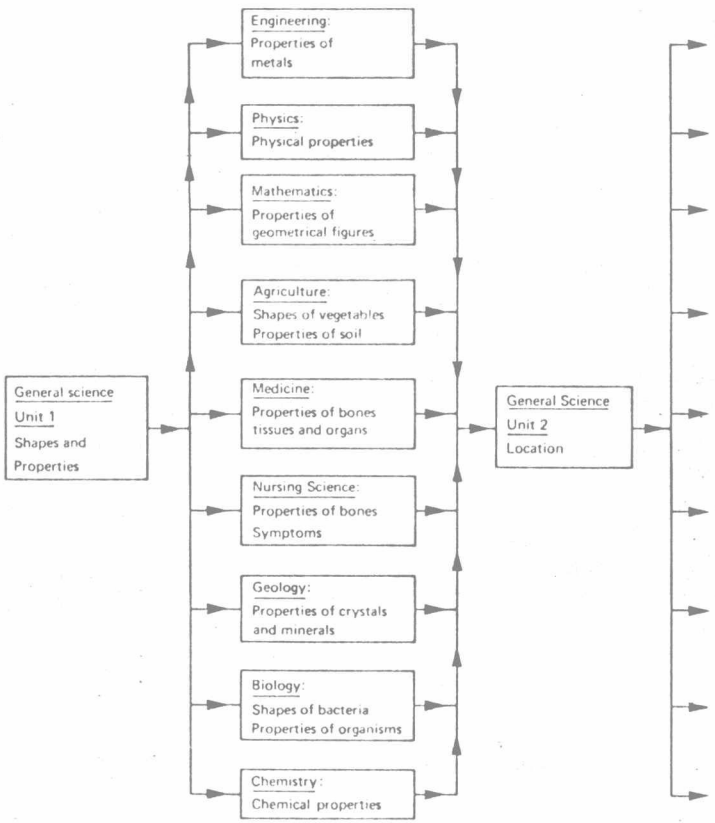


Thus the course is mainly concerned with ways in which the scientist and technologist describes and measures forms and processes in English, these activities being fundamental to the language of all the disciplines. Various other communicative activities occur incidentally, including observation, explanation, conclusion, prediction and proof.

Each book also contains revision materials: Units A, B and C, together with the final consolidation unit. In these the various concepts are shown in combination in continuous reading and listening texts.

The different parts of the series may be used together or separately. The General Science book is suitable for any educational level where the student is about to or beginning to specialise. It can be used on its own, as an introduction to English for specific purposes, or as a lead-in to the books for different specialities. The specific books are, however, designed to stand on their own, in cases where the student has begun to specialise and has little time available.

If the General Science book is used in combination with the specific books, it may either precede them as a whole or be used in parallel with them: all students doing Unit 1 of the General Science course, then dividing into subject-groups for Unit 1 of the specific groups, then going on to Unit 2 of the General Science course, and so on. The chart shows the first stage of such a syllabus, with topics covered in Unit 1 of each specific book.



Contents

Introduction to Nucleus: Biology

1 Content and aims of the Students' Book

The aim of the Biology course is to develop in the student a competence in using English both actively and receptively in order to extract information from written and oral texts and from visual forms of presentation, and to develop the student's ability to follow continuous arguments. With the exception of the revision units and Unit 12, the opening sections of each unit contain active exercises which introduce and manipulate new language items and various ways of presenting, interpreting and connecting information, as a preparation for the study of continuous texts. The language items and the concepts which they embody are essential to the study of Biology. While this course does not claim to cover all the main branches of Biology (it is primarily a *language* course), there is a fairly representative range of different types of topic, use of language and study method on which the subject depends. There is a balance between botanical and zoological topics, which are often linked by the concept which sets the theme to the unit.

The conceptual syllabus covers the two main aspects of biological study of organisms: *morphology*, or the study of their form and structure (Units 1, 2 and 3), and *physiology*, or the study of their functions (Units 5, 6 and 8); these aspects are interwoven in later units. In addition, there are units devoted to various ways of measuring and quantifying (Units 4, 7, 9 and 11), the emphasis being on relative measurements which are important in the explanation of the behaviour and characteristics of organisms. The later units of the course also develop ways of ordering and communicating information connected with scientific method, and this topic becomes explicit in Unit 11.

