BIOZONE

CIE BIOLOGY 2

Cambridge International Examination

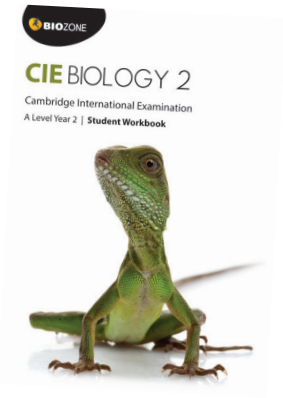
A Level Year 2 | **Student Workbook**

CLASSROOM GUIDE

Contents

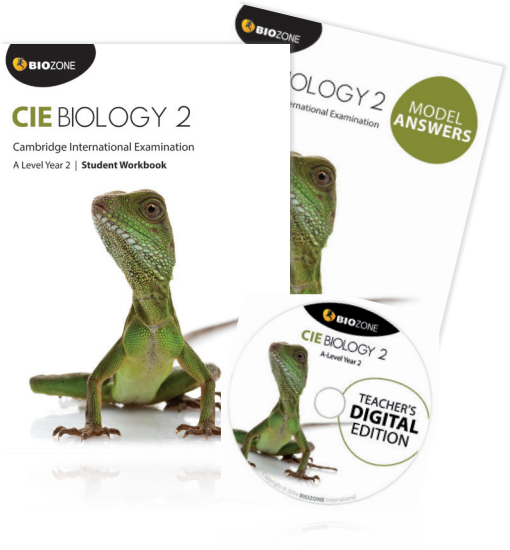
Making the most of *CIE BIOLOGY 2*

FAQs ABOUT OUR CIE BIOLOGY 2 STUDENT WORKBOOK



Meeting Key Competencies

We want today's biology students to be self-motivated, lifelong learners, to develop a sound grasp of biological knowledge, to plan and evaluate their work, and to think critically and independently. In developing CIE Biology 2, we have utilised the 5Es instructional model as a basis for developing materials to specifically address the CIE Biology syllabus. By successfully completing the activities, which make up the bulk of the student workbook, students can demonstrate competence in skills and knowledge. BIOZONE's workbooks and associated products provide a varied and interesting suite of resources which, if used effectively, can help your students achieve key competencies in all areas of biology.



BIOZONE encourages the development of an independent learner profile using the 5 Es model

The Five Es

Engage:	make connections between past and present learning experiences.
Explore:	become actively involved in the activity.
Explain:	communicate the learning experience.
Elaborate:	expand on the concepts learned.
Evaluate:	assess understanding of the concepts.

ENGAGE: **Highly visual activities**	Use activities in class to engage a student when introducing a topic, or to consolidate student understanding and summarise the material covered by other methods. Using activities in class provides valuable opportunities for peer-to-peer learning.
ENGAGE: **A connected plan of study**	The check-box format of the contents pages and the chapter introductions provides a focus for planning achievement.
EXPLORE: **Independent, self directed study**	Activities are self-contained so students are encouraged to be independent learners and seek the answers to questions posed by the activity. Capable students can work quickly and independently through the material and can use the time for extension. Less able students can review or finish activities at home. Most activities are supported by web-based resources in the form of animations and video clips.
EXPLAIN: **Communicating is the key to consolidation**	All activities first engage the student with a key idea and a visually inviting delivery of content. Student engagement with this material leads them to the questions in which they must communicate their understanding of the content. Students are encouraged to use appropriate biological terms as referenced in the chapter introduction (key terms).
ELABORATE: **Building up**	Most introductory activities are supported by activities in which students apply their understanding of ideas to a new situation. These 'follow-on' activities often involve data analysis, and support science practices.
EVALUATE: **Easy assessment**	Encourage self assessment with chapter reviews (these can be graded if desired) or use specific activities to evaluate a student's skills and understanding or ideas.
WHAT ABOUT HOMEWORK?	Assign activities as homework to review a completed topic, explore a related concept, or introduce a topic prior to in-class practical work.

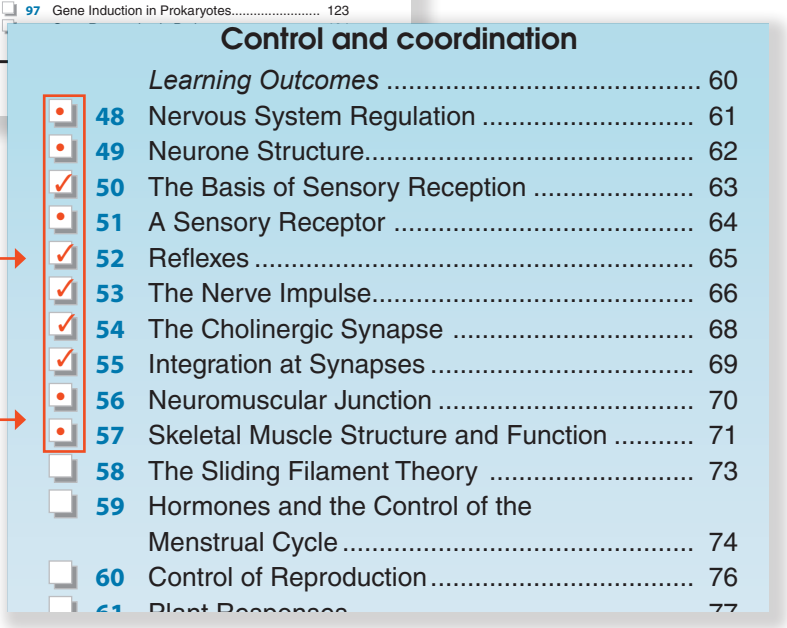
The Contents: A Planning Tool

The contents pages are not merely a list of the activities in the workbook. They serve as a planning tool for the programme of work to be completed. Students can identify the activities they are to complete and then tick them off when completed. The teacher can also see at glance how quickly the student is progressing through the assigned material.

Contents

Activity is marked: ▪ to be done; ✓ when completed

The teacher can see at a glance how this student is progressing through this unit of work. Any concerns with progress can be addressed early.



Control and coordination

Students can mark the check boxes to indicate the activities they should complete. This helps them to quantify the work to be done and plan their work.

Ticking off the activities as they are completed gives students a sense of progression and helps them to be more personally organised in their work.

Introducing the CIE Biology 2 Content

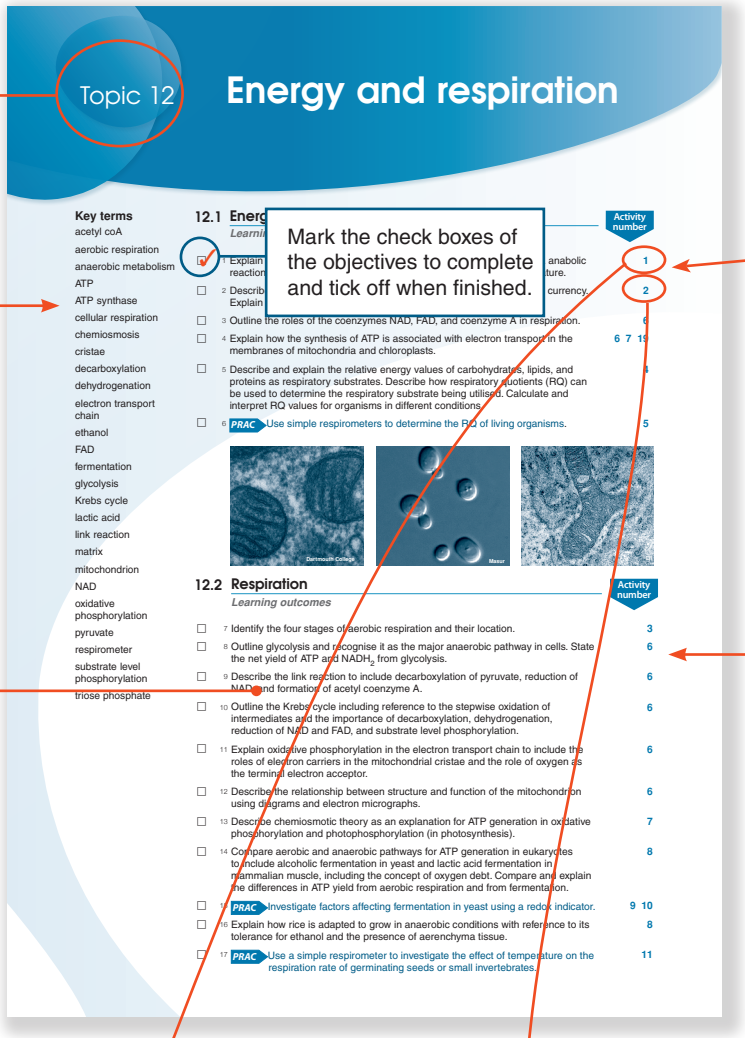
Each chapter in CIE Biology 2 is prefaced with a one page introduction, providing students with an overview of the chapter content and organisation. Each of the numbered learning outcomes pertains to a point of key knowledge or a skill, and is matched to one or more activities. A list of key terms for the chapter is also included. The comprehensive, but accessible, list of learning outcomes encourages students to approach each topic confidently. Familiarity with the scientific terms used in each topic is implicit in this.

