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Teacher Guide

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Biology
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Cambridge Secondary 2

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Introduction

The purpose of the teacher guide

This teacher guide is designed to introduce you to the Cambridge IGCSE Biology syllabus and the related support materials available from Cambridge. It will help you to organise and plan your teaching. It also offers advice and guidance on delivery, classroom practice (including practical work) and preparing your learners for their final assessment.

What do I need to get started?

When planning your course, your starting point should be the **syllabus**, which contains a large quantity of essential information. It is most important that you become thoroughly familiar with all parts of the syllabus document.

You then need to devise a **scheme of work**. To do this, you need to think how you will organise the time that you have available to help learners to understand and learn all of the facts and concepts required by the syllabus, and to develop the skills – such as handling data and planning experiments – that are also required. Cambridge provides a sample scheme of work that you could use as a starting point, but you may want to adapt it or produce your own to best meet the needs of your learners.

Your scheme of work will help you to determine what **resources** you will require to deliver the course. You need to ensure that you have sufficient laboratory facilities to allow learners to carry out the practical work that is needed. You will also need to build up teaching, learning and reference resources such as text books and worksheets.

You should make sure, at an early stage, that you have access to the secure online support available to Cambridge teachers at **Teacher Support**, http://teachers.cie.org.uk. This provides a wide range of resources to help you, including past examination papers, mark schemes and examiner reports. All of these are invaluable in helping you and your learners to understand exactly what Cambridge expects of candidates in examinations, which will help you to prepare your learners appropriately.

This teacher guide provides suggestions and help with all of these aspects of planning your IGCSE Biology course.

Please have your copy of the most recent syllabus at your side as you read through this document, as you will need to refer to it frequently. References are provided throughout the document that indicate the relevant sections of the syllabus, and other documents that you should refer to, as you work through this guide.

Section 1: Syllabus overview

1.1 Aims

The syllabus aims, which are not in order of priority, are listed at the start of Section 3 in the syllabus.

The aims provide you with an overview of what Cambridge expects learners to experience and achieve as they follow their IGCSE Biology course. You should bear these in mind as you plan your scheme of work. Notice that many of the aims relate to attitudes and skills, rather than simply the accumulation of knowledge. A Cambridge IGCSE Biology learner should develop attitudes and skills that will be useful in many areas of their life, long after they have taken their IGCSE Biology examinations.

1.2 Assessment Objectives

The assessment objectives (which can be found in section 3.2 of the syllabus) are statements about what will actually be tested in the final examinations. Each question or task that is set in the examination relates to one or more of these assessment objectives (AOs).

All of the IGCSE Science syllabuses have the same three AOs. These are:

A: Knowledge with understanding

B: Handling information and problem solving

C: Experimental skills and investigations

Each of these AOs has several components.

A: Knowledge with understanding

Candidates should be able to demonstrate knowledge and understanding of:

1. scientific phenomena, facts, laws, definitions, concepts, theories
2. scientific vocabulary, terminology, conventions (including symbols, quantities and units)
3. scientific instruments and apparatus, including techniques of operation and aspects of safety
4. scientific quantities and their determination
5. scientific and technological applications with their social, economic and environmental applications.

The knowledge that learners should acquire is described in the 'Contents' section of the syllabus.

B: Handling information and problem solving

Candidates should be able, using oral, written, symbolic, graphic and numerical forms of presentation, to:

1. locate, select, organise and present information from a variety of sources
2. translate information from one form to another
3. manipulate numerical and other data
4. use information to identify patterns, report trends and draw inferences

5. present reasoned explanations of phenomena, patterns and relationships
6. make predictions and propose hypotheses
7. solve problems, including some of a quantitative nature.

Questions testing AO B will frequently be based on contexts and information that are unfamiliar to candidates. They will require candidates to apply the facts, principles and concepts that they have learnt (specified in the syllabus content) to new situations. Candidates need to develop confidence in applying their knowledge and understanding in a logical way, using reasoning or calculation to deduce suitable answers. This means that your course needs to do much more than simply teach learners the material described in the 'Contents' section of the syllabus. It must also help them to develop these skills of reasoning and deduction.

C: Experimental skills and investigations

Candidates should be able to:

1. know how to use techniques, apparatus and materials (including following a sequence of instructions, where appropriate)
2. make and record observations and measurements
3. interpret and evaluate experimental observations and data
4. plan investigations, evaluate methods and suggest possible improvements (including the selection of techniques, apparatus and materials).

The development of experimental skills (scientific enquiry skills) should be an important part of your scheme of work. Learners should have the opportunity to do a wide range of practical work throughout their course. Some of this will require laboratory facilities and equipment, but there are many practical activities in Biology that can be done in a normal classroom, or outdoors.

1.3 The assessment structure

It is a good idea, right from the start of planning your IGCSE Biology course, to make sure that you have a full understanding of how your learners will be assessed by Cambridge at the end of it. There are choices to be made about which papers candidates can be entered for. You do not need to make final decisions about these straight away – they are made when you actually enter your learners for the examinations, a few months before the examination period – but you should keep them in mind as you construct your scheme of work and lesson plans.

Each learner will need to take three components, called 'papers'.

Paper 1

All candidates take Paper 1. This is a multiple-choice paper. The questions are set on the Core syllabus content only. The questions test AO A and AO B. The paper is taken in an examination room, under strict examination conditions. The completed answer sheets are sent to Cambridge to be marked.

Paper 2 or Paper 3

Each candidate takes either Paper 2 or Paper 3. You can find examples of these on Teacher Support at http://teachers.cie.org.uk. These are both made up of structured questions, which test AO A and AO B. The papers are taken in an examination room, under strict examination conditions. The completed papers are sent to Cambridge to be marked.

You need to be aware of the differences between these two papers.

Paper 2 is easier than Paper 3. This is because:

- Paper 2 tests candidates on their knowledge and understanding of the Core syllabus content only, while Paper 3 tests them on their knowledge and understanding of the Core and Supplement content. (See 1.4.1 for an explanation of Core and Supplement content)
- Paper 2 tends to contain questions that are slightly less demanding in terms of reasoning skills than Paper 3. The questions tend to be shorter, contain less reading for candidates, and require shorter answers
- However many marks candidates obtain on Paper 2, they cannot achieve more than a Grade C. Candidates taking Paper 3 can achieve any grade from A* down to G.

An understanding of the differences between these two papers will help you to decide on whether you will teach both the Core and Supplement syllabus content, or the Core only. Candidates who are unlikely to get a Grade C are likely to achieve a better grade if they study only the Core and take Paper 2. However, candidates who you think stand a good chance of achieving a Grade C or above should study both the Core and Supplement, and take Paper 3. This is also important for candidates who are likely to want to continue their studies of Biology beyond IGCSE.

Paper 4, Paper 5 or Paper 6

Each candidate takes either Paper 4, Paper 5 or Paper 6. These all test AO C, Experimental skills and investigations. Again, you can find examples of these papers on Teacher Support.

Paper 4 is not really a 'paper' at all. If you choose to enter candidates for Paper 4, you yourself will assess their practical skills throughout the course. The details of how this should be done are explained in the *Coursework Training Handbook (Part 1): Guidance* booklet. If you are not familiar with coursework assessment, it is recommended that you also obtain and work through the *Cambridge IGCSE Sciences Coursework Training Handbook (Part 2): Teacher Accreditation* booklet.

Paper 5 is a practical examination. Several weeks before the examination is taken, Cambridge will send you a list of apparatus and materials that you need to supply. During the examination, your candidates will work in a laboratory, each with their own working space and set of apparatus, under strict examination conditions. They will write answers in an examination paper, just as they would for a theory examination. The examination paper is sent back to Cambridge to be marked.

Paper 6 is a written paper. It looks just like Paper 2 or Paper 3, but it tests AO C. The questions test learners' experience of practical work. The paper is taken in a normal examination room, and is sent to Cambridge to be marked.

Weightings

The 'weighting' of a paper tells you the relative importance of that paper in deciding the candidate's overall mark and final grade (see section 3.4 of the syllabus).

The table below summarises the weightings of the three components that a candidate will take at the end of their course.

Paper	Weighting
Paper 1	30%
Paper 2 or Paper 3	50%
Paper 4 or Paper 5 or Paper 6	20%

You will remember that Paper 1, Paper 2 and Paper 3 test largely AO A and AO B. The questions in these papers will have approximately five eighths of their marks that test AO A, and approximately three eighths that test AO B.

Paper 4, Paper 5 and Paper 6 each test AO C.

The table below summarises how the three assessment objectives are tested in the three examination components. It also shows the weighting of the three AOs in the whole examination.

Assessment Objective	Number of marks in Paper 1	Number of marks in Paper 2 or Paper 3	Number of marks in Paper 5 or 6 (or 4)	Overall percentage for the whole set of Papers
A	25–30	48–52	0	47–54
B	10–15	27–32	0	26–33
C	0	0	40 (48)	20

If you look at the final column of the table above, you can see that:

- Assessment Objective A makes up about 50% of the whole assessment.
- Assessment Objective B makes up about 30% of the whole assessment.
- Assessment Objective C makes up about 20% of the whole assessment.