2 Aims of the Teacher's Notes

The comments on each unit consist of: *a*) a brief summary of aims; *b*) an outline of the language content described in both functional and formal terms; *c*) notes on the background to the unit and exercises; *d*) the listening text (which is also available on cassette) and answers to exercises.

The notes *c*) have several purposes:

i) to advise the teacher on how to introduce and teach the exercises and how to extend them to other activities and situations where appropriate;

ii) to explain the purpose of the language exercises and the particular functions of lexical and structural items in biological study;

iii) to provide some information about the subject as background to the exercises so that the teacher can handle questioning and discussions with confidence;

iv) to suggest project activities through which the student can reinforce and apply what he has learned in each unit and relate it to his own study of the subject.

3 The language content

Explanation of the language concentrates on uses of English which are specific to Biology. Very often this overlaps with the comments on the scientific content of the exercises, since the choice of language depends on the information it conveys and the scientifically determined communicative activity involved. The explanation may include why a certain item takes on a different meaning in Biology from its use in everyday language. In some cases, fine distinctions of meaning are drawn which are not made

explicit in the Students' Book. For reasons of economy, certain items with *similar* meaning are presented as *identical*; e.g. *sufficient* and *adequate* in Unit 7, and the passive use of *can* and *may* in 11. We assume that to present a large number of subtle variants of the same general meaning would confuse the student, but these distinctions are made clearer for the benefit of teachers in the notes. The explanation also points out distinctions between semantically related expressions in terms of formality, where one item may be more appropriate for textbook writing and another for discussion or informal lecture. Semantic comments sometimes bring out the importance in biological statements of modifiers and of relativity; e.g. the subjective quantifiers in Unit 7 and the modifiers of generalisations in Unit 10.

Comments on the language also refer to the way items are used in continuous writing. Many expressions are first practised in separate sentences (in the Presentation and Development Sections). Although these sentences are usually linked by a common topic, often presented diagrammatically, the use of language at this stage is necessarily artificial, since it is determined by the pedagogic need to practise the items repeatedly rather than by the communicative need to combine them with others in the development of continuous text. Sometimes this practice of isolated items leads up to their synthesis in a piece of continuous writing, as in the practice of simple and modal passives in the opening section of Unit 11. In addition, the Reading and Listening Sections show how the items may be 'contextualised' in actual descriptions, reports, explanations etc.

Some of the language items relate specifically to the interrelationship of different statements in consecutive writing. These 'cohesive devices' are usually presented in the Reading Sections and include the comparing and contrasting connectives in the early units and phrases which introduce results of and conclusions from previous statements in later units. A good deal of attention is paid in later units to the way in which the different parts of a text are connected to develop an argument. There is practice in recognising the sequence of ideas or order of events. There are also exercises drawing attention to the relation between main and dependent statements, where the student is given a skeleton text and has to build up a fully developed argument by inserting appropriate amplifying statements–examples, exceptions, results, conclusions etc.

4 The scientific content

Notes on the units include summaries of the background information. This is not essential for the teaching of the exercises, but the teacher may find them helpful in stimulating further discussion of the topics introduced in the exercises; and he or she may even wish to refer the enthusiastic student to them as a basis for further inquiry into the way language is used to convey aspects of his subject. It is also possible that the teacher who has the time available may be encouraged to read around the subject more; for this the bibliography in the Students' Book will be useful.

A large part of the scientific content of the units consists of descriptions of the structure and behaviour of organisms and the functioning of their parts. This relates to the two branches of study mentioned above – morphology and physiology. Two other main features of the subject play an important part in the course: classification and ecology. Organisms are classified according to their distinguishing properties or characteristics (cf. Unit 1); the groups into which they are placed are sub-divided within a hierarchial system (cf. Unit 12). Ecology is the study of the relationship of the organism to its environment, and its importance is implicit in many units, in the treatment of processes

and conditions essential for the continuation of life (for example, the nitrogen cycle in Unit 6, photosynthesis in Unit 8, nutrition in Unit 7, the food-web in Unit 10); it is made explicit in Unit 12.