This identifies the part of the course to which this chapter applies.

The list of **key terms** can be used to create a glossary for revision and encourages appropriate use of the correct terms when answering questions.

For students:

Key knowledge and skills are drawn from the study design. They are purposefully brief, with enough information to provide a framework, but not so much that students are overwhelmed.



Topic 12

Energy and respiration

Key terms
acetyl coA
aerobic respiration
anaerobic metabolism
ATP
ATP synthase
cellular respiration
chemiosmosis
cristae
decarboxylation
dehydrogenation
electron transport chain
ethanol
FAD
fermentation
glycolysis
Krebs cycle
lactic acid
link reaction
matrix
mitochondrion
NAD
oxidative phosphorylation
pyruvate
respirometer
substrate level phosphorylation
triose phosphate

Mark the check boxes of the objectives to complete and tick off when finished.

12.1 Energ

Learning

Activity number

1 Explain ... reaction ... anabolic ... ture. 1

2 Describ... Explain ... currency. 2

3 Outline the roles of the coenzymes NAD, FAD, and coenzyme A in respiration. 6

4 Explain how the synthesis of ATP is associated with electron transport in the membranes of mitochondria and chloroplasts. 6 7 15

5 Describe and explain the relative energy values of carbohydrates, lipids, and proteins as respiratory substrates. Describe how respiratory quotients (RQ) can be used to determine the respiratory substrate being utilised. Calculate and interpret RQ values for organisms in different conditions. 4

6 PRAC Use simple respirometers to determine the RQ of living organisms. 5

12.2 Respiration

Learning outcomes

Activity number

7 Identify the four stages of aerobic respiration and their location. 3

8 Outline glycolysis and recognise it as the major anaerobic pathway in cells. State the net yield of ATP and $NADH_2$ from glycolysis. 6

9 Describe the link reaction to include decarboxylation of pyruvate, reduction of NAD and formation of acetyl coenzyme A. 6

10 Outline the Krebs cycle including reference to the stepwise oxidation of intermediates and the importance of decarboxylation, dehydrogenation, reduction of NAD and FAD, and substrate level phosphorylation. 6

11 Explain oxidative phosphorylation in the electron transport chain to include the roles of electron carriers in the mitochondrial cristae and the role of oxygen as the terminal electron acceptor. 6

12 Describe the relationship between structure and function of the mitochondrion using diagrams and electron micrographs. 6

13 Describe chemiosmotic theory as an explanation for ATP generation in oxidative phosphorylation and photophosphorylation (in photosynthesis). 7

14 Compare aerobic and anaerobic pathways for ATP generation in eukaryotes to include alcoholic fermentation in yeast and lactic acid fermentation in mammalian muscle, including the concept of oxygen debt. Compare and explain the differences in ATP yield from aerobic respiration and from fermentation. 8

15 PRAC Investigate factors affecting fermentation in yeast using a redox indicator. 9 10

16 Explain how rice is adapted to grow in anaerobic conditions with reference to its tolerance for ethanol and the presence of aerenchyma tissue. 8

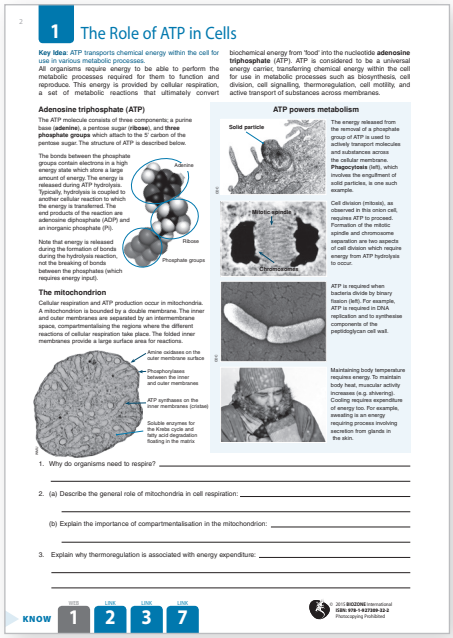
17 PRAC Use a simple respirometer to investigate the effect of temperature on the respiration rate of germinating seeds or small invertebrates. 11

The activities in the workbook with the activities pertaining to these key knowledge outcomes

Activities that cover practical skills are identified.

Introduce the concept with a grounding activity

Follow with an activity expanding on that concept



1 The Role of ATP in Cells

Key idea: ATP transports chemical energy within the cell for use in various metabolic processes.

All organisms require energy to be able to perform the metabolic processes required for them to function and reproduce. This energy is provided by cellular respiration, a set of metabolic reactions that ultimately convert biochemical energy from 'food' into the nucleotide **adenosine triphosphate** (ATP). ATP is considered to be a universal energy carrier, transferring chemical energy within the cell for use in metabolic processes such as biosynthesis, cell division, cell signalling, thermoregulation, cell motility, and active transport of substances across membranes.

Adenosine triphosphate (ATP)

The ATP molecule consists of three components; a purine base (**adenine**), a pentose sugar (**ribose**), and **three phosphate groups** which attach to the 5' carbon of the pentose sugar. The structure of ATP is described below.

The bonds between the phosphate groups contain electrons in a high energy state which store a large amount of energy. The energy is released during ATP hydrolysis. Typically, hydrolysis is coupled to another cellular reaction to which the energy is transferred. The end products of the reaction are adenosine diphosphate (ADP) and an inorganic phosphate (P_i).

Note that energy is released during the formation of bonds during the hydrolysis reaction, not the breaking of bonds between the phosphates (which requires energy input).

Adenine
Ribose
Phosphate groups

The mitochondrion

Cellular respiration and ATP production occur in mitochondria. A mitochondrion is bounded by a double membrane. The inner and outer membranes are separated by an intermembrane space, compartmentalising the regions where the different reactions of cellular respiration take place. The folded inner membranes provide a large surface area for reactions.

Amine oxidases on the outer membrane surface
Phosphorylases between the inner and outer membranes
ATP synthases on the inner membranes (cristae)
Soluble enzymes for the Krebs cycle and fatty acid degradation floating in the matrix

ATP powers metabolism

Solid particle

The energy released from the removal of a phosphate group of ATP is used to actively transport molecules and substances across the cellular membrane. **Phagocytosis** (left), which involves the engulfment of solid particles, is one such example.

Mitotic spindle
Chromosomes

Cell division (mitosis), as observed in this onion cell, requires ATP to proceed. Formation of the mitotic spindle and chromosome separation are two aspects of cell division which require energy from ATP hydrolysis to occur.

ATP is required when bacteria divide by binary fission (left). For example, ATP is required in DNA replication and to synthesise components of the peptidoglycan cell wall.

Maintaining body temperature requires energy. To maintain body heat, muscular activity increases (e.g. shivering). Cooling requires expenditure of energy too. For example, sweating is an energy requiring process involving secretion from glands in the skin.

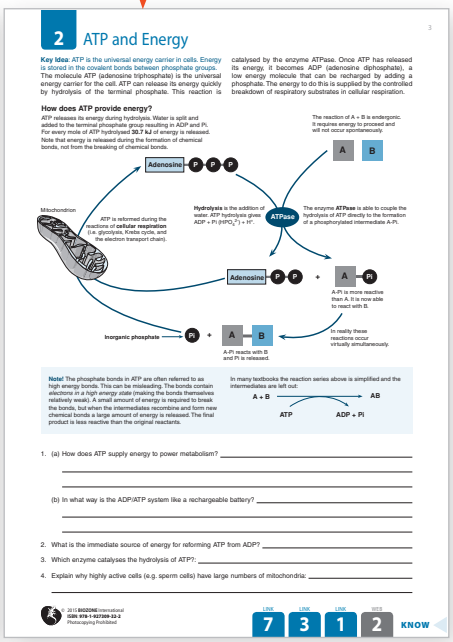
1. Why do organisms need to respire? _____

2. (a) Describe the general role of mitochondria in cell respiration: _____

(b) Explain the importance of compartmentalisation in the mitochondrion: _____

3. Explain why thermoregulation is associated with energy expenditure: _____

KNOW 1 2 3 7



2 ATP and Energy

Key idea: ATP is the universal energy carrier in cells. Energy is stored in the covalent bonds between phosphate groups. The molecule ATP (adenosine triphosphate) is the universal energy carrier for the cell. ATP can release its energy quickly by hydrolysis of the terminal phosphate. This reaction is catalysed by the enzyme ATPase. Once ATP has released its energy, it becomes ADP (adenosine diphosphate), a low energy molecule that can be recharged by adding a phosphate. The energy to do this is supplied by the controlled breakdown of respiratory substrates in cellular respiration.

How does ATP provide energy?