This means that only half of the total marks in the three examination papers are for knowledge and understanding of the syllabus content. Half of the marks are for being able to use this knowledge and understanding in new contexts, and for experimental skills. It is essential to bear this in mind as you plan your IGCSE Biology course. You need to spend at least as much time helping learners to develop their AO B and AO C skills, as in helping them to learn facts and concepts.

1.4 Curriculum content

The largest section in the syllabus is Section 4, Curriculum Content. It is here that you will find details of exactly what your learners need to know and understand by the end of the course. It is presented as a series of bullet points (learning objectives) which state clearly what candidates should be able to do in the examination papers that they take at the end of their course. Each of the questions that are included in the examination papers tests one or more of these learning objectives.

You should read each learning objective very carefully. Each one gives you clear guidance about exactly what candidates should learn. Some of them provide definitions of important biological terms, and these are the definitions that your learners should use.

1.4.1 Core and supplement

One of the first things you will notice about the curriculum content is that it is presented in two columns. The left hand column is the Core content. *All* candidates need to cover *all* of this. This will be tested in all papers.

The right hand column is the Supplement content. All candidates who you think are likely to achieve a good Grade C or above should cover all of this, as well as the Core. **The Core plus Supplement makes up the Extended curriculum.** This will be tested only in Paper 3.

1.4.2 Time allocation

The syllabus content has four main sections. Suggested time allocations are as follows:

Section 1:	Characteristics and classification of living organisms	5%
Section 2:	Organisation and maintenance of the organism	50%
Section 3:	Development of the organism and the continuity of life	25%
Section 4:	Relationships of organisms with one another and with their environment	20%

It is important to appreciate that these are only recommendations, and you should not feel that you need to follow them exactly. Much will depend on what your learners have done before they begin their IGCSE course. Time allocation will also be affected by how you decide to deal with developing the AO B and AO C skills.

It is suggested that – as for all other IGCSE syllabuses – learners should have about 130 guided learning hours to cover this course.

'Guided learning hours' means the time that the learner spends being directly taught by the teacher, or carrying out supervised work or directed study. In addition, learners will need to spend some time in private study.

Most Centres cover the IGCSE Biology course over two years. However, this is not essential. There is no upper or lower limit on the age at which a learner can take the IGCSE Biology examinations.

The quantity of factual content contained in the syllabus has been limited, to ensure that you will be able to devote sufficient time to developing the AO B and AO C skills. You will want to include plenty of

experimental and other practical work throughout the course. Some areas of the syllabus lend themselves more easily to this approach than others, which you will need to take into consideration when constructing your scheme of work.

1.4.3 Using the correct terminology

IGCSE Biology is an international examination, taken by candidates all over the world. It is therefore important that each learner becomes familiar with the terminology and symbols that are used in the examination papers (see section 6.2 of the syllabus). Because of different conventions in different countries, this means that there are inevitably instances in which these will not be the same as those that the learner has used previously.

All of the IGCSE Science syllabuses use the International System of units (SI units). These are shown in a table in section 6 in the syllabus. It is most important that learners are completely familiar with these units, and their symbols. These are the symbols that will be used in examination questions, and candidates will be expected to use them in their answers. Other symbols may not be accepted if given in a candidate's answer.

Note that Cambridge uses the cubic decimetre, dm^3, rather than the litre, *l*, as the unit of volume. This is because the symbol for litre can easily be confused with the number 1. Similarly, cm^3 is used rather than ml. Learners will need to have this explained to them, particularly if they are using apparatus that has volumes marked in ml. They should know that one ml is the same as one cm^3.

In table and graph axes, quantities are separated from their units using a solidus, /. So, for example, a graph axis showing time in seconds will be labelled 'time/s'.

Decimal points will be shown as a dot on the line, not raised above the line, for example 2.3.

Section 2: Planning the course

This section looks at how you can plan your course to ensure that you can cover the whole syllabus (whether this is to be just the Core, or the Core plus Supplement) within the time that you have available to you. It includes long-term planning, medium-term planning (developing a scheme of work) and planning for individual lessons.

2.1 Key factors to consider when planning your course

There are a number of factors that you need to bear in mind when you begin to plan how you will deliver the IGCSE Biology course. These are likely to include some or all of the following. There may also be other factors, not listed here, that are specific to your school. It's very important to consider these right from the start of the planning process, rather than trying to accommodate them into your plan at a later stage.

These factors will include:

- the amount of teaching time available for the whole duration of the course; note that the recommendation for guided learning hours is 130
- the number and length of lessons that you expect to have available (remember to take into account time lost to internal examinations or other school activities that will take learners away from your lessons)
- the number of lessons that you will be able to have in a laboratory, rather than in a normal classroom
- the resources that you have available, for example laboratory apparatus and materials
- whether or not you have help to organise practical work, for example a laboratory technician
- the possibility of taking your learners outside school, for example to visit a museum or to study ecology
- the climate and seasons in your country, that will affect when you decide to cover areas of the syllabus where resources and practical work may be affected by this, for example plant reproduction or photosynthesis
- any cultural and religious conventions that may affect the way you can treat particular areas of the syllabus, for example human reproduction
- the previous experience of your learners – for example, whether you expect most of them to have followed a course where they will have developed scientific enquiry skills (for example, Cambridge Secondary 1 Science) or whether they will come from a range of backgrounds
- whether or not most of your learners are likely to be studying other science courses at an equivalent level, which may help to support some of the topics in Biology, and also the development of scientific enquiry skills
- the homework policy of your school
- the assessment policy of your school

All of these factors can vary greatly between different schools. It is therefore most important that you develop your plans to suit your particular circumstances.

2.2 Long-term planning

The purpose of a long-term plan is to set out a framework that ensures the whole syllabus (including the development of the AO B and AO C skills) is covered within the time that you have available. There is a sample long-term plan in Appendix A of this guide. This is very much for guidance only, and your own long-term plan will almost certainly differ from this, as it will need to take into account all of the factors listed in section 2.1 above.

It is important to appreciate that you do not have to follow the order of topics as they are listed in the syllabus. The syllabus tells you what will be assessed; it does *not* tell you how to deliver the material. This is for you to decide. So, for example, you might decide to start your course with Section 1 (Characteristics and classification of living organisms) and Section 4 (Relationships of organisms with one another and with their environment), perhaps because you can see ways of linking the learning objectives in these two areas together, or because this is a good time of year to take learners outside to find and identify organisms using keys, and also to investigate food chains, to study the growing of crops or to visit a sewage treatment works.

If there is more than one teaching group in your school, then you may decide that each teaching group will follow the same long-term plan. However, this is not always essential, or even a good idea. For example, if you only have limited laboratory space, you could plan so that topics such as enzymes, which involve a great deal of practical work, are not studied by all the classes at the same time. Also, if your classes are streamed by ability, you may decide that one or more classes will cover only the Core curriculum, while others will cover both the Core and Supplement.

If you have decided to enter candidates for Paper 4, (the school-based assessment of practical skills), then it would be a good idea to include an outline of when you will do these assessments in your long-term plan. There are many good reasons for beginning assessments in the first term, providing learners with feedback and giving them plenty of time to build up their practical skills throughout the course.

You will almost certainly find that you need to review your long-term plan each year. You may find that some topics took you longer than expected, while others were covered more quickly. The availability of resources may change. You may decide to change the sequence in which you originally decided to teach certain topics, perhaps because it became clear that learners needed to acquire more underlying knowledge and understanding before they were able to deal effectively with a particular set of learning objectives. Ideally, all teachers within the Biology department should be involved in reviewing how well the long-term plan is working, and suggesting how it could be improved.

2.3 Medium-term planning

A medium-term plan is often known as a scheme of work. This sets out in more detail how you intend to cover each learning objective in the syllabus, and also how you will help learners to develop the AO B and AO C skills.

The scheme of work is of tremendous importance in:

- providing a framework to help everyone in the Biology department to feel secure in delivering the course effectively, and within the time that you have available
- enabling you to see, early on, what resources you will require, so that you can ensure that these are on hand when you need them
- ensuring that due consideration is given to developing AO B and AO C skills (it is all too easy to get so tied up in covering the 'Content' section of the syllabus that these can be forgotten)

- identifying where links can be made between different areas of the syllabus
- making sure that there will be time at the end of the course for revision.

Cambridge provides a sample scheme of work on Teacher Support, at http://teachers.cie.org.uk. (You will need a password, obtainable from your Exams Officer, to get access to this website.) An extract from this scheme of work is provided in Appendix B. It is most important to understand that this scheme of work is intended only as an example, and you do not need to follow it. Each school will wish to develop their own scheme of work, to suit their particular circumstances.

As for the long-term plan, it is good to involve everyone in the department in the construction of the scheme of work. And, once again, you should not view this as something set in stone. The scheme of work should be constantly reviewed and improved.

2.4 Short-term planning

A short-term plan is an outline of what you intend to do in a particular lesson, or perhaps a small group of lessons. These are called lesson plans, and suggestions about how to plan lessons are provided in section 3.