5 Methods of scientific study

In addition to the treatment of various biological topics as a basis for the exercises in language use, the course aims to introduce the student to certain basic communicative functions, and sequences of functions, on which the study of the subject in English depends. This involves practice in such activities as describing, classifying, observing facts and drawing conclusions from them, generalising, modifying generalisations and giving examples, making predictions based on generalisations, explaining biological behaviour and reporting the procedures and results of experiments. The practice includes the use of key verbs like *observe*, *conclude*, *predict* etc., connectives which relate one stage of study to another, and simple 'chains of reasoning' such as *observation* + *conclusion* + *explanation* and *generalisation* + *exemplification* + *prediction*.

One other important aspect of the organisation and presentation of scientific information is practised incidentally throughout the course – the use of *visual* forms of communication. These include morphological diagrams and stereograms (three-dimensional representations) showing the structure of all or a section of the organism, flow-charts to illustrate stages in a process, classificatory tree-diagrams, tables of properties and quantities, graphs to indicate variation and pie-charts to indicate percentages. They constitute an essential means of communicating biological information, and their use in exercises is aimed at showing how they relate to the verbal presentation of information.

6 How to teach the course

The notes on the units contain fairly full suggestions on methodology, so here we will limit ourselves to a few general points.

Handling the subject-matter

The teacher should not feel intimidated by the biological content. Much is self-explanatory because of the visual presentation. On the whole, the level is fairly elementary. A few of the concepts, such as *osmosis* (Unit 8) are rather complex, and we recommend reference to a biological textbook or dictionary or, better still, preliminary discussion of the subject with a scientific colleague. In fact, the more co-operation between language and science teaching the better. On the other hand, we should perhaps point out that the authors of this course were originally trained in literature and linguistics, and are very conscious of the problems facing the non-scientist language teacher. Where possible, we have made suggestions about extending the discussion of the subject to familiar facts of life, which is relatively easy to do in Biology. Finally, we would recommend that you make clear to the students that you are there to teach the language, not the subject, and that they are welcome to make further explanations of the topics from their own knowledge.

Information transfer: visual and verbal communication

We have referred above to the importance for the study of science of visual displays of information such as diagrams and tables. In this course they are also an important aid to the teaching of language. They provide a direct and memorable way of learning the

meaning of new items, reducing the need for verbal explanation by the teacher; this is especially true of the separate diagrams in early units which present vocabulary items. Their second purpose is to draw attention to the communicative effect of language and to guide the student in extracting key pieces of information from a text, as in the diagram-labelling and table-completion exercises. They also provide a stimulus for the active use of language. In these exercises, such as the description of the nitrogen cycle (Unit 6), the differentiation between plants and animals (Unit 10) and experimental procedures (Unit 11), the visual stimuli generally contain verbal expressions as well, and the language is often in a reduced or abbreviated form. You may find it useful to point out the main differences between this reduced form and expanded writing: the deletion of articles, noun phrases as subject, the verb *be* etc., as a basis for later work in making notes from texts.

It is a good idea also to support this use of diagrams etc. in the book with real objects which the teacher or the students can bring into the classroom – parts of plants, biological specimens and instruments etc. These can be used to reinforce and elaborate on the language work in the book.

Extension of the textbook material

The Students' Book can be taught as a continuous, self-sufficient course, but it may also prove necessary or desirable to go beyond the boundaries of some of the exercises. This would probably be for one of two reasons. If your students are going to have to do a lot of writing or speaking about their subject in English, then it may be useful to devise additional drills to reinforce the harder concepts and their expressions. The parallel General Science course provides much practice material within easy or non-technical contexts, and mention is made in the notes of points where this material could provide useful support to the teaching of the Biology course.