ATP releases its energy during hydrolysis. Water is split and added to the terminal phosphate group resulting in ADP and P_i. For every mole of ATP hydrolysed **30.7 kJ** of energy is released. Note that energy is released during the formation of chemical bonds, not from the breaking of chemical bonds.

The reaction of A + B is endergonic. It requires energy to proceed and will not occur spontaneously.

Adenosine
Mitochondrion
ATP is reformed during the reactions of **cellular respiration** (i.e. glycolysis, Krebs cycle, and the electron transport chain).
Hydrolysis is the addition of water. ATP hydrolysis gives ADP + P_i (HPO_4^{2-}) + H^+.
ATPase
The enzyme **ATPase** is able to couple the hydrolysis of ATP directly to the formation of a phosphorylated intermediate A-P_i.
A-P_i is more reactive than A. It is now able to react with B.
Inorganic phosphate
A-P_i reacts with B and P_i is released.
In reality these reactions occur virtually simultaneously.

Note! The phosphate bonds in ATP are often referred to as high energy bonds. This can be misleading. The bonds contain electrons in a high energy state (making the bonds themselves relatively weak). A small amount of energy is required to break the bonds, but when the intermediates recombine and form new chemical bonds a large amount of energy is released. The final product is less reactive than the original reactants.

In many textbooks the reaction series above is simplified and the intermediates are left out:

A + B → AB

ATP → ADP + P_i

1. (a) How does ATP supply energy to power metabolism? _____

(b) In what way is the ADP/ATP system like a rechargeable battery? _____

2. What is the immediate source of energy for reforming ATP from ADP? _____

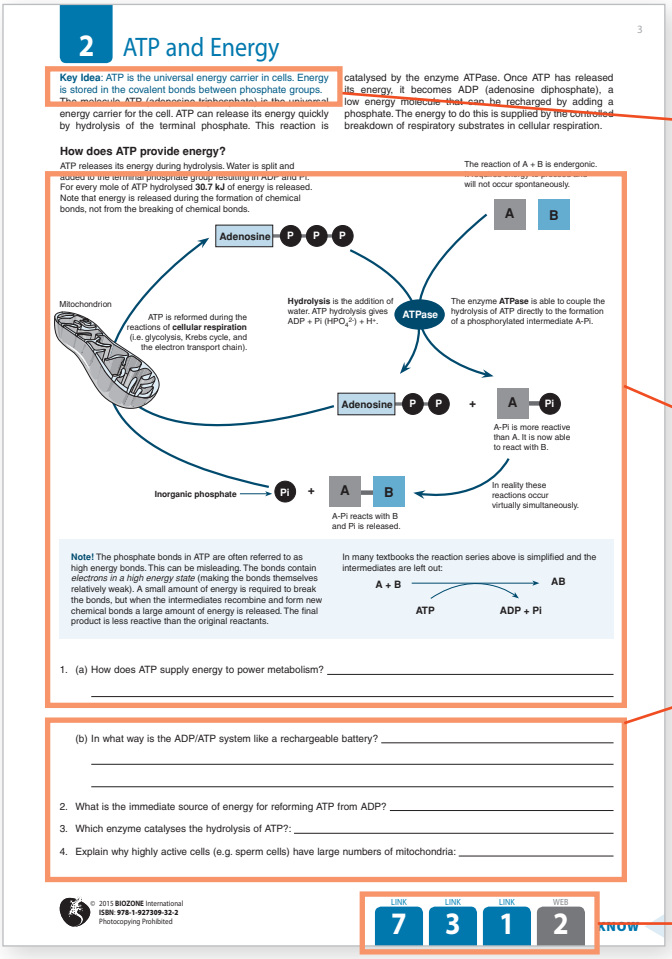
3. Which enzyme catalyses the hydrolysis of ATP?: _____

4. Explain why highly active cells (e.g. sperm cells) have large numbers of mitochondria: _____

7 3 1 2 KNOW

Finding Your Way Around

The content of the CIE Biology 2 is organised into 8 chapters, each one beginning with an introduction and concluding with a student's self-test of understanding and vocabulary. Inviting, concept-based activities make up the bulk of each chapter, with each activity focussing on the student developing an understanding of a concept, applying that understanding to another scenario, and/or developing an essential skill, such as graphing, data analysis, or biological drawing. An important feature of each activity is the key idea, which encapsulates the main focus of the content provided. Clear annotated diagrams and photographs are a major part of almost all activities and the student's understanding of the information is tested through a series of questions and/or data handling and interpretation tasks. The tabs for each activity identify the nature of the activity, and identify related material and external weblinks, which provide support for the activity.



2 ATP and Energy

Key Idea: ATP is the universal energy carrier in cells. Energy is stored in the covalent bonds between phosphate groups. The molecule ATP (adenosine triphosphate) is the universal

The **key idea** provides a focus for each activity. It summarises the focus of the activity and provides a clear take-home message for the student.

Annotated diagrams, sometimes including photo panels, explain the content of the page, providing the information necessary to complete the activity.

Understanding of content is tested through questions, data handling, analysis, prediction, or summary. Students are often required to apply their understanding to a new scenario or make connections to related content. Students must interact with the information on the page in order to complete the activity. It is this interaction that provides the valuable learning experience and reinforcement and explanation of the key idea.

Related content is identified through the tab system. This activity also has a **weblink** assigned to it (see below).

THE ACTIVITY CODING SYSTEM

Main focus of the activity is:

DATA = data handling and interpretation

KNOW = content you need to know

PRAC = a paper practical or a practical focus

REFER = reference - use this for information

REVISE = review the material in the section

SKILL = a specific skill to be demonstrated

TEST = test your understanding

EXT = Extension activity

Links

These blue tabs indicate activities that provide content which is related to or builds on the content on the page.

Weblinks

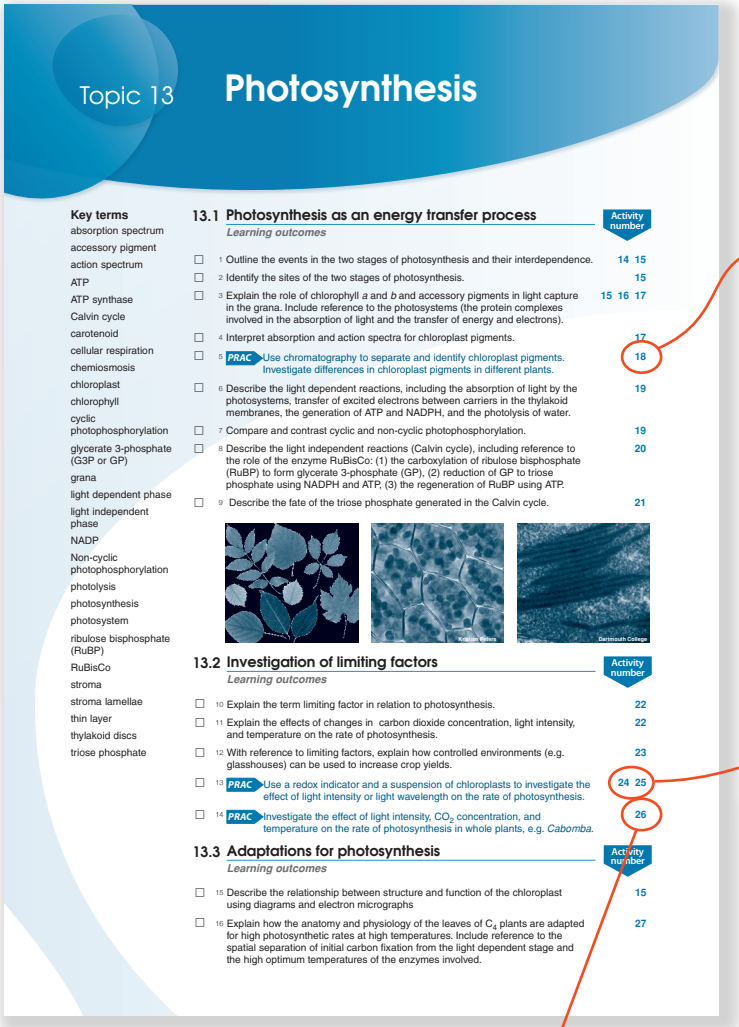
This grey tab indicates a weblink. Bookmark the weblinks page:

www.biozone.co.uk/weblink/CIE-2-9322

Access the external URL for the activity by clicking the link next to its number.

Practical Investigations

The basic techniques and skills required for practical work and mathematical skills are addressed throughout the workbook. Activities that support practical investigations are identified in the introduction of the relevant chapters.