Section 3: Planning lessons

The purpose of a lesson plan is to set out, in detail, exactly how you intend to work with your learners during a lesson (or perhaps a small sequence of lessons). The lesson plan will help you to focus clearly on:

- what you are intending your learners to achieve during the lesson – including not only the curriculum content, but also AO B and AO C skills
- how you are intending to help them to achieve these goals
- what resources you will need (e.g. worksheets, video clips, ICT resources, apparatus for practical work)
- how you will start and end the lesson
- the approximate timings you expect each stage of the lesson to take
- how you will organise the classroom – for example, by arranging tables for group work or pair work
- how you will ensure that all learners, no matter what their ability, will be suitably challenged and occupied throughout the lesson
- how you will use assessment for learning to judge what your learners know and understand, and what they need to do next

It takes time to plan a good lesson, but this is time very well spent. You can re-use lesson plans developed in one year, or for one teaching group, in the following year or for another teaching group.

3.1 Constructing a lesson plan

A search on the internet will enable you to find numerous different examples of lesson plan templates. One example is shown in Appendix C.

3.1.1 Learning objectives

The learning objectives that you intend to cover in the lesson can be taken from your scheme of work, or from the syllabus. Remember that these can include objectives relating to skills (for example, constructing a results table, or analysing data) as well as those from the 'Curriculum Content' section of the syllabus.

3.1.2 Lesson objectives

These are the particular objectives that you plan to address during the lesson. They may sometimes be identical to the learning objectives. However, they may be significantly different from these. For example, a learning objective might be:

- explain the effect of changes in temperature on enzyme activity (taken from the syllabus content, section II.5).

The lesson objectives might be:

- be able to draw a graph to show how enzyme activity varies with temperature
- use particle theory to explain why the rate of an enzyme-catalysed reaction increases up to an optimum temperature
- use an understanding of the effect of temperature on the shape of the enzyme molecule to explain why the rate of reaction decreases at temperatures above the optimum.

3.1.3 Vocabulary

Biology is renowned for its large quantity of subject-specific terminology. Learners need to be introduced to new terms carefully, and it is a good idea to identify these clearly so that you can ensure you give your learners thorough guidance in their meaning. Remember that many of these specialist terms have definitions provided in the syllabus, and it is a good idea for learners to know these particular definitions.

You may also need to consider any potential difficulties that could arise because learners are working in their second language. For example, you may need to help them to construct suitable phrases or sentences to describe trends in a graph, or to explain a set of results.

3.1.4 Previous learning

You should always bear in mind where you expect your learners to be starting from. You may already have a very good idea of what you would expect them to know at the start of the lesson, but it is never safe to take this for granted. For example, if you are doing work on enzymes, learners will need to have a good grasp of the concept of what a molecule is, have a sound understanding of particle theory, and know what is meant by a 'chemical reaction'. As biologists, we often take for granted that all of this will have been covered in Chemistry lessons – but just because it has been taught does not mean that all of the learners will actually have learnt it!

Once you have identified what learners need to know, in order to be able to progress during your lesson, you may like to include a quick check on this at the start of the lesson. You could perhaps do this with oral questioning, or a short quiz or multiple-choice test. If this shows up shortcomings, then you will need to respond to this discovery and amend your lesson to ensure that you help learners to build up the necessary background before you embark on your planned work.

3.1.5 Planned timings

A good lesson has a clear beginning, middle and end. The start of the lesson should try to grab the attention of the learners, and get them interested and involved in what is to follow. A search on the internet for 'biology starter activities' can provide you with many different ideas for 'starter activities' that you could try.

The main part of the lesson is where you help learners to develop the knowledge, understanding and skills that you have identified in the Lesson objectives. It is good to do this in different ways in different lessons. You should ensure that learners are actively involved in their learning in some way, rather than passively absorbing information provided by you.

The final part of the lesson is often called a plenary. This is where you can pull together what has been learnt in the lesson. It can be very valuable in helping learners to see just how much they have learnt, and can also give you feedback on how successful the lesson has been, and whether your learners are ready to move on from this topic or whether they need more time to develop a full understanding of it. An internet search will provide many ideas for a variety of ways of conducting a plenary session.

3.1.6 Additional information

This part of the lesson plan is where you can decide how you are going to deal with differentiation, assessment and any health and safety issues.

Differentiation means ensuring that every individual learner in your class, no matter what their ability, is involved in tasks that are suitable for them, and that will enable them to make good progress. This is particularly important if you have a wide ability range in your class. You will need to think about how you can make sure that your brightest learners are being fully stimulated and stretched, while the least able can still feel fully engaged with the lesson, and make confident progress.

Assessment that takes place within a lesson will almost always be **formative** assessment. Formative assessment means finding out what your learners know and understand, so that you can:

- make adjustments to your teaching – if you find that learners do not understand a particular topic, then you need to review how you have covered this, and make changes in your teaching to help learners to improve their understanding
- plan where your learners need to go next – once you and they are aware of what they already know and understand, you can identify the next step they need to take to move forward.

Much of the formative assessment that happens during lessons is very informal. For example, you might listen to your learners talking to each other as they work on a group task. You might move around between the groups and ask specific, pre-planned questions to check a particular aspect of their learning. These questions could be listed in this part of the lesson plan. Or you might encourage learners to ask *you* questions – another very good way of finding out what they know and understand.

Health and safety issues will be particularly important if you are doing practical work. This is perhaps also an area where you can list any ICT skills that you hope learners will develop during your lesson.

3.2 Reflection and evaluation

However carefully you plan your lesson, it is almost certain that things will not work out exactly as you had hoped. Perhaps you got the timings wrong, and tried to fit more into the time than was realistically achievable. Perhaps the learners did not have enough challenging activities to do, and lost interest. Perhaps you had failed to appreciate a lack of previous knowledge that should have been addressed before you began this particular topic.

You may well have been able to deal with many of these problems at the time, making on-the-spot changes to your initial plans. In other cases, you may not be able to do this, but will want to make changes when you teach this particular lesson in future. In either case, it is very important to make a note of these changes either during the lesson, or immediately afterwards, before you forget. The lesson plan template in Appendix C has spaces specifically for you to do this.

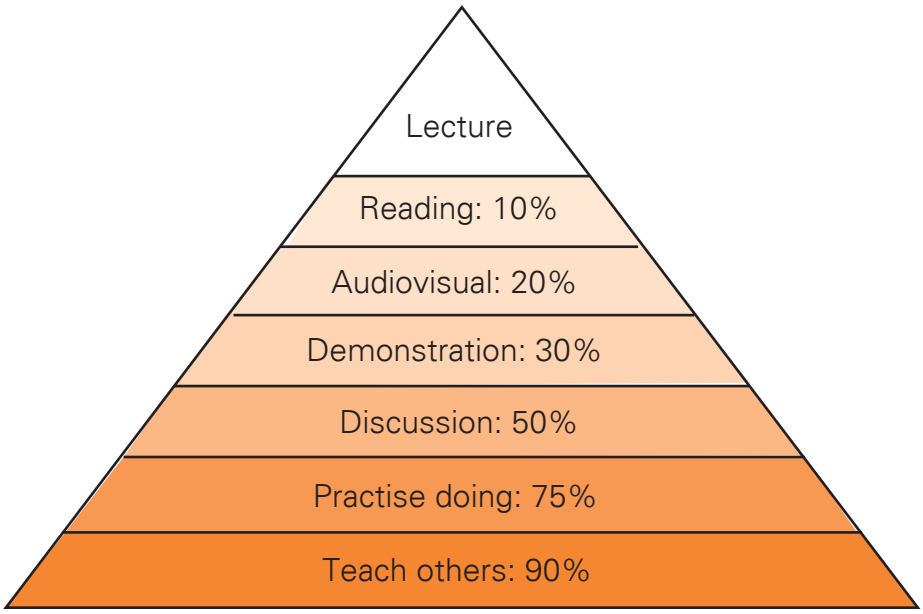
Section 4: Classroom practice

4.1 Active learning

Active learning is about learners being engaged in their learning. They are not simply passive recipients of information supplied by you. They are involved in a variety of activities that involve thinking, moving, talking, doing practical work and developing their understanding of a topic.

Cambridge syllabuses aim to produce learners who are actively involved in their own learning. They should become self-confident biologists, able to look critically at information provided in the media, willing to ask questions and try to find answers, and take an informed interest in the wide range of important issues in today's world that relate to Biology, such as climate change, population growth, habitat destruction or how lifestyle and diet can affect health.

Active learning will help to achieve these aims. Active learning techniques also increase learners' enjoyment of learning. Research shows that active learning is associated with much higher retention rates. Typical learner retention rates for different types of learning activities are illustrated in the 'learning pyramid'.



Biology is a subject that easily lends itself to a very wide variety of different styles of active learning. If you would like to learn more you could consider taking part in one of the Cambridge courses for teachers, outlined in Section 6.4.

4.2 Practical work

Practical work should be an important feature of your scheme of work and lesson plans. There is a huge range of practical activities that Biology learners can engage in, which will not only be enjoyable in themselves but will also help them to develop skills, and to increase their understanding of the learning objectives described in the Curriculum Content section of the syllabus.