A second reason for extending the limits of the course would be to relate the content and the modes of expression to the students' own interests and study needs. The notes on project work give some ideas on how this might be done. Students could be encouraged to produce short talks or written reports amplifying the information presented in the exercises or dealing with related topics; for example, having done the exercise on the structure of the leaf and the stem of plants (Units 3 and A), they might make similar descriptions of the roots of a plant.

The reading and listening texts can form the basis for discussion. The reading should be done silently at first, but it may prove helpful to introduce the topic by asking students to say what they know about them. If necessary, this preliminary discussion could begin in the first language, the teacher drawing attention to how important features of the topic are described in English and thus introducing features of the reading passage.

Preparation for this discussion, and solving some of the exercises, can be done in groups. Many of the exercises lend themselves to group work, e.g. those concerned with measurement and the indentification exercises in some revision units. Working in groups should be mutually beneficial and help to maintain interest. It also helps to ensure that students participate actively in the activities, which is an essential part of learning.

Note: In the section Answers to units, alternative answers, of which the student may choose one only, are indicated by strokes (/). Optional items, which fit well into answers but are not demanded by the questions, are placed between brackets ().

UNIT 1 Properties and Shapes

Aims

To present and practise ways of expressing shape and other properties in describing the appearance of living things and in classifying them.

Main language items

Statements in the simple present which name and classify living things: singular *a/an*: e.g. *A lion is a mammal*; plural without article: e.g. *Sharks are cold-blooded animals.*

Descriptions of property: Noun phrase + *be* + adjective phrase: *Cocci are spherical in shape.* Noun phrase + *have* + noun phrase: e.g. *Birds have wings.*

Defining statements + *with*: e.g. *Birds are warm-blooded vertebrates with wings.*

Notes

Classification has an important function in Biology, and organisms are classified according to their properties. Members of one group or class share certain properties which distinguish them from other groups.

Section 1 presents the distinctive properties (features) of plants and animals, and of different kinds of vertebrate. (The table in Exercise 2 extends the left-hand branch of the table in Exercise 1.) Section 2 deals with the classification of bacteria into three groups according to shape.

Biologists should be familiar with classification, but for further practice, or for individual project work, present objects or pictures which students can classify according to shape, colour, size, material etc.; e.g. kinds of food, furniture, plants etc. (introduce here the phrase *according to*, which occurs in Exercise 5). Students can make their own classificatory diagrams like those in the first two exercises.

Exercise 1 familiarises the student with a simple classificatory diagram and practises definitions derived from it. Exercise 2 extends this and practises two ways of making general statements with countable nouns – in the singular with *a an* and in the plural with no article. Additional practice from the first two diagrams might include:
(cf. *General Science*, Unit 1) *What do mammals and birds have in common? They are both warm-blooded animals.* etc. *How do reptiles and fish differ? Reptiles live on land, but/whereas fish live in water.* etc.

And using the connected pronouns *some . . . others . . .*, which occur in Exercise 5, students can make statements like: *Some vertebrates are warm-blooded; others are cold-blooded.* etc.

Exercise 3 combines the sentences in 2, practising definitions with *with* and participle phrases.

Exercise 4 is a simple inference exercise; answers to *Why?* questions are deduced from the diagrams above.

In Exercise 5 students have to match pictures of bacteria with features distinguishing different kinds in the text.

The vocabulary referring to shape, illustrated at the beginning of Exercises 5 and 6, can be practised by asking students to point out the shapes of objects or parts of objects in the classroom or illustrated in Biology textbooks. Distinguish between saying something *is flat* etc. and saying something *is shaped like a hook* etc. Note that *flagella*,

anterior and *posterior* are technical terms; the last two are practised further in Unit 2. Note Latin plurals – *bacterium/bacteria*; *salmonella/salmonellae*; *bacillus/bacilli*. In Exercise 5 take care with agreement between the verb and unfamiliar nouns: *Cocci are . . . Streptococcus is. . . .* In Exercise 5 the diagram of *clostridum tetani* shows a spore at one end. When the bacterium does not possess a spore (reproducing part), both ends are square.