Topic 13 **Photosynthesis**

Key terms
absorption spectrum
accessory pigment
action spectrum
ATP
ATP synthase
Calvin cycle
carotenoid
cellular respiration
chemiosmosis
chloroplast
chlorophyll
cyclic photophosphorylation
glycerate 3-phosphate (G3P or GP)
grana
light dependent phase
light independent phase
NADP
Non-cyclic photophosphorylation
photolysis
photosynthesis
photosystem
ribulose bisphosphate (RuBP)
RuBisCo
stroma
stroma lamellae
thin layer
thylakoid discs
triose phosphate

13.1 Photosynthesis as an energy transfer process — Activity number

Learning outcomes

- ☐ 1 Outline the events in the two stages of photosynthesis and their interdependence. — 14 15
- ☐ 2 Identify the sites of the two stages of photosynthesis. — 15
- ☐ 3 Explain the role of chlorophyll *a* and *b* and accessory pigments in light capture in the grana. Include reference to the photosystems (the protein complexes involved in the absorption of light and the transfer of energy and electrons). — 15 16 17
- ☐ 4 Interpret absorption and action spectra for chloroplast pigments. — 17
- ☐ 5 PRAC Use chromatography to separate and identify chloroplast pigments. Investigate differences in chloroplast pigments in different plants. — 18
- ☐ 6 Describe the light dependent reactions, including the absorption of light by the photosystems, transfer of excited electrons between carriers in the thylakoid membranes, the generation of ATP and NADPH, and the photolysis of water. — 19
- ☐ 7 Compare and contrast cyclic and non-cyclic photophosphorylation. — 19
- ☐ 8 Describe the light independent reactions (Calvin cycle), including reference to the role of the enzyme RuBisCo: (1) the carboxylation of ribulose bisphosphate (RuBP) to form glycerate 3-phosphate (GP), (2) reduction of GP to triose phosphate using NADPH and ATP, (3) the regeneration of RuBP using ATP. — 20
- ☐ 9 Describe the fate of the triose phosphate generated in the Calvin cycle. — 21

13.2 Investigation of limiting factors — Activity number

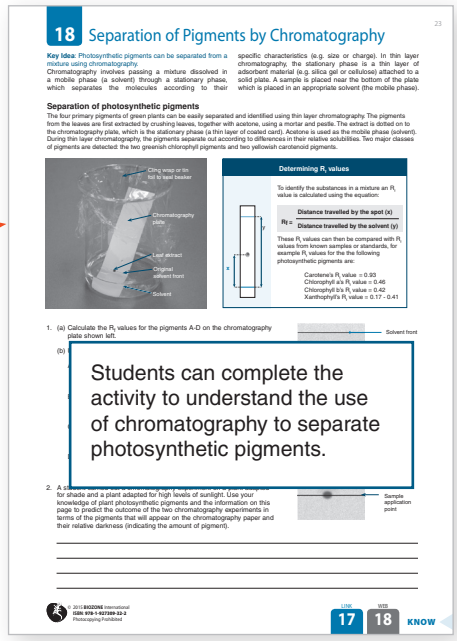
Learning outcomes

- ☐ 10 Explain the term limiting factor in relation to photosynthesis. — 22
- ☐ 11 Explain the effects of changes in carbon dioxide concentration, light intensity, and temperature on the rate of photosynthesis. — 22
- ☐ 12 With reference to limiting factors, explain how controlled environments (e.g. glasshouses) can be used to increase crop yields. — 23
- ☐ 13 PRAC Use a redox indicator and a suspension of chloroplasts to investigate the effect of light intensity or light wavelength on the rate of photosynthesis. — 24 25
- ☐ 14 PRAC Investigate the effect of light intensity, CO_2 concentration, and temperature on the rate of photosynthesis in whole plants, e.g. *Cabomba*. — 26

13.3 Adaptations for photosynthesis — Activity number

Learning outcomes

- ☐ 15 Describe the relationship between structure and function of the chloroplast using diagrams and electron micrographs — 15
- ☐ 16 Explain how the anatomy and physiology of the leaves of C_4 plants are adapted for high photosynthetic rates at high temperatures. Include reference to the spatial separation of initial carbon fixation from the light dependent stage and the high optimum temperatures of the enzymes involved. — 27



18 Separation of Pigments by Chromatography

Key Idea: Photosynthetic pigments can be separated from a mixture using chromatography.

Chromatography involves passing a mixture dissolved in a mobile phase (a solvent) through a stationary phase, which separates the molecules according to their specific characteristics (e.g. size or charge). In thin layer chromatography, the stationary phase is a thin layer of adsorbent material (e.g. silica gel or cellulose) attached to a solid plate. A sample is placed near the bottom of the plate which is placed in an appropriate solvent (the mobile phase).

Separation of photosynthetic pigments

The four primary pigments of green plants can be easily separated and identified using thin layer chromatography. The pigments from the leaves are first extracted by crushing leaves, together with acetone, using a mortar and pestle. The extract is dotted on to the chromatography plate, which is the stationary phase (a thin layer of coated card). Acetone is used as the mobile phase (solvent). During thin layer chromatography, the pigments separate out according to differences in their relative solubilities. Two major classes of pigments are detected: the two greenish chlorophyll pigments and two yellowish carotenoid pigments.

Cling wrap or tin foil to seal beaker
Chromatography plate
Leaf extract
Original solvent front
Solvent

Determining R_f values

To identify the substances in a mixture an R_f value is calculated using the equation:

R_f = Distance travelled by the spot (x) / Distance travelled by the solvent (y)

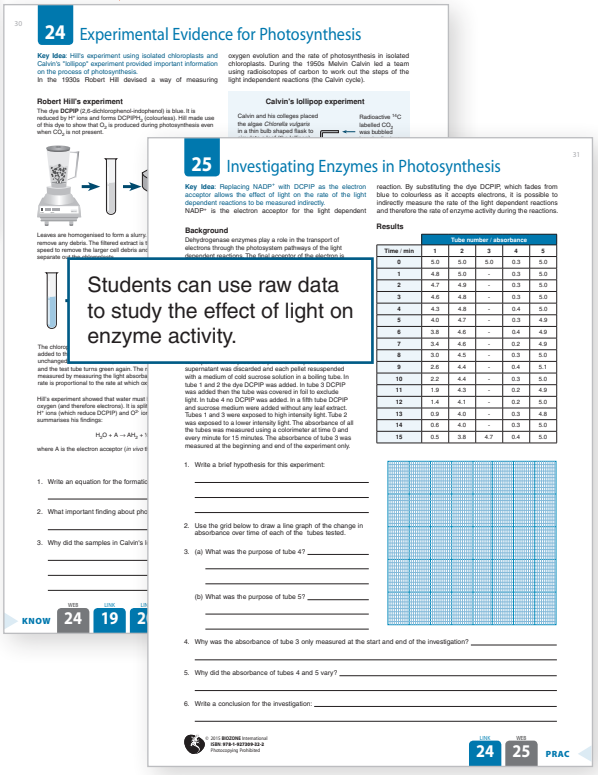
These R_f values can then be compared with R_f values from known samples or standards, for example R_f values for the the following photosynthetic pigments are:

Carotene's R_f value = 0.93
Chlorophyll a's R_f value = 0.46
Chlorophyll b's R_f value = 0.42
Xanthophylls R_f value = 0.17 - 0.41

1. (a) Calculate the R_f values for the pigments A-D on the chromatography plate shown left.

Solvent front
Sample application point

Students can complete the activity to understand the use of chromatography to separate photosynthetic pigments.



24 Experimental Evidence for Photosynthesis

Key Idea: Hill's experiment using isolated chloroplasts and Calvin's "lollipop" experiment provided important information on the process of photosynthesis.

In the 1930s Robert Hill devised a way of measuring oxygen evolution and the rate of photosynthesis in isolated chloroplasts. During the 1950s Melvin Calvin led a team using radioisotopes of carbon to work out the steps of the light independent reactions (the Calvin cycle).

Robert Hill's experiment

The dye **DCPIP** (2,6-dichlorophenol-indophenol) is blue. It is reduced by H^+ ions and forms DCPIPH$_2$ (colourless). Hill made use of this dye to show that O_2 is produced during photosynthesis even when CO_2 is not present.

Calvin's lollipop experiment

Calvin and his colleges placed the algae *Chlorella vulgaris* in a thin bulb shaped flask to

Radioactive ^{14}C labelled CO_2 was bubbled

Students can use raw data to study the effect of light on enzyme activity.

25 Investigating Enzymes in Photosynthesis

Key Idea: Replacing NADP$^+$ with DCPIP as the electron acceptor allows the effect of light on the rate of the light dependent reactions to be measured indirectly.

NADP$^+$ is the electron acceptor for the light dependent reaction. By substituting the dye DCPIP, which fades from blue to colourless as it accepts electrons, it is possible to indirectly measure the rate of the light dependent reactions and therefore the rate of enzyme activity during the reactions.