4.2.1 What practical work should I do?

Teachers often ask if there is a definitive list of practicals that they should do with their learners. There is not. The only specific practicals that you should ensure that you cover are those that are specifically stated within the Curriculum Content section of the syllabus.

For example, in Section II 5, there is a learning objective which states that learners should:

- Investigate and describe the effect of changes in temperature and pH on enzyme activity.

It is therefore possible that questions could be set on the examination papers that test whether learners understand how to carry out these investigations, including practical details of how to set up their apparatus, collect results and analyse them. Unless your learners have actually done these experiments, they are unlikely to perform well when answering such questions.

However, the syllabus does not specify *which* enzymes should be used in the practical work. This is your choice. You might decide to use catalase, amylase, trypsin, pepsin or any other enzyme that you have available. Nor does it specify the techniques that should be used. This is also your choice.

The important point is that, having done a range of practicals, learners should be able to apply their knowledge and understanding to answer questions that relate to unfamiliar practicals. You should not aim to do every single practical activity that has ever been used in previous examination papers during your course, in the hope that one of these will appear again on the forthcoming examination paper. Examiners are good at coming up with new practicals that have not been used before. They are testing whether your learners are able to apply their knowledge in new situations. Your task is therefore to help your learners to develop the *skills* of doing practical work, so that they can apply these to new and unfamiliar situations.

You should not limit the practical work that you do to those that are specifically required by the syllabus. For example, there are no practicals mentioned in the syllabus section on osmosis (Section II 4.3), but this is an excellent area in which to use a range of practical activities to engage learners' interest, to help them to understand the concept of osmosis, and to help them develop the AO B and AO C skills.

4.2.2 Facilities for practical work

There are many Biology experiments that can be done in a normal classroom, or outside in the school grounds. However, to enable learners to experience a full range of practical work, you will also need to have access to a properly equipped laboratory.

Ideally, you would have all of your Biology lessons in a laboratory. This makes it easy to integrate practical work with theory, and enables a lesson to move seamlessly from one to the other. However, in many schools this is not possible, and you will need to consider how timetabling can best be organised to ensure that each class has sufficient laboratory time.

A list of the equipment that is considered appropriate for teaching IGCSE Biology can be found in Section 5 in the syllabus. Note that some of this equipment is also required for IGCSE Chemistry and IGCSE Physics, so it may be possible to share resources across all of the sciences.

Some Centres have laboratory technicians, who will help teachers to prepare for practical work and also to clear the laboratory afterwards, ready for the next class; some however, do not, and the teacher will need to consider how they will organise their time to ensure that preparation for practical classes can be fitted in between other tasks.

4.2.3 Organising practical work

In general, it is recommended that learners carry out practical work in groups. Research shows that there are many advantages to this approach, and learners will improve their knowledge, understanding and skills more rapidly when working in groups and discussing their work together, rather than working alone. It has also been shown that there are even more advantages when the teacher chooses the groups, rather than allowing learners to choose who they work with, especially if these groups are changed from time to time, allowing each learner to work at some point with every other learner in the class.

To ensure that each member of the group is contributing fully to the task, you can allocate a different role to each individual (or allow the group to do this themselves). For example, one person could be responsible for collecting and organising the apparatus and materials, others for carrying out the experiment, and another for recording the results. You could also ask one person from each group to feed back about their findings during the plenary at the end of the lesson.

However, if you are planning to enter learners for Paper 4 or Paper 5, then it is also important to give each learner the opportunity to work alone. This is necessary so that you are able to assess their individual performance for Paper 4, or to prepare them for working in examination conditions for Paper 5. This may mean that not all of the class can carry out an experiment at the same time, and you will need to consider how to manage this. For example, half of the class could do some written work while the other half does practical work, and then swap over part way through the lesson, or in the next lesson.

4.2.4 Safety in the laboratory

Many teachers are surprised to learn that statistics show that the laboratories are often the parts of the school in which fewest accidents occur. This good safety record can be attributed to the care that science teachers take in ensuring that behaviour and organisation in a laboratory always takes accounts of any risks that the practical work might introduce.

It is important to have a set of clear rules that all learners follow when in a laboratory, and to enforce these rigidly. Each school will have its own set of rules.

You also need to consider any specific risks that may arise during a particular practical exercise. There should be space for noting these on the lesson plan template (see Appendix C). Once the risks have been identified, then you should consider what needs to be done to minimise them. Learners should be made aware of the risk, and told what they should do to avoid them.

In general, most Biology experiments pose little if any risk. Although it is important to consider and reduce risks, it is also important not to make learners nervous of carrying out experiments.

There may be specific health and safety regulations in your country that you need to be aware of. For example, there may be restrictions on the use of material derived from animals, or from the learners themselves (such as cheek cells). Do make sure that you are fully aware of any such regulations.

Section 5: Preparing learners for final assessment

Cambridge IGCSE examinations are available at two times during the year – in October/November, and in May/June. Your school will have a policy about which of these series the majority of learners will take their examinations in.

IGCSE syllabuses are linear. This means that learners take all of the examination components during the same examination series. The exception to this is Paper 4, Coursework, in which the teacher carries out assessment throughout the course.

For learners to do the very best that they can in their examinations, it is important that they are fully aware of:

- the papers that they will be taking
- the format, style and requirements of these papers
- the kinds of answers expected by Cambridge examiners
- how their current level of performance matches up to the IGCSE Grades.

Cambridge provides a wide range of resources that can help with all of this.

5.1 Past papers

Past papers going back for the last five or six years can be found on Teacher Support, at http://teachers.cie.org.uk. In recent years, more than one paper has been produced for each examination series (the different versions are taken in different areas of the world), and this means that you have a very large number of past papers available to use.

Familiarity with these papers will help you to pitch your lessons appropriately. For example, you can use them to help you to appreciate the depth to which a particular topic needs to be taught, and the kind of terminology and phrasing that you need to ensure your learners understand.

Past papers will also show you how important it is that you help your learners to gain the confidence to tackle questions containing entirely unfamiliar contexts, and to be able to analyse data presented in various forms. They need to learn how to *use* their knowledge and understanding of the facts and concepts stated in the syllabus, perhaps to explain a set of data, or to make a prediction about what might happen in a particular set of circumstances.

A careful look at a range of past papers will also show that learners need to be prepared to make links between different areas of the syllabus – something that many learners do not find easy. This is especially noticeable in Paper 3. You can make sure that your scheme of work and lesson plans make provision for this, by identifying opportunities to link current work (for example, the nervous system) with earlier work (for example, cell structure or respiration).

5.1.1 Command words

You will also notice that it is rare for a 'question' to end with a question mark. Instead, the great majority of questions use a word that tells the learner what they need to do. These words, often called **command words**, need to be read carefully by the learner, who needs to be familiar with exactly what they mean.

The meanings of the command words are explained in Section 6.3 in the syllabus. These explanations are written in language that is directed at you (the teacher) rather than your learners, so it is not recommended that you ask learners to learn the meanings from this syllabus section. Instead, you will need to provide learners with questions, throughout their course, that use these command words appropriately, and give them feedback on their answers that will help them gradually to learn the meaning of each one.

The two command words that most often are misunderstood are 'describe' and 'explain'. Describing is generally easier than explaining, because it simply involves writing about *what* happens, rather than *why* or *how* it happens. Answers that provide descriptions when asked for explanations are unlikely to gain many marks, even if the descriptions are correct. Similarly, candidates frequently attempt to provide explanations when asked for descriptions, which again is unlikely to allow them to gain marks, even if their explanations are entirely correct.

5.1.2 Time allocation

A general rule of thumb that can help learners to judge time during an examination is 'a mark a minute'. In Papers 1, 2, 3 and 6, this works well. In each case, if learners try to spend approximately one minute on each one-mark question, three minutes on each three-mark question and so on, this will allow them to complete the paper within the time allowed and also have some spare time to read through the questions before they begin to answer, and to check their answers at the end. You should bear this in mind when you give your learners tests or 'mock examinations' during the course, so that they become accustomed to working at an appropriate speed.

5.2 Mark schemes, examiner reports and example candidate responses

5.2.1 Using mark schemes

Mark schemes for each paper are also available on Teacher Support. These are invaluable in helping you to plan your teaching, and especially in preparing your learners for the examinations.

Each mark scheme is preceded by explanations of the various symbols that are used. The mark schemes themselves consist of 'marking points', each of which ends with a semicolon and is worth one mark. The right hand part of the page provides additional information about how particular marking points should be applied.

Some question parts may have mark schemes that include more marking points than the number of marks that are available. In general, a learner can get maximum marks by including any combination of these points in their answer, up to the number of marks available. For example, if a question part is worth 3 marks, and there are 5 marking points, then an answer that includes any 3 of the points will get full marks. An answer that includes 4 or even all 5 marking points will still only get 3 marks.

It is very important to appreciate that these mark schemes are applied rigorously by Cambridge examiners when marking examination answers. You can use past questions as homework or classwork for your learners during the course, and then mark them using the appropriate mark scheme. This will help you to appreciate how important it is that your learners answer questions appropriately. They need to:

- use precise language that is appropriate to the question asked, making good use of the correct scientific terms rather than everyday language
- do exactly what the question asks them to do, rather than what they would have preferred it to ask them to do

- include a suitable depth and breadth of answer to match the question that is asked; the number of marks available, as well as the precise wording of the question, can be used as a guide for this.