Section 3 (reading) presents expressions of shape in the description of two simple invertebrates. Students should read the passage silently, referring to the illustrations, then identify the diagrams which follow, quoting descriptions from the text to justify their choice. For the expressions *transverse section* (or *cross-section*) and *longitudinal section*, cf. *General Science*, Unit 1, Exercise 5.

Exercise 7 clarifies details of shape.

Section 4 practises listening to separate statements which reinforce items already used. Before reading out the statements, ask the students to identify the animals in the diagrams, making sure that they know how the names are pronounced. Read the sentences out at normal speed first; students write T(true) or F(false). Then read them again more slowly so that they can write them down correctly, changing the false statements.

Project work: students can follow up this unit by collecting plants, animals, fruit, bones etc. and describing their shapes.

Listening text for Section 4

Exercise 8: true/false sentences: read twice

a) An antelope is a warm-blooded creature.
b) A frog is an amphibian with four legs.
c) A hawk has lungs.
d) Tortoises have gills.
e) A snail is a cold-blooded invertebrate.
f) Sharks live on land and in water.
g) An earthworm lives in the soil.
h) The shell of a tortoise is flat.
i) The anterior end of an earthworm is flattened.
j) The body of an antelope is roughly cylindrical.
k) A shark does not have vertebrae.
l) The shell of a snail is spiral in shape.

Answers to exercises

Exercise 1

a) living organisms . . . animals . . . plants
b) vertebrates/vertebrate animals . . . invertebrates/invertebrate animals
c) non-flowering plants . . . flowering plants
d) vertebrate/vertebrate animal . . . vertebrae
e) an invertebrate animal/an invertebrate . . . does not have vertebrae
f) is a non-flowering plant . . . does not have flowers
g) is a flowering plant. It has flowers.

Exercise 2

Birds are warm-blooded vertebrates. They have feathers and wings. They have lungs. They live on land.

Reptiles are cold-blooded vertebrates. They have dry scales. They have lungs. They live on land.

Amphibians are cold-blooded vertebrates. They have damp skin. The young have gills. Adults have lungs. They live on land and in water.

(Point out the plural form.) Fish are cold-blooded vertebrates. They have damp scales. They have gills. They live in water.

A duck is a bird. It has feathers and wings. It has lungs. It lives on land.

A lizard is a reptile. It has dry scales. It has lungs. It lives on land.

A frog is an amphibian. It has damp skin. The young have gills.

An adult has lungs. It lives on land and in water.

A shark is a fish. It has damp scales. It has gills. It lives in water.

Exercise 3

Reptiles are cold-blooded vertebrates with dry scales and lungs, living on land.

Mammals are warm-blooded vertebrates with hair, skin and lungs, living on land.

Fish are cold-blooded vertebrates with damp scales and gills, living in water.

Exercise 4

a) Because they do not have lungs. *b*) Because they have wings. *c*) Because they have hair. *d*) Because they have gills. *e*) Because it is warm-blooded. *f*) Because it is cold-blooded.

Exercise 5

a)

Cocci	**Bacilli**	**Spirilla**
Streptococcus	*Bacillus tuberculosis*	*Vibrio cholerae*
Diplococcus	*Salmonella typhi*	*Spirochaete*
Staphylococcus	*Clostridium tetani*	
	Escherichia coli	

b) *Streptococcus* is spherical in shape and occurs in chains.

Vibrio cholerae is comma-shaped with a single flagellum.

Diplococcus is spherical/round and has two cells joined together.

Spirochaete is spiral in shape.

Bacillus tuberculosis is (shaped like) a square-ended rod/a rod with square ends. *Or* it is rod-shaped with square ends.

Salmonella typhi is rod-shaped with round ends/shaped like a round-ended rod, with long flagella.

Clostridium tetani is rod-shaped. One end is square and the other is round/spherical.

Staphylococcus is spherical in shape and occurs in groups.

Escherichia coli is rod-shaped with round ends/is (shaped like) a round-ended rod/a rod with round ends.