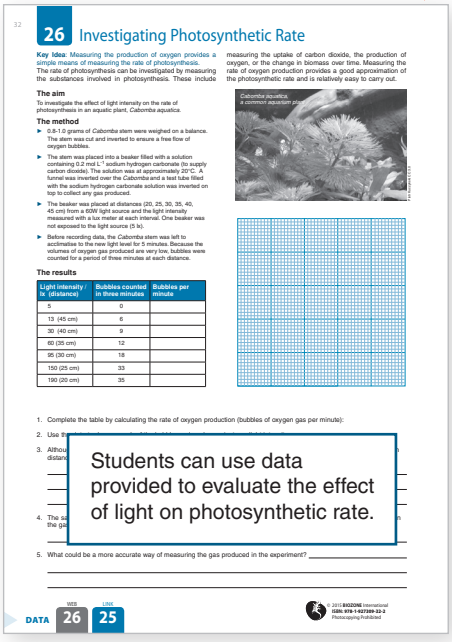
Background

Dehydrogenase enzymes play a role in the transport of electrons through the photosystem pathways of the light dependent reactions. The final acceptor of the electron is NADP$^+$.

Results

	Tube number / absorbance				
Time / min	1	2	3	4	5
0	5.0	5.0	5.0	0.3	5.0
1	4.8	5.0	-	0.3	5.0
2	4.7	4.9	-	0.3	5.0
3	4.6	4.8	-	0.3	5.0
4	4.3	4.8	-	0.4	5.0
5	4.0	4.7	-	0.3	4.9
6	3.8	4.6	-	0.4	4.9
7	3.4	4.6	-	0.2	4.9
8	3.0	4.5	-	0.3	5.0
9	2.6	4.4	-	0.4	5.1
10	2.2	4.4	-	0.3	5.0
11	1.9	4.3	-	0.2	4.9
12	1.4	4.1	-	0.2	5.0
13	0.9	4.0	-	0.3	4.8
14	0.6	4.0	-	0.3	5.0
15	0.5	3.8	4.7	0.4	5.0

1. Write a brief hypothesis for this experiment:
2. Use the grid below to draw a line graph of the change in absorbance over time of each of the tubes tested.
3. (a) What was the purpose of tube 4?
   (b) What was the purpose of tube 5?
4. Why was the absorbance of tube 3 only measured at the start and end of the investigation?
5. Why did the absorbance of tubes 4 and 5 vary?
6. Write a conclusion for the investigation:



26 Investigating Photosynthetic Rate

Key Idea: Measuring the production of oxygen provides a simple means of measuring the rate of photosynthesis.

The rate of photosynthesis can be investigated by measuring the substances involved in photosynthesis. These include measuring the uptake of carbon dioxide, the production of oxygen, or the change in biomass over time. Measuring the rate of oxygen production provides a good approximation of the photosynthetic rate and is relatively easy to carry out.

The aim

To investigate the effect of light intensity on the rate of photosynthesis in an aquatic plant, *Cabomba aquatica*.

The method

- 0.8-1.0 grams of *Cabomba* stem were weighed on a balance. The stem was cut and inverted to ensure a free flow of oxygen bubbles.
- The stem was placed into a beaker filled with a solution containing 0.2 mol L^{-1} sodium hydrogen carbonate (to supply carbon dioxide). The solution was at approximately 20°C. A funnel was inverted over the *Cabomba* and a test tube filled with the sodium hydrogen carbonate solution was inverted on top to collect any gas produced.
- The beaker was placed at distances (20, 25, 30, 35, 40, 45 cm) from a 60W light source and the light intensity measured with a lux meter at each interval. One beaker was not exposed to the light source (5 lx).
- Before recording data, the *Cabomba* stem was left to acclimatise to the new light level for 5 minutes. Because the volumes of oxygen gas produced are very low, bubbles were counted for a period of three minutes at each distance.

Cabomba aquatica, a common aquarium pl

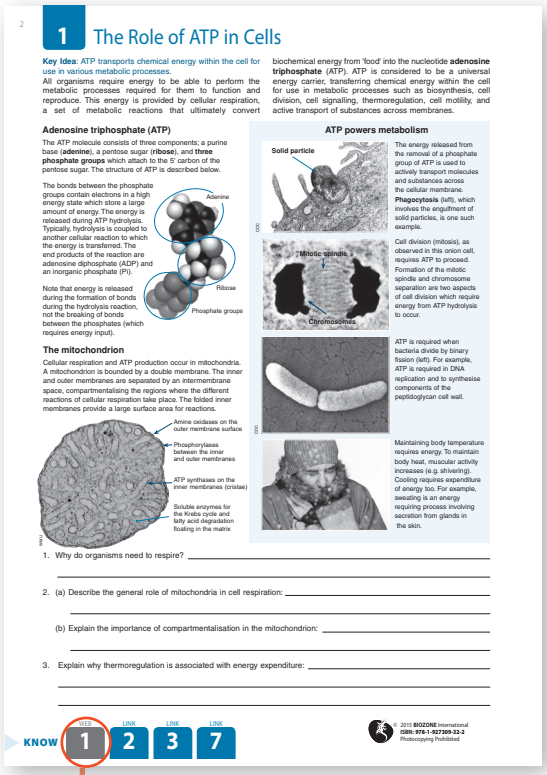
The results

Light intensity / lx (distance)	Bubbles counted in three minutes	Bubbles per minute
5	0	
13 (45 cm)	6	
30 (40 cm)	9	
60 (35 cm)	12	
95 (30 cm)	18	
150 (25 cm)	33	
190 (20 cm)	35	

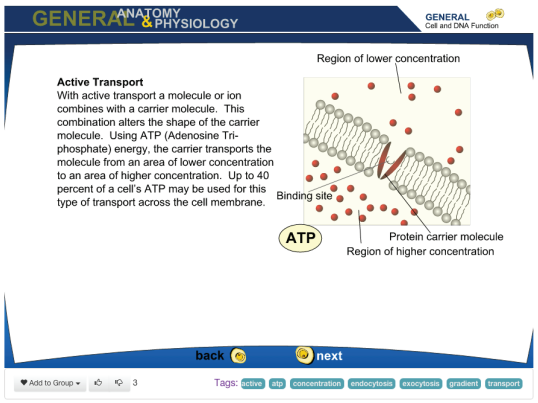
1. Complete the table by calculating the rate of oxygen production (bubbles of oxygen gas per minute):
2. Use th
3. Althou
4. The a
5. What could be a more accurate way of measuring the gas produced in the experiment?

Students can use data provided to evaluate the effect of light on photosynthetic rate.

Making Use of Weblinks



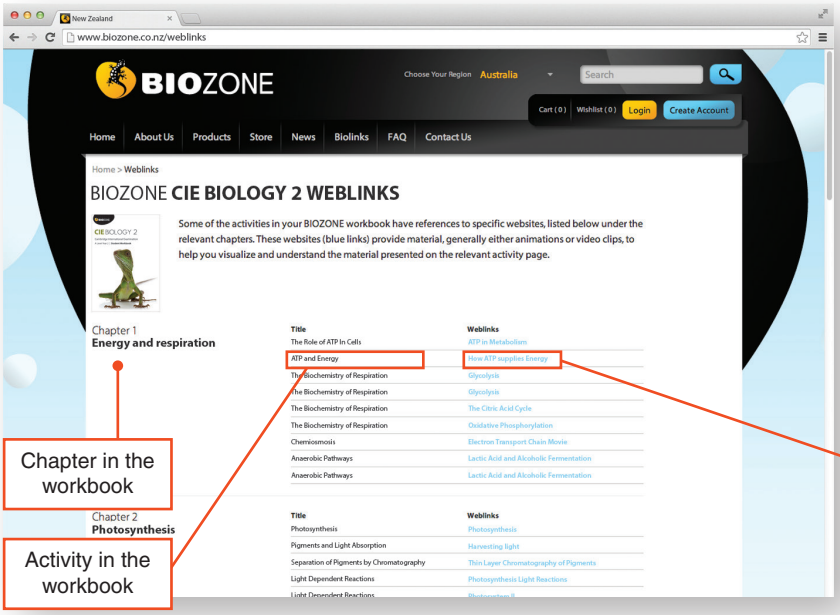
The tab system at the base of each activity identifies if there is a weblink available to support the activity's content. The weblinks are distinct from the general Biolinks area of BIOZONE's website. They are coded with the activity number and are only accessible through a specific url (below), so bookmark the address at the beginning of your teaching year and always have them on hand. The weblinks comprise short video clips or animations aimed specifically at the activity content. These are external sites from a wide range of reputable sources and are invaluable as support to explain content or view an animation of a process such as diffusion or active transport. It's easy and we've done the hard work for you. Just click and view.

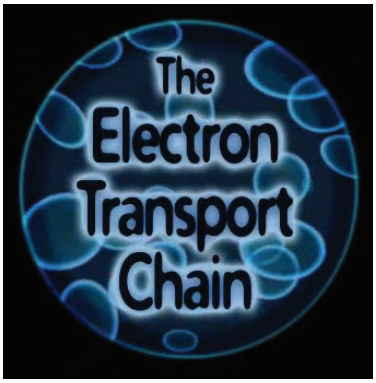


Weblinks exist for most of the activities in the workbook, from cells to evolution.

www.biozone.co.uk/weblink/CIE-2-9322

This WEBLINKS page provides links to **external web sites** with supporting information for the activities. Almost exclusively, they are narrowly focussed animations and video clips relevant to the activity on which they are cited. They offer great support to aid student understanding of basic concepts, especially for visual learners.