5.2.2 Examiner reports

Following each examination series, Cambridge publishes a report compiled by examiners that describes how candidates performed on the various papers. These reports are available on Teacher Support, alongside the papers and mark schemes for each session.

You should read these reports carefully. They bring to light various issues that may be important for you to consider in your teaching. For example, they may highlight a particular misconception that was common among the candidates. Once you are aware of this, you can take steps in your scheme of work and lesson plans to try to address it with your own learners and help them to avoid similar mistakes. The reports also note any problems that candidates had with answering specific questions, perhaps in their failure to read and absorb information provided, or not considering carefully what the command word required.

5.2.3 Example Candidate Responses (Standards booklets)

Cambridge publishes a set of examples of responses made by candidates to a particular set of IGCSE Biology examination papers. These exemplify the types of answers given by candidates who achieved a Grade A, Grade C and Grade E. Each answer has a commentary, explaining why the candidate was given a particular mark, and what they could have done to earn more marks. These are available on Teacher Support.

It is very helpful to study this booklet carefully, matching the answers against the mark scheme and considering how you can help your learners to write answers that will give them as many marks as possible. You will see that it is often poor examination technique, rather than lack of understanding of the subject matter, that prevents a candidate obtaining full marks for a question.

The booklet will also help you to appreciate the standard required to achieve a particular grade. You can use this knowledge to give your learners guidance about the grade they are currently working towards, and to help to motivate them to try to improve to a higher grade, with specific things that they can do to increase their chances of achieving this.

Section 6: Resources and support

Cambridge provides a wide range of support materials, and also recommends other resources that you will find invaluable in helping you to plan your IGCSE Biology course.

6.1 Teacher Support

Teacher Support at http://teachers.cie.org.uk, is an invaluable resource for all IGCSE teachers. You should ensure that you have a log-in and password for this site (available from your Examinations Officer), and visit it regularly.

The site contains many subject-specific resources, many of which we have already referred to. To access these, click on Cambridge IGCSE and select Biology. You can also set up a short-cut that will take you here directly. Teacher Support provides the following resources:

- past papers and mark schemes, with examiner reports and grade thresholds for each examination session
- the syllabus; note that the year of the syllabus is the year it will be examined, (so the 2014 syllabus is the one from which the 2014 examinations will be set)
- a document listing opportunities for practical activities
- a discussion forum for IGCSE Biology teachers, where you can post questions and take part in syllabus-specific discussions
- a suggested scheme of work, which may give you ideas for developing your own; this also contains links to numerous websites that you may find helpful
- sets of questions that relate to each Unit of the scheme of work, which you may find helpful even if you do not use this particular scheme
- Example Candidate Responses

A list of recommended and endorsed books and other materials. An 'endorsed' resource, for example a text book, is one that has undergone rigorous quality assurance by Cambridge to ensure that it cloesely matches for the IGCSE Biology syllabus (or the part(s) of the syllabus that it claims to cover). A recommended resource is one that you may find helpful, but that has not been specifically designed to match the IGCSE Biology syllabus.

There are other resources in the Community Resource section, a link to which appears on most of the IGCSE Biology pages. These are resources that have been added to the site by IGCSE BIology teachers.

6.2 Coursework guidance and support

The coursework component of the Cambridge IGCSE Biology qualification is marked by the Centre and moderated by Cambridge. In order to mark, Centres must have at least one accredited teacher registered with Cambridge.

Cambridge provides a coursework guide which offers extensive advice on planning, delivery and assessment as well as exemplar material, called the: *Coursework Training Handbook (Part 1): Guidance*. It covers all the Cambridge IGCSE Sciences including (Combined, Coordinated and Physical Science). You can find a copy of the guide on Teacher Support or you can order a printed version through the Publications Catalogue, (accessible via the Cambridge public website www.cie.org.uk). This guide aims to provide material that will help teachers deliver the coursework in alignment with the assessment criteria, throughout the duration of the course.

A separate publication is available for those seeking accreditation, called: *Coursework Training Handbook (Part 2): Teacher Accreditation*. This publication is available on Teacher Support and through the Publications Catalogue.

Teachers seeking accreditation must work through Part 1 of the *Coursework Training Handbook* before attempting the accreditation course (Part 2) which consists of a number of tasks that teachers must work through and then submit to Cambridge for appraisal.

Teachers are notified (by post) within 4–6 weeks as to whether they have achieved accreditation status. If accreditation status is not awarded then the teacher can still continue to teach and mark coursework though they should not take part in moderating the marking of others. Teachers are free to resubmit their applications for accreditation any number of times, though each submission will incur a fee.

6.3 Training

The Events and Training section on Teacher Support takes you to a list of upcoming training events. These include:

- on-line courses, both self-study and tutor-led. The tutor-led courses are highly recommended to help you to improve your teaching skills. They are intended for teachers who have already been teaching IGCSE Biology for one year
- face-to-face courses, held at various venues at different times throughout the year. These enable you to meet up with other IGCSE Biology teachers, and also to interact directly with a trainer from Cambridge
- online seminars, which are led over a short period of time by an expert, and focus on specific issues such as syllabus changes or the recent examination session

You can also find information about face-to-face training events at www.cie.org.uk/events

In addition, Cambridge runs professional development courses for teachers who want to develop their thinking and practice. These include the Cambridge International Certificate for Teachers and Trainers, and the Cambridge International Diploma for Teachers and Trainers. You can find information about these at www.cie.org.uk/qualifications/teacher

Appendices

Appendix A: Sample long-term plan

Appendix B: Extract of a sample medium-term plan (scheme of work)

Appendix C: Lesson plan template

Appendix D: Sample lesson plan on ‘Variation’

Appendix A: Sample long-term plan

This plan is based on a two-year IGCSE course, with the final examinations being taken in the sixth term. It is most important that you do not consider this plan to be something that you must follow. It is entirely up to you how to plan to cover the syllabus within the time that is available to you.

The plan sets out which sections of the syllabus will be covered in each term. The development of the scientific enquiry skills (AO C) and the AO B skills will be integrated within this overall structure. The syllabus referred to is the one for examination in 2014.

Term	Unit	Syllabus sections
1	1 Cells and cell processes	I, 1 Characteristics of living organisms I, 2 Classification and diversity of organisms I, 3 Simple keys II, 1 Cell structure and organisation II, 2 Levels of organisation II, 3 Size of specimens II, 4 Movement in and out of cells II, 5 Enzymes
2	2 Animal nutrition 3 Plant nutrition and transport	II, 6.1 Nutrients II, 6.3. Animal nutrition II, 6.2 Plant nutrition II, 7.1 Transport in plants
3	4 Respiration and the human transport system 5 Coordination, response and homeostasis Practice examinations	II, 8 Respiration II, 7.2 Transport in humans II, 10 Coordination and response II, 9 Excretion in humans
4	6 Reproduction in plants 7 Human reproduction 8 Inheritance and evolution	III, 1.1, 1.2 Asexual and sexual reproduction III, 1.2.1 Sexual reproduction in plants III, 1.2.2 Sexual reproduction in humans III, 1.3 Sex hormones III, 1.4 Methods of birth control III, 1.5 Sexually transmissible diseases III, 2 Growth and development III, 3 Inheritance
5	9 Organisms and environment Revision	IV, 1 Energy flow IV, 2 Food chains and food webs IV 3 Nutrient cycles IV 4 Population size IV 5 Human influences on the ecosystem
6	Revision Final examinations	

Appendix B: Extract of a sample medium-term plan (scheme of work)

This example of a small section of a scheme of work is taken from Teacher Support. It is most important to recognise that this is only an example, and it is unlikely that you would want to use this scheme of work exactly as it is. You will want to develop your own scheme of work to match the particular circumstances within which you and your learners are working.

Unit 1: Cells and cell processes

Recommended prior knowledge

Learners can come to this unit with very little prior knowledge. In order to understand diffusion and osmosis, they will need some understanding of particle theory. Some knowledge of catalysts will also be helpful, and they should know a little about simple chemical reactions and how to represent these by word equations. The concept of pH should also be understood at a simple level.

Context

This unit covers some fundamental topics that will be drawn on in all the units that follow, and therefore the majority of it is covered by both Core and Supplement (Extended).

Outline

The unit first considers the special features that make living things different from non-living objects, and then looks at the structure and functions of animal and plant cells, which leads into the organisation of cells into tissues. Some particular examples of specialised cells are considered, which introduces the idea of structural adaptations for particular functions. Movement of substances within living organisms by diffusion, osmosis and active transport (the latter for the Supplement only) is considered. A simple treatment of enzyme function and some applications completes the unit.

Note that Unit 1.2, 1.3 and 1.4 (dealing with classification and keys) are included in this unit, but some teachers may prefer to cover these topics at the beginning of Unit 9 Organisms and environment.