Exercise 6

Diagram 2 shows the longitudinal section of an earthworm. It is roughly cylindrical in shape. The anterior end is tapering. The body is divided . . . into . . . rings.

Diagram 3 shows the transverse section of an earthworm. It is roughly cylindrical in shape.

Diagram 4 shows the longitudinal section of a tapeworm. Its body is flat. The body is divided into flat rectangular segments.

Diagram 5 shows the head of a tapeworm. The head is small and spherical. It has . . . a ring of hooks (remainder of first paragraph).

Diagram 6 shows a tapeworm. Its body is flat and ribbon-like. The body is divided into flat rectangular segments. These are smaller at the anterior end.

Diagram 7 shows the transverse section of a tapeworm. Its body is flat (i.e. not cylindrical).

Exercise 7

a) a cylindrical segment *b*) a transverse groove *c*) a swelling *d*) a flattened part *e*) a circular part *f*) a curved projection *g*) a ring of hooks *h*) evenly spaced parts *i*) a spherical part *j*) a rectangular segment

Exercise 8

a) False; an antelope is a warm-blooded vertebrate. *b*) True *c*) True *d*) False: a tortoise has lungs/does not have gills. *e*) True *f*) False: sharks live in water. *g*) True *h*) False: the shell of a tortoise is curved/round. *i*) False: the posterior end of an earthworm is flattened. The anterior end is tapering. *j*) True *k*) False: a shark has vertebrae. *l*) True

UNIT 2 Location

Aims

To extend the ways of describing the appearance of living things by practising expressions which refer to position and location.

Main language items

Statements about position: *be* + preposition + noun phrase: e.g. *The style is above the ovary.*

Technical terms for position: adjectives (*superior* etc.) preposition phrases (*anterior to* etc.); nouns (*surface* etc.).

Verbs associated with position: *be located/found/situated in* etc. *lie in/run through/project from.*

Connectives used in comparing and contrasting: *both . . . and . . . while . . ./whereas. . . .*

Notes

The prepositions of place include basic ones like *above* and specialised usages such as *superior to*. Students who have done Unit 2 of *General Science* will be familiar with the non-technical items, which are used in elementary biological textbooks. In addition to these, he needs to know the specialised expressions, which are often more precise and are found in more advanced texts. The meaning of the scientific terms does not depend on the position of the observer.

These expressions are also used in naming certain organs which are distinguished by their position, e.g. the *anterior* and *posterior vena cava*. Abstract diagrams are used to show the meaning of new terms, which are then practised with the aid of actual biological drawings.

In Section 1 certain technical terms are presented together with roughly equivalent non-technical expressions. *Superior*, *inferior* and *lateral* are used frequently in the description of the structure of plants. The items are presented through abstract diagrams before being used to describe parts of plants. You can reinforce them with the aid of real objects: a whole plant for Exercise 1, plant stems or fruit in cross section (transverse section) for Exercise 2, different kinds of flower for Exercise 3. These can be used both to practise the items initially and for group and pair work following the exercises: students ask one another where the parts of the plants are.

In Exercise 1 note the term *in relation to* (g), which is practised in *General Science*, Unit 2.

The term *layer* in Exercise 2 has many uses, referring to the structure of cells, stems, leaves, skin etc. Demonstrate by cutting across and down an onion (transverse and longitudinal sections). Each layer has *surfaces*, adjoining the next layers. In this exercise, the term is limited to the surface of the outer layer, which can be seen. Note that, where there are several *outer/inner* layers, we also use the terms *outermost/innermost*.

Exercise 3 is about different kinds of flower, which are classified according to the shape and position of their parts. Note the meaning of the Latin and Greek prefixes, used in the formation of many other technical terms: *hypo-* = below; *peri-* = around; *epi-* = on. (The word-stem *gyno-* means 'female' and in botany refers to the pistil or ovary.)

For Section 2, models, large pictures or preserved bodies of animals would be useful to demonstrate the technical adjectives for positions. Exercise 5 explains these terms in non-technical language; students then show that they understand by labelling diagrams with the technical words. Exercise 6 applies them to the description of the human blood system. Note the special use of *left* and *right* here: *left* – on the left side of the body, but on the right of the diagram.