Hyperlink to the external website page.

Bookmark weblinks by typing in the address: it is not accessible directly from BIOZONE's website

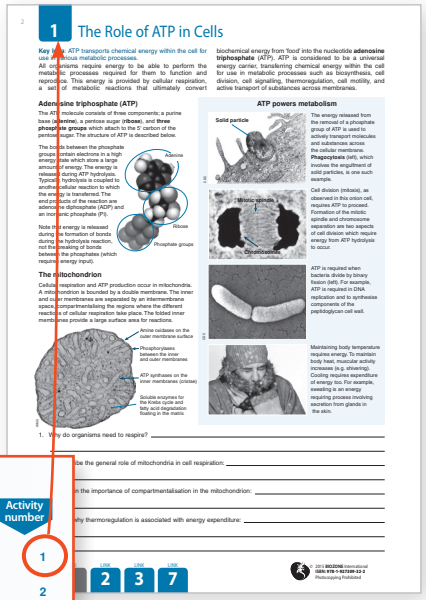
Corrections and clarifications to current editions are always posted on the weblinks page

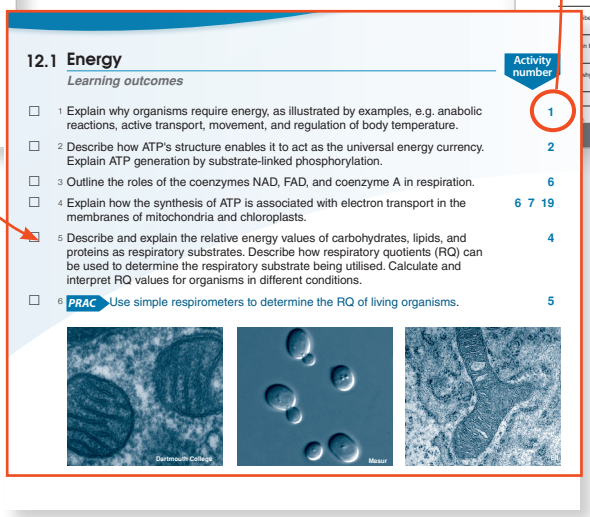
Engage, Explore, Explain, Elaborate, and Evaluate

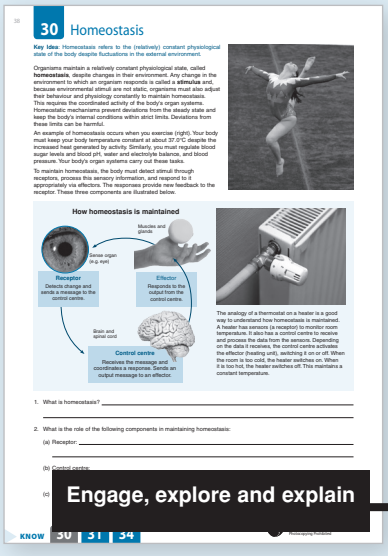
In developing CIE Biology 2, we have focussed on the key knowledge and skills requirements identified in the CIE Biology syllabus. The activities in CIE Biology 2 have been specifically written to address this content. Our focus is student engagement through the use of a concept-based, highly visual design and opportunity to demonstrate skills and understanding.

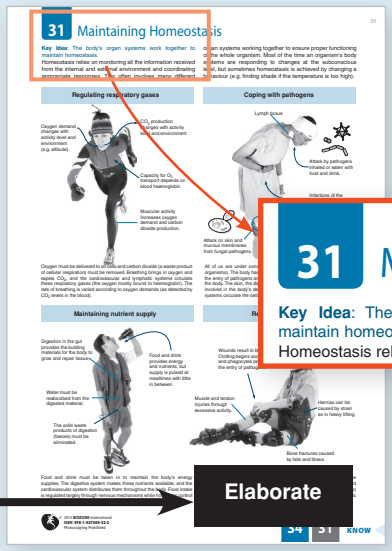
The introduction to each chapter provides a summary of the learning outcomes and appropriate practicals, presented as a series of short student learning aims. The students achieve understanding of each statement by completing its corresponding activity.

Activities are written and presented so that students progressively extend and deepen their understanding, using what they have learned in earlier activities to complete later related activities and to solve new problems.





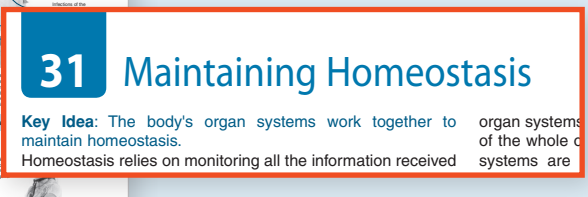




Engage, explore and explain

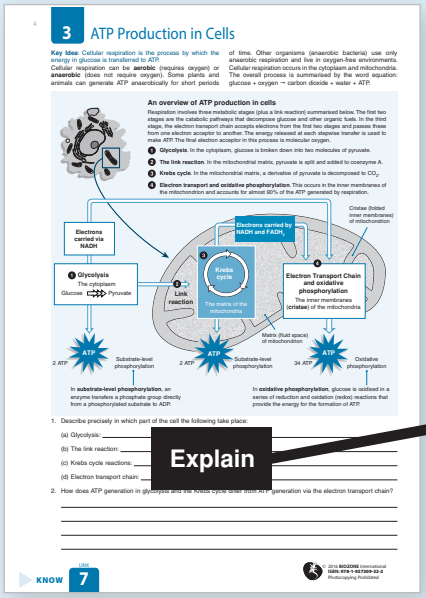
Elaborate

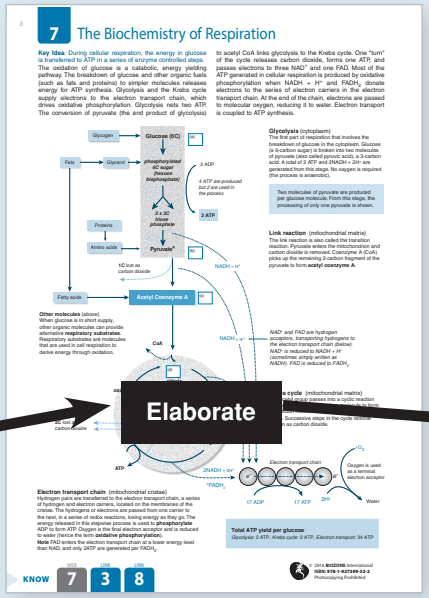
The KEY IDEA provides a focus for each activity. The key ideas through a chapter provide a concise summary of the chapter content.

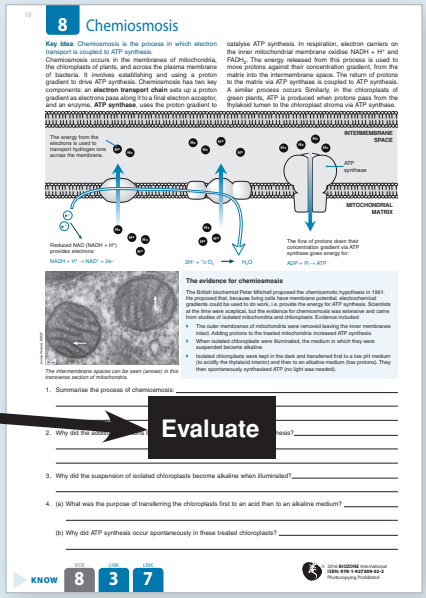


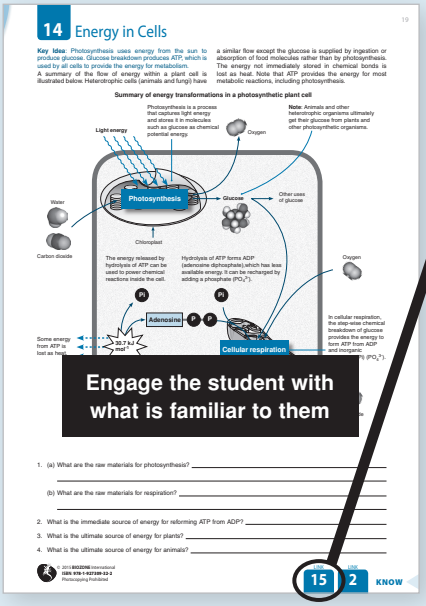
Students become actively involved in the learning activity by interacting with the material, answering the question and completing the set tasks. Many activities are suitable as assessment tasks.