(Please note: **(S)** in **bold** denotes material in the Supplement (Extended syllabus) only)

Syllabus ref	Learning objectives	Suggested teaching activities	Learning resources
I 1	1.1 Characteristics of living organisms • List and describe the characteristics of living organisms • Define the terms: – *nutrition as taking in of nutrients which are organic substances and mineral ions, containing raw materials or energy for growth and tissue repair, absorbing and assimilating them* – *excretion as removal from organisms of toxic materials, the waste products of metabolism (chemical reactions in cells including respiration) and substances in excess of requirements* – *respiration as the chemical reactions that break down nutrient molecules in living cells to release energy* – *sensitivity as the ability to detect or sense changes in the environment (stimuli) and to make responses*	Section 1 of this unit can provide an introduction to the Biology course. The seven characteristics of living things form a basis from which the themes underlying many biological concepts can be developed. Activities can include: 1. The comparison of the characteristics of living organisms with those of non-living things – for example, what are the characteristic of life shown by a petrol engine. The comparison is clear when written in a table. 2. The mnemonic, MRS GREN is useful to remember the seven characteristics. 3. Learners should understand that single-celled organisms, plants and animals all have these characteristics. 4. The characteristic of nutrition could be extended to include autotrophic and heterotrophic nutrition and the terms parasite and saprophyte. 5. If models or specimens are available, learners could discuss the importance of having a large surface area in relation to volume for diffusion. The importance of diffusion of gases in respiration will be understood more easily when Unit 4 is studied. 6. Growth could also be explained as an increase in size due to cell division. There might be a change in shape with growth.	*Biology for IGCSE*, Williams et al. Nelson Thornes, 2009 pp2–3 Learner activity – Characteristics of Living things: www.exploratorium.edu/imaging_station/activities/classroom/characteristics/ca_characteristics.php Including video clips and learner worksheet. Revision – Cells and Life Processes: www.lgfl.skoool.co.uk/content/keystage4/biology/pc/lessons/uk_ks4_cells_life_processes/h-frame-ie.htm_ Revision – Characteristics of Life: www.s-cool.co.uk/gcse/biology/cells/revise-it/characteristics-of-life_

Syllabus ref	Learning objectives	Suggested teaching activities	Learning resources
	– *reproduction as the processes that make more of the same kind of organism* – *growth as a permanent increase in size and dry mass by an increase in cell number or cell size or both* – *movement as an action by an organism or part of an organism causing a change of position or place*	7. Examples to explain the need for energy to carry out each of the characteristics should be discussed. Learners will appreciate that energy is required for movement and this can be extended to show that energy is needed for growth, nutrition and sensitivity. Extension – learners could perform a search of the characteristics of life. Do all scientists use the same list? How do we classify viruses? Learner progress could be assessed using: May/June 2011 Paper 0610/22 question 1 May/June 2008 Paper 0610/02 question 1	
I 2.1	1.2 Concept and use of a classificatory system • Define and describe the *binomial system* of naming species in which the scientific name of an organism is made up of two parts showing the genus and species • List the main features of the following vertebrates: – *bony fish* – *amphibians* – *reptiles*	Learners may know some binomials, such as *Homo sapiens*. Use this as an introduction of the Latin names for classification of all organisms. Carl Linnaeus can be mentioned and his work discussed. Emphasise the format of binomial names: Genus with a capital letter and species with a lower case letter and the possible use of *italics* or underlining. The use of the internet, photographs or specimens of the five groups of vertebrates can be used to draw up a table or produce a poster to include the main characteristics of each class.	*Biology for IGCSE*, Williams et al. Nelson Thornes 2009 pp4–13 Learners can visit a variety of living organisms to appreciate the variety amongst living things: Local zoo Game park Natural history museum Online specimen collections www.nhm.ac.uk/index.html The four species of crow can serve to explain the importance of classification. *Corvus coroner*: carrion

Syllabus ref	Learning objectives	Suggested teaching activities	Learning resources
	– *birds* – *mammals*	Learners should understand the specific features that differentiate each class: e.g. Birds have feathers, beaks, front limbs modified into wings and lay hard-shelled eggs. Learner progress could be assessed using: May/June 2010 Paper 0610/21 question 2 May/June 2009 Paper 0610/31 question 1 Oct/Nov 2010 Paper 0610/21 question 1 Oct/Nov 2010 Paper 0610/22 question 2 Oct/Nov 2008 Paper 0610/02 question 1	*Corvus corax*: raven *Corvus frugilus*: rook *Corvus monedula*: jackdaw www.rspb.org.uk/wildlife/birdguide/name/c/carrioncrow/index.aspx Bird images: www.allaboutbirds.org/Page.aspx?pid=1189 Species diversity: www.seaworld.org/animal-info/info-books/bio-diversity/index.htm An exploration of Biodiversity
I 2.1 (S)	**1.2** • **Know that there are other classification systems e.g. cladistics (based on RNA/DNA sequencing data)** • **List the main features used in the classification of the following groups:** – **viruses** – **bacteria** – **fungi** **and their adaptation to the environment, as appropriate**	Viruses and bacteria should be studied from photomicrographs or diagrams but their relevance can be mentioned in nutrition and disease ref: Unit 2 and Unit 7.1. Mucor as a fungus can be grown and the gross structure studied under a light microscope. Emphasise the role of spores in dispersal. Positive applications of viruses and bacteria can be mentioned in Unit 2.2 and 8.6. Learner progress could be assessed using: Oct/Nov 2009 Paper 0610/31 question 1.	Cladistics: www.evolution.berkeley.edu/evolibrary/article/phylogenetics_01 *Biology for IGCSE*, Williams et al. Nelson Thornes 2009 p10–11 The virtual virus experience: www.library.thinkquest.org/13373/intro/intro.htm

Syllabus ref	Learning objectives	Suggested teaching activities	Learning resources
			Infectious diseases – Pathogens: www.abpischools.org.uk/page/modules/infectiousdiseases_pathogens/index.cfm
I 2.2	1.3 Adaptations of organisms to their environment (to be illustrated by examples wherever possible) • List the main features used in the classification of the following groups: – *flowering plants: monocotyledons and eudicotyledons (dicotyledons)* – *arthropods:* insects crustaceans arachnids myriapods – *annelids* – *nematodes* – *molluscs*	*This section focuses on the adaptations of animals and plants to their environment. Specimens from each group can be viewed under the microscope and the main features noted. Emphasis should be given to drawing clear diagrams in pencil.* *Learners can draw a chart to list and then compare the distinguishing features of each group.* *Reference should be made to the organism's habitat and reference later in Units 3.6, 9.2 and 10.5.* *Extension – learners could be asked to search the ARKive database and compile a presentation of the listed groups of organisms.*	*Biology for IGCSE*, Williams et al. Nelson Thornes 2009 pp4–13 & pp94–95 A comparison of monocots and dicots: www.csdl.tamu.edu/FLORA/201Manhart/mono.vs.di/monosvsdi.html Preserved specimens if available, are excellent for explaining external features. An excellent source for images and video clips of animals and plants is ARKive: www.arkive.org/

Syllabus ref	Learning objectives	Suggested teaching activities	Learning resources
I 3	1.4 Simple keys • Use simple dichotomous keys based on easily identifiable features	Many learners have difficulty in constructing dichotomous keys. The concept can be introduced with coins or nails/ screws with different shaped heads or even with postage stamps. The learners can then classify a selection of leaves from the school grounds or from a selection of small pictures of different arthropods. Extension – more complex keys could be used to identify local flora or fauna. Learner progress could be assessed using: May/June 2011 Paper 0610/21 question 1 May/June 2010 Paper 0610/22 question 1 May/June 2009 Paper 0610/02 question 1 Oct/Nov 2010 Paper 0610/33 question 1a	*Biology for IGCSE*, Williams et al. Nelson Thornes 2009 pp14–15

Syllabus ref	Learning objectives	Suggested teaching activities	Learning resources
II 1	1.5 Cell structure and organisation • State that living organisms are made of cells • Identify and describe the structure of a plant cell (palisade cell) and an animal cell (liver cell) as seen under a light microscope • Describe the differences in structure between typical animal and plant cells	Palisade cells can be seen using prepared slides or transparencies of leaf sections. Learners can make their own slides of freshwater filamentous algae, Elodea or moss that can be mounted in a drop of water on a slide and viewed with a microscope. Liver cells are difficult to observe, but it may be possible to make temporary mounts of wrist cells. Wash the inside of the wrist and place a piece of scotch tape onto this part of the wrist. Pull off the scotch tape and view the cells under the microscope. Extension – Learners can also make models of a plant cell and/or an animal cell to gain an idea of the orientation of the main structures of each type of cell. Show video clip – cell structure: www.bbc.co.uk/learningzone/clips/parts-of-plant-and-animal-cells/10602.html Learner progress could be assessed using: May/June 2010 Paper 0610/21 question 1 Oct/Nov 2009 Paper 0610/02 question 2	PowerPoint presentation – Cells and Tissues: www.biology-resources.com/biology-CD.html Illustrations of cells: www.cellsalive.com/ *An Atlas of Histology,* Freeman and Bracegirdle. An excellent reference book for teachers. Cell structure: www.exploratorium.edu/imaging_station/activities/classroom/elodea_explorations/ca_elodea_explorations.php Revision – Cell structure: www.s-cool.co.uk/gcse/biology/cells/revise-it/plant-and-animal-cells