In Exercise 7, Section 3, the diagram helps to explain the parts of the tooth described in the reading passage. Some real or model teeth would be useful here. The tooth illustrated has a double root; some teeth have single roots. The references in the text to *upper* and *lower* parts is true for the lower set of teeth. When describing the upper set of teeth, the terms have to be reversed.

Exercise 9 practises connectives which are useful in comparing and contrasting. Note that joining sentences with *both . . . and . . .* may involve changing the sentence into the plural. Students can make their own comparisons and contrasts about other things mentioned in the unit: different kinds of flowers, veins and arteries etc.

The listening exercises in Section 4 present the ways of describing position in the spoken form. Exercise 10 introduces the different parts of the cockroach, for recognition purposes. Exercise 11 is about their positions.

Project work: students can collect plants, fruit and vegetables in section, insects etc., and describe the location of different parts. They can do the same for the cross section of plant stems, leaves etc., if they have access to microscopes.

Listening texts for Section 4

Exercise 10

This diagram shows a cockroach – *Periplaneta americana* – viewed laterally. It shows some of the external parts of its body: the abdomen, the position of the spiracles along the side, the thorax at the front, the style and cercus in a posterior position. In this diagram the wings are lying along the top of the body; the fore-wing is superior to the hind-wing, which cannot be seen. The parts of the head include the jaw, also called the mandible, the compound eye and the other mouth parts. There are two antennae over and behind the head. The parts of the legs include the femur, the tibia, the tarsus and the claw.

True/false sentences: read twice

a) The diagram shows a ventral view of a cockroach.
b) The head is located at the front of the insect.
c) The fore-wing is anterior to the thorax.
d) The thorax is on the anterior part of the abdomen.
e) The jaw is situated in the superior part of the head.
f) The base of the antenna is inferior to the compound eye.
g) The position of the spiracles is between the lower abdomen and the fore-wing.
h) The cercus is situated under the base of the wing.
i) In this diagram, the tips of the antennae are on the wings.
j) The claw is at the end of the leg.
k) The tibia is situated at the base of the leg.
l) The tarsus is between the tibia and the femur.

Answers to exercises

Exercise 1

a) The shoot is usually found above the ground.
b) The root is usually found below the ground.
c) The lateral shoots and the leaves are lateral to the stem.
d) The buds, flowers and fruit are located at the tip of the flowering shoot.
e) The root is situated at the base of the plant.
f) The lateral roots project laterally from the root.
g) The internode is between the nodes.
h) No, in this diagram they are superior.

Exercise 2

surface layers outer inner layer Between . . . middle layer centre through in the vascular bundle pericycle . . . xylem . . . phloem

Exercise 3

end stem lowest outermost inside higher inside outside centre base above tip

Exercise 4

a) the receptacle
b) the ovary
c) a hypogynous flower
d) a perigynous flower
e) a hypogynous flower
f) in an epigynous flower
g) Students should suggest examples, e.g. buttercup (hypogynous), rose (perigynous), apple (epigynous).

Exercise 5

(labels) *a*) medial *b*) superior *c*) inferior *d*) lateral *e*) anterior *f*) ventral *g*) dorsal *h*) posterior *i*) lateral view *j*) superior *k*) dorsal *l*) ventral *m*) inferior *n*) lateral view *o*) anterior *p*) posterior *q*) medial *r*) lateral *s*) dorsal view

Exercise 6

a) True *b*) True *c*) False: it takes blood from the right ventrical to the lungs. *d*) True *e*) False: it enters by the right auricle. *f*) False: they are lateral to them. *g*) False: it is superior to the heart. *h*) False: it passes through the hepatic portal veins. *i*) True *j*) True *k*) True *l*) True

Exercise 7

(labels) *a*) blood capillaries *b*) pulp *c*) root *d*) enamel *e*) dentine *f*) sensory nerve ending *g*) gum *h*) cement *i*) jaw-bone

Exercise 8

a) The upper part of the tooth is outside the jaw-bone.