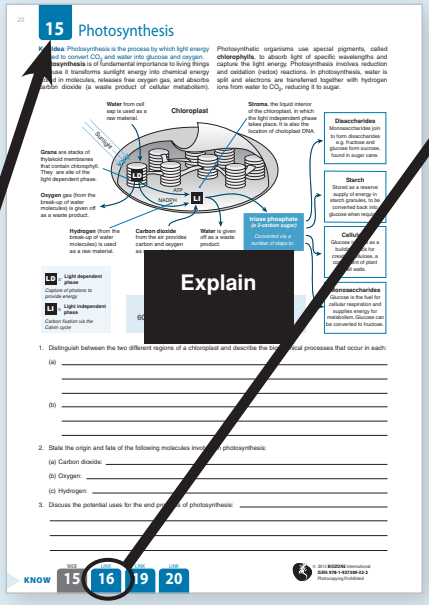
Engage, explain, elaborate, and evaluate: Activities are nested. An introductory activity introduces and builds understanding of a specific core idea, and a subsequent activity involves applying that understanding to a new situation, e.g. analysing data, finding a solution, or interpreting new information.

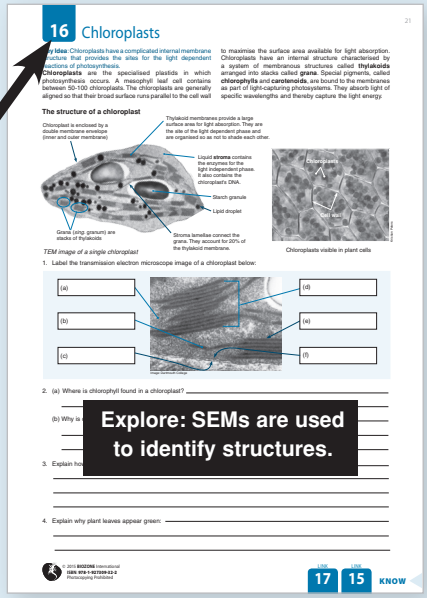












This activity begins by engaging the student with something familiar (glucose is used in respiration) and introduces the concept of photosynthesis.

Students then explore the chloroplast and the sites of the light dependent and independent reactions.

Students apply their understanding to the identification of structures in the chloroplast.

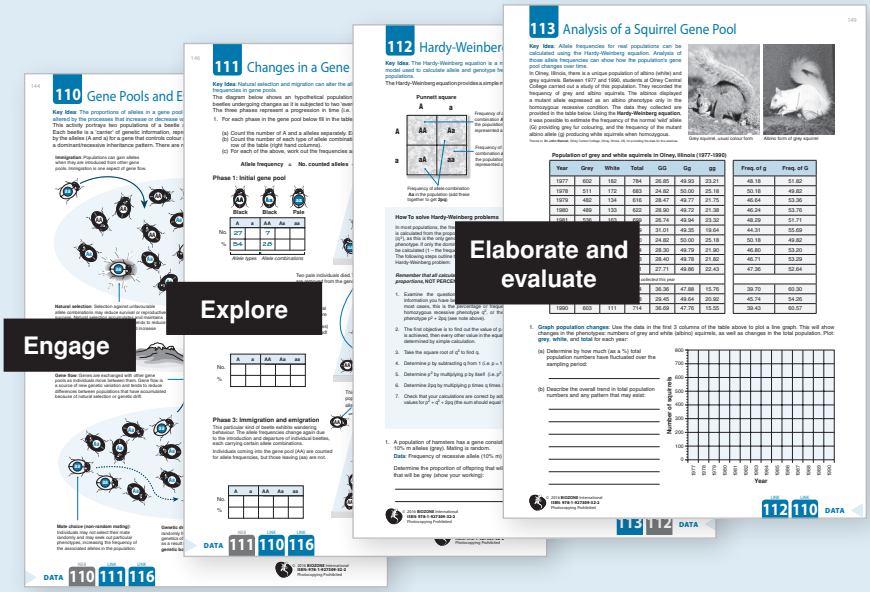
Groups of activities build knowledge and understanding by giving students the chance to learn and apply their knowledge in a series of linked activities.

Engage: visualise the concept of a gene pool

Explore: relate changes in allele frequencies to microevolutionary processes

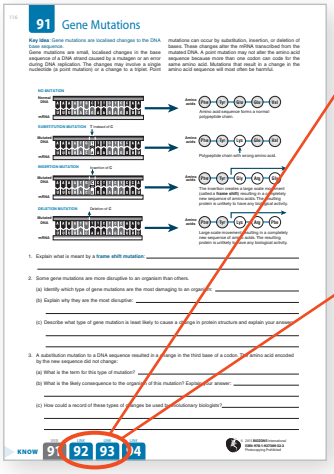
Elaborate: calculate allele frequencies from provided data

Evaluate: apply understanding of the Hardy-Weinberg principle to the analysis of allele frequencies in a real population



LINKS - Making Connections

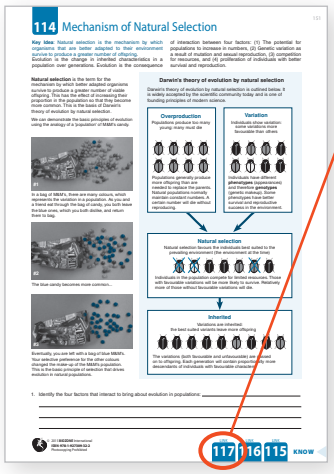
The **LINK** tabs help students to connect ideas between different topics in the CIE Biology syllabus. Connections may be made to activities that build on or develop an idea, utilise the same core principles in another biological context, or examine the evidence for a biological process. The connections help students to appreciate that the same core principles underlie many biological phenomena and there is evidence to support them. Understanding these core principles brings understanding to a wide range of contexts and situations, even if they are unfamiliar.



EXAMPLE ❶

Gene Mutations

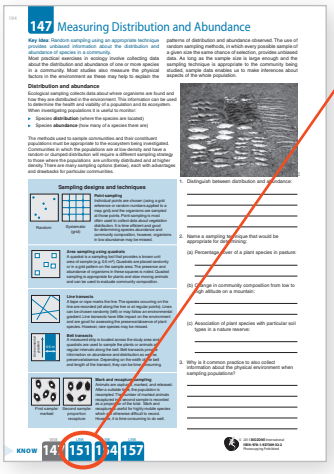
Understand what causes mutations, different types of mutation, and examples of harmful and beneficial mutations.



EXAMPLE ❷

Natural selection

Explore the mechanism of natural section and understand the characteristics of the three main types. An analysis of real population data involving directional section follows.



EXAMPLE ❸

Sampling

Understand the features of different types of sampling, and examine the use quadrat sampling in more depth. Apply this understanding in a sampling simulation of rocky shore populations.

Differential Instruction with BIOZONE

Achieving effective differential instruction in classes is a teaching challenge. Students naturally have mixed abilities, varying backgrounds in the subject, and different language skills. Used effectively, BIOZONE's workbooks and supporting products can make teaching a mixed ability class easier. Here, we offer three approaches for differential instruction.

MAKING A START

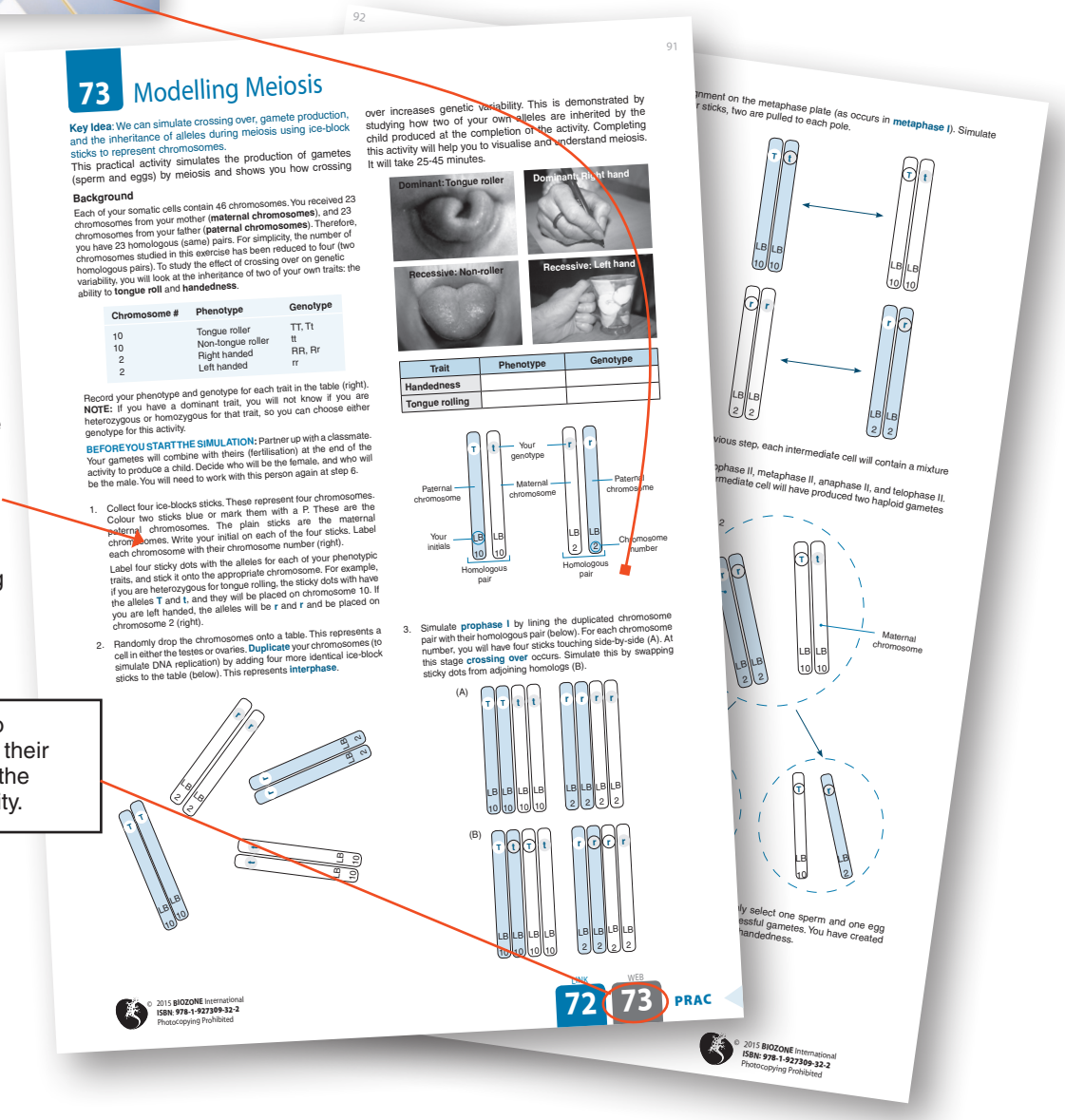
Regardless of which activity you might be attempting in class, a 5-10 minute introduction to the task by the teacher is useful orientation for all students. For collaborative work, the teacher can then divide the class into appropriate groups, each with a balance of able and less able students.