Syllabus ref	Learning objectives	Suggested teaching activities	Learning resources
II 1 (S)	**1.5** **Relate the structures seen under the light microscope in the plant cell and the animal cell to their functions**	Candidates studying the supplement should consider functions of features that are common to plant and animal cells, and those that are found in plant cells only. They should understand how the differences between animal and plant cells relate to their different methods of obtaining nutrients. Examine a temporary mount of epidermal tissue peeled from the inner surface of an onion bulb. Learners could review cell structure ("cell structure and function" or "organelles"): www.exploratorium.edu/imaging_station/gallery.php	*Biology for IGCSE*, Williams et al. Nelson Thornes 2009 p19 Inside animal and plant cells: learn.genetics.utah.edu/content/begin/cells/insideacell/ Video clip – Cell structure: www.bbc.co.uk/learningzone/clips/plant-and-animal-cell-structures/4188.html

Syllabus ref	Learning objectives	Suggested teaching activities	Learning resources
II 2	1.6 Levels of organisation • Relate the structure of the following to their functions: – *ciliated cells – in respiratory tract* – *root hair cells – absorption* – *xylem vessels – conduction and support* – *muscle cells – contraction* – *red blood cells – transport* • Define: – *tissue as a group of cells with similar structures, working together to perform a shared function* – *organ as a structure made up of a group of tissues, working together to perform specific functions* – *organ system as a group of organs with related functions, working together to perform body functions using examples covered in Sections II and III*	The coverage of these examples of cells and of organs and organ systems could come later when they can be dealt with in context but it may help to introduce the learners to cells with different functions at this stage using an overhead or on a PowerPoint presentation. Learners can select their own specialised cell, draw and label it on A3 paper. Flash cards are an interactive way of learning about specialised cells. Learners can draw a flow diagram from cells to the particular organ system to begin to understand the complexity of the human body. An outline of the human body can be used to draw in the main organ systems of the body. Extension –learners could research a greater range of specialised cells. This could link to stem cells and their uses. Learner progress could be assessed using May/June 2009 Paper 0610/02 question 5.	*Biology for IGCSE*, Williams et al. Nelson Thornes 2009 pp20–23 Examples of differentiated cells: www.rothamsted.ac.uk/notebook/organ.htm

Syllabus ref	Learning objectives	Suggested teaching activities	Learning resources
II 3	1.7 Size of specimens • Calculate the magnification and size of biological specimens using millimetres as units	Use the temporary mount of epidermal tissue peeled from the inner surface of an onion bulb or rhubarb stem and to use an appropriate scale to determine the size of cells. Learners can magnify a piece of hair to understand that magnification is $\frac{\text{size of image}}{\text{size of object}}$ Learner progress could be assessed using: May/June 2009 Paper 0610/31 question 2b	*Microscope magnification specifications & field of view:* www.microscope-microscope.org/advanced/magnification-1.htm *Learner activity – Specimen size:* www.exploratorium.edu/imaging_station/activities/classroom/size/ca_size.php_ *Relative sizes of cells:* www.cellsalive.com/howbig.htm *Scale:* learn.genetics.utah.edu/content/begin/cells/scale/

Syllabus ref	Learning objectives	Suggested teaching activities	Learning resources
II 4.1	1.8 Diffusion • Define *diffusion* as the net movement of molecules from a region of their higher concentration to a region of their lower concentration down a concentration gradient as a result of their random movement • Describe the importance of gaseous and solute diffusion and of water as a solvent	Use a simple demonstration of diffusion, for example a potassium manganate VII crystal in a gas jar of water or a drop of methylene dye on gelatine solidified in a test tube (diffusion of a solute), or ammonia and hydrochloric acid placed at opposite ends of a long glass tube, or simply a perfume container opened in one corner of the room. Bromine in a gas jar (carried out in a fume cupboard) can quickly show diffusion (gaseous diffusion). Teachers should be aware that these experiments are often carried out by the Chemists at the beginning of the Cambridge IGCSE course and collaboration is important. Emphasise the random motion of particles. Variables of temperature, pressure, distance moved, concentration and size of particles. Consider the relevance of diffusion to living organisms – for example, the diffusion of oxygen and carbon dioxide into and out of a plant leaf or across the surface of the alveoli in the human lungs. Emphasise that water is an important solvent and most cells contain about 75% water. Water transports substances and allows many chemical reactions to take place.	*Biology for IGCSE*, Williams et al. Nelson Thornes 2009 p26–27 PowerPoint presentation – Diffusion: www.biology-resources.com/biology-CD.html Experiments in biology – Diffusion: www.biology-resources.com/biology-experiments2.html Practical Biology – Diffusion: www.nuffieldfoundation.org/practical-biology/diffusion Diffusion and animation and text: www.bbc.co.uk/schools/gcsebitesize/science/add_gateway/living/diffusionrev1.shtml

Syllabus ref	Learning objectives	Suggested teaching activities	Learning resources
		Extension – learners could investigate the effects of surface area/volume ratio on rates of diffusion. Learner progress could be assessed using: May/June 2011 Paper 0610/22 question 6 Oct/Nov 2009 Paper 0610/02 question 9	
II 4.2 (S)	**1.9 Active Transport** • **Define *active transport* as movement of ions in or out of a cell through a cell membrane, from a region of their lower concentration to a region of their higher concentration against their concentration gradient, using energy released during respiration** • **Discuss the importance of active transport as an energy-consuming process by which substances are transported against a concentration gradient e.g. ion uptake by root hair cells and the uptake of glucose by epithelial cells of villi**	A simple explanation is climbing uphill. No detail of the molecular mechanism of active transport needs to be considered. Learners should understand that energy for this process is provided by respiration. Learners will understand the importance of the movement of particles by active transport after having studied Units 2, 3 and 5.	*Biology for IGCSE*, Williams et al. Nelson Thornes 2009 p32–33 Practical Biology – Active uptake: www.nuffieldfoundation.org/practical-biology/active-uptake

Syllabus ref	Learning objectives	Suggested teaching activities	Learning resources
II 4.3	1.10 Osmosis • Define *osmosis* as the diffusion of water molecules from a region of their higher concentration to a region of their lower concentration, through a partially permeable membrane • Describe the importance of osmosis in the uptake of water by plants and its effects on plant and animal tissues	Osmosis should be treated as a special case of diffusion, in which only *water* molecules are able to move from one side of a partially permeable membrane to another. Ensure that learners understand what a *solution* is in terms of particles, so that they are able to imagine the water molecules and solute particles behaving independently of each other. Use visking tubing to demonstrate osmosis. Investigation of changes in mass or length of potato chips or of dried raisins placed in a range of different concentrations of sugar solution provides good opportunity for quantitative treatment of results, as well as enhancing understanding of osmosis. Discuss differences in the effects of water uptake and loss on animal cells that lack a cellulose cell wall and plant cells that have a cellulose cell wall. Turgor as an important mechanism of support in plants could be discussed (Unit 3.4 & 3.5). Relate water uptake by osmosis to the structure of root hair cells covered earlier in this unit. Learner progress could be assessed using: Oct/Nov 2008 Paper 0610/02 question 9	*Biology for IGCSE*, Williams et al. Nelson Thornes 2009 p28–31 PowerPoint presentation – Osmosis: www.biology-resources.com/biology-CD.html Experiments in biology – Osmosis: www.biology-resources.com/biology-experiments2.html Practical Biology – Osmosis: www.nuffieldfoundation.org/practical-biology/osmosis Osmosis animation and text: www.bbc.co.uk/schools/gcsebitesize/science/add_gateway/greenworld/waterrev1.shtml Interactive osmosis (advanced for IGCSE): www.physioweb.uvm.edu/bodyfluids/osmosis.htm Revision – Osmosis: www.s-cool.co.uk/gcse/biology/cells/revise-it/moving-molecules

Syllabus ref	Learning objectives	Suggested teaching activities	Learning resources
II 4.3 (S)	**1.10** • **Describe and explain the importance of a water potential gradient in the uptake of water by plants**	Explain water potential as the tendency for water to leave a solution. The more water (that is then a more dilute the solution) the higher the water potential. Water moves from a high water potential to a low water potential – that is, down a water potential gradient. Do not introduce the idea of negative water potentials at this level. Relate to intake of water by root hairs.	
II 5	1.11 Enzymes • Define the term *catalyst* as a substance that speeds up a chemical reaction and is not changed by the reaction • Define *enzymes* as proteins which function as biological catalysts • Investigate and describe the effect of changes in temperature and pH on enzyme activity	Simple experiments with catalase are an excellent introduction to enzymes. Revise the meaning of the term 'catalyst'. Ensure that learners understand that enzymes are simple (protein) molecules, not living organisms. They cannot, therefore, be 'killed'. Investigate the effect of temperature on the effect of enzyme activity, for example using starch and amylase, or pepsin and milk powder. Explain the rise in activity with temperature, in terms of kinetic theory, and the fall as temperature rises above the optimum in terms of denaturation of the enzyme molecules. Consider the different optimum temperatures of different enzymes, not only those in humans. Extension – learners could investigate the effectiveness of enzyme based washing powders.	*Biology for IGCSE*, Williams et al. Nelson Thornes 2009 p36–39 Experiments in biology – Enzymes: www.biology-resources.com/biology-experiments2.html Practical Biology – Enzymes: www.nuffieldfoundation.org/practical-biology/investigating-enzymes-used-laundry-detergents Simple account of how enzymes work: www.abpischools.org.uk/page/modules/enzymes/enzymes1.cfm

Syllabus ref	Learning objectives	Suggested teaching activities	Learning resources
		Use the kscience animation on an interactive whiteboard to demonstrate enzyme actions. Learner progress could be assessed using: Oct/Nov 2010 Paper 0610/22 question 1 May/June 2008 Paper 0610/02 question 3	Interactive model of enzyme action: www.kscience.co.uk/animations/model.swf Revision – Enzyme experiments: http://lgfl.skoool.co.uk/content/keystage4/biology/pc/modules/digestion/digestion_experiments/index.html Revision – Enzymes: www.lgfl.skoool.co.uk/content/keystage4/biology/pc/modules/digestion/digestion_part_3/index.html Revision – Enzymes: www.s-cool.co.uk/gcse/biology/enzymes/revise-it/enzymes

Syllabus ref	Learning objectives	Suggested teaching activities	Learning resources
II 5 (S)	**1.11** • **Explain enzyme action in terms of the 'lock and key' model** • **Explain the effect of changes in temperature and pH on enzyme activity** • **Describe the role of enzymes in the germination of seeds and their uses in biological washing products and in the food industry (including pectinase and fruit juice)** • **Outline the use of microorganisms and fermenters to manufacture the antibiotic penicillin and enzymes for use in biological washing products** • **Describe the role of the fungus *Penicillium* in the production of antibiotic penicillin**	Power point demonstrations and graphs to show the trends of increasing temperature and of different pH solutions provide useful means of interpreting data. The role of amylase in the breakdown of starch to maltose in seeds provides an example of enzymes in plants. Germinating barley seeds, dipped into a sterilising solution to destroy any micro-organisms on their surfaces, can be placed on sterile starch agar in a Petri dish, which can later be tested for starch with iodine solution. Extension: proteases, lipases and amylases, often with high optimum temperatures, are all used in biological washing products. Investigations can be carried out into the effectiveness of these in removing different types of stains. Simple experiments on the effect of pectinase on the yield of juice from crushed apples or tinned apple purée can be carried out. Learner progress could be assessed using: May/June 2009 Paper 0610/31 question 3 Oct/Nov 2010 Paper 0610/33 question 3 May/June 2008 Paper 0610/31 question 3	Biology for IGCSE, Williams et al. Nelson Thornes 2009, pp36–41 Downloadable booklets with practical investigations using a variety of enzymes: www.ncbe.reading.ac.uk/NCBE/PROTOCOLS/pracbiotech.html www.ncbe.reading.ac.uk/NCBE/PROTOCOLS/juice.html

Appendix C: Lesson plan template

This is one example of a template that can be used for constructing lesson plans.

LESSON:	**School:**	
Date:	**Teacher name:**	
CLASS:	**Number present:**	**absent:**
Learning objectives(s) that this lesson is contributing to		
Lesson objectives		
Vocabulary, terminology and phrases		
Previous learning		
Plan		
Planned timings	**Planned activities**	**Resources**
Beginning		
Middle		
End		
Additional information		

Differentiation – how do you plan to give more support? How do you plan to challenge the more able learners?	**Assessment – how are you planning to check learners' learning?**	**Health and safety check ICT links**

Reflection and evaluation	
Reflection Were the lesson objectives realistic? What did the learners learn today? What was the learning atmosphere like? Did my planned differentiation work well? Did I stick to timings? What changes did I make from my plan and why?	**Use the space below to reflect on your lesson. Answer the most relevant questions from the box on the left about your lesson.**

Summary evaluation

What two things went really well (consider both teaching and learning)?
1:
2:
What two things would have improved the lesson (consider both teaching and learning)?
1:
2:
What have I learned from this lesson about the class or individuals that will inform my next lesson?

Appendix D: Sample lesson plan on 'Variation'

The following lesson plan was for a double lesson (two back-to-back 40 minute lessons). It was the first lesson on the topic of variation in the IGCSE course. Most learners had studied variation before, at Science Secondary 1 level. This lesson introduced the concepts of discontinuous and continuous variation, and posed questions about their causes that would be explored further in the next lesson.

LESSON:	**School:**	
Date:	**Teacher name:**	
CLASS:	**Number present: 30**	**absent: 0**
Learning objectives(s) that this lesson is contributing to	Section III, 3.5 State that continuous variation is influenced by genes and environment, resulting in a range of phenotypes between two extremes; state that discontinuous variation is caused by genes alone and results in a limited number of phenotypes with no intermediates	
Lesson objectives	• be able to explain the differences between continuous and discontinuous variation, using human height and gender as examples • measure length accurately, using a ruler • construct and complete tally charts and frequency diagrams • begin to think about causes of variation	
Vocabulary, terminology and phrases	variation; continuous variation; discontinuous variation; tally chart; frequency diagram; phenotype	
Previous learning	Most, but not all, learners are likely to remember something about variation from Year 9. They know that genes affect phenotype. They have drawn frequency diagrams in maths.	

Plan		
Planned timings	**Planned activities**	**Resources**
10 minutes	As soon as learners have settled, ask them all to stand up and then– without speaking – arrange themselves standing in height order. Then ask them to organise themselves into two groups – boys and girls. While they are in these two groups, explain that this is an example of discontinuous variation. Ask them to go back into height order. While they are standing in height order, explain that this is an example of continuous variation.	

15 minutes 40 minutes	Seat learners in mixed ability groups of three or four and ask each group to write down a sentence that explains the difference between continuous and discontinuous variation. Ask one person from each group to feed back their ideas to the class. Use their ideas to build up definitions of the two types of variation. Hand out the worksheet *Measuring and recording continuous variation in leaves*. Ask two learners from each group to collect 30 leaves from a tree. Working in groups, learners follow instructions on the worksheet to measure, record and group the leaf lengths, and construct a frequency diagram.	rulers to measure in mm recently-picked sets of 30 leaves in plastic bags (alternatively, two learners from each group can go outside and pick 30 leaves from a tree) graph paper – one sheet per learner
15 minutes	Settle groups. Ask: why are the leaves on a tree different lengths? Write ideas on the board. Build up the idea that all the leaves have the same genes, so the differences must be due to their environment or the stage of growth (age) of each leaf. With the class, think of questions relating to this that can be investigated – for example, are the leaves on the sunny side of the tree longer than the ones on the shady side? Set homework: Plan an investigation to find the answer to one of these questions.	

Additional information

Differentiation – how do you plan to give more support? How do you plan to challenge the more able learners?	**Assessment – how are you planning to check learners' learning?**	**Health and safety check ICT links**
Groups will be organised as mixed ability, so less able learners will have support from others in the group. I will move between the groups to provide further support. Where possible, I will not solve problems for them, but will ask the group to suggest solutions, which will challenge the more able learners.	Move between groups as they work; ask questions of individuals in the group – Why is this an example of continuous variation? How are you going to group the leaf lengths? What do you think is a good number of groups to aim for? Can you explain why you draw the bars so that they are touching?	If learners go outside to pick leaves, they must go in pairs and remain within a stated area.

Reflection and evaluation	
Reflection Were the lesson objectives realistic? What did the learners learn today? What was the learning atmosphere like? Did my planned differentiation work well? Did I stick to timings? What changes did I make from my plan and why?	**Use the space below to reflect on your lesson. Answer the most relevant questions from the box on the left about your lesson.** Timings were mostly OK. There was a bit of a delay when seating them in groups ready for the first discussion, because they had already put their bags down where they thought they were going to sit. I should have sat them in their working groups right at the start. I didn't leave quite long enough for the discussion and homework preparation at the end of the lesson – I should have been firmer with getting them to finish the worksheet within the 40 minutes I had planned. The nature of the task, and the fact that they were working in mixed ability groups, meant that learners of all abilities were able to achieve most of the lesson objectives.

Summary evaluation

What two things went really well (consider both teaching and learning)?

1: Sorting themselves into height order and then by gender worked well - they enjoyed doing this and it really helped them to see the difference between continuous and discontinuous variation.

2: Almost every learner managed to draw a reasonable frequency diagram of leaf lengths, though some needed a lot of guidance from me or from others in their group.

What two things would have improved the lesson (consider both teaching and learning)?

1: It would have been better to seat them in their working groups right at the start of the lesson, before asking them to organise themselves in height order.

2: The groups who picked their own leaves were more engaged in the task than those who used leaves given to them; they were also much more able to think of interesting questions to investigate in the plenary session. In future, I will ask all groups to pick their own leaves, even though this took longer.

What have I learned from this lesson about the class or individuals that will inform my next lesson?

Quite a few learners found it difficult to work out how to group the leaf lengths – we need to spend some more time on this.

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