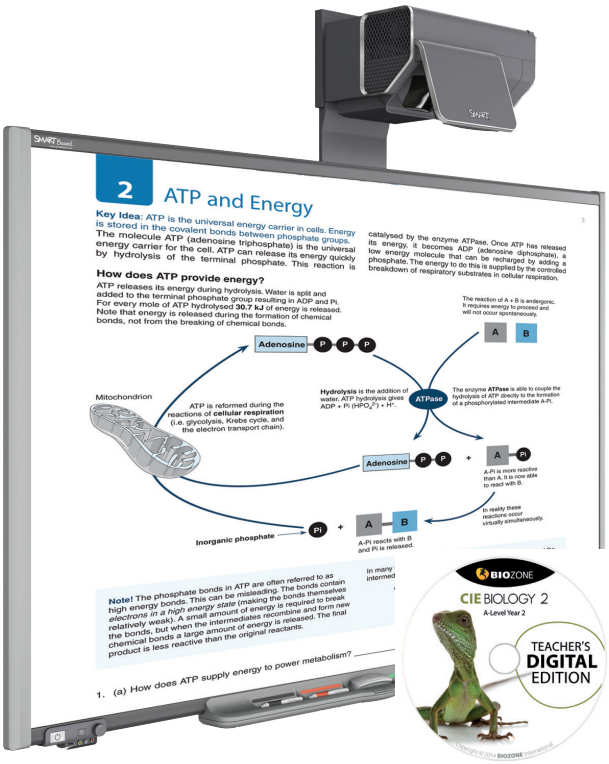
1 Efficient Differential Instruction

- Use **peer-to-peer learning** for more challenging activities where the level of content is more difficult and the questions require students to draw on several areas of their knowledge to synthesise an answer.
- Stronger peers can assist weaker students and both groups benefit from verbalising their thoughts and presenting them to a group. **ESL students** can ask their peers to explain unfamiliar terms (both scientific and English) and this benefits both parties. **Paper practicals** (e.g. *Modelling Meiosis, Sampling a Rocky Shore Community)* are another ideal vehicle for this kind of peer-to-peer learning.

In Modelling Meiosis, students can collaborate in pairs to determine the outcome of a mating between two individuals with different traits. This tests and creates understanding by putting theory into practice.

Encourage students to consolidate ad extend their knowledge by visiting the **weblinks** for the activity.





2 Interactive revision of tasks in class

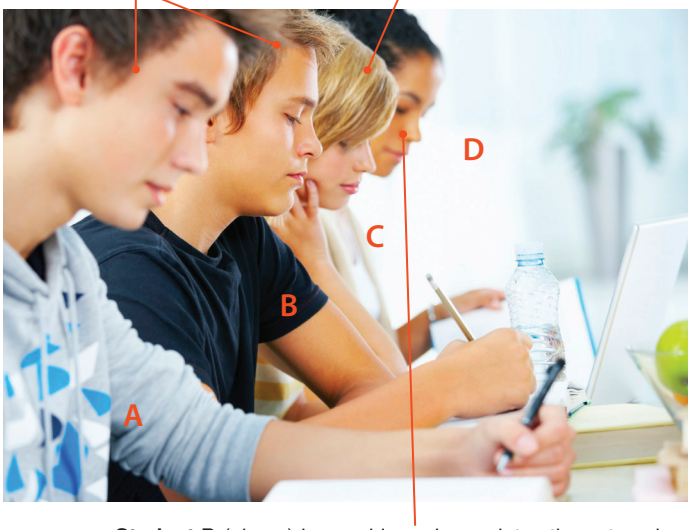
- Use the workbook PDFs with HIDE/SHOW answers on the **Teacher's Digital Edition** to review activities in class using a data projector or interactive whiteboard.
- Students benefit from the feedback in class, where questions can be addressed, and teachers benefit by having students self-mark their work and receive helpful feedback on their responses.
- This approach is particularly suited to activities with questions requiring a discussion, as students will be able to clarify some aspects of their responses. Stronger students can benefit by contributing to the explanatory feedback and class discussion.

3 Gaining Confidence

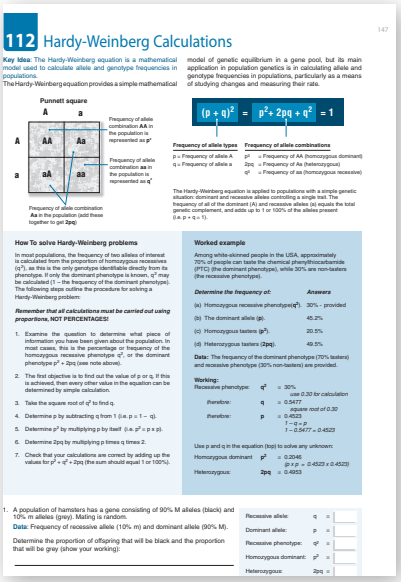
- The questions in BIOZONE's workbook activities have generally been written in a direct questioning style, e.g. "What are the differences between A and B", or "Why are A and B different?". This makes it easier for the students to understand what is required to answer the question.
- Questions are also arranged so that simpler questions (describe, what, identify, name) are generally asked first, followed by questions demanding an explanation (explain, how, why, account for). This allows students to gain confidence from answering the simpler questions first before attempting the questions that require more comprehensive answers.
- This arrangement also allows teachers to direct students appropriately so that some may attempt only the simpler questions themselves and work with peers to attempt the more challenging questions.

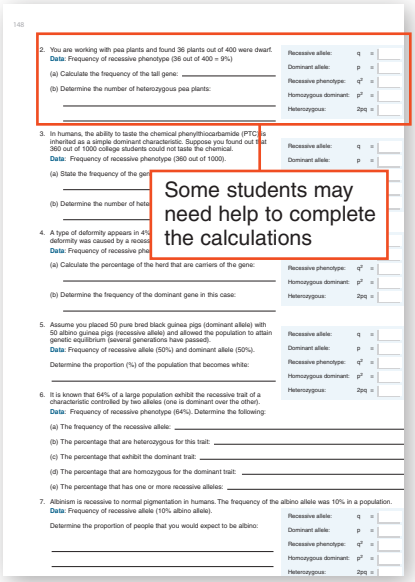
Students A and B will work through simpler questions themselves but may require assistance with the more challenging questions in this activity.

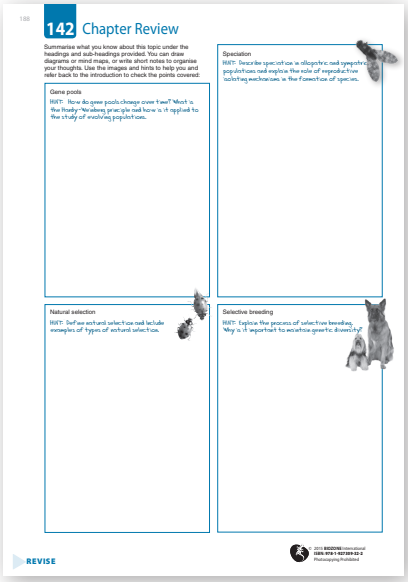
Student C is capable. She completes all of this activity including the more challenging questions.



Student D (above) is capable and completes the set work quickly. She can assist her peers and demonstrate her understanding in the relevant section of the review sheets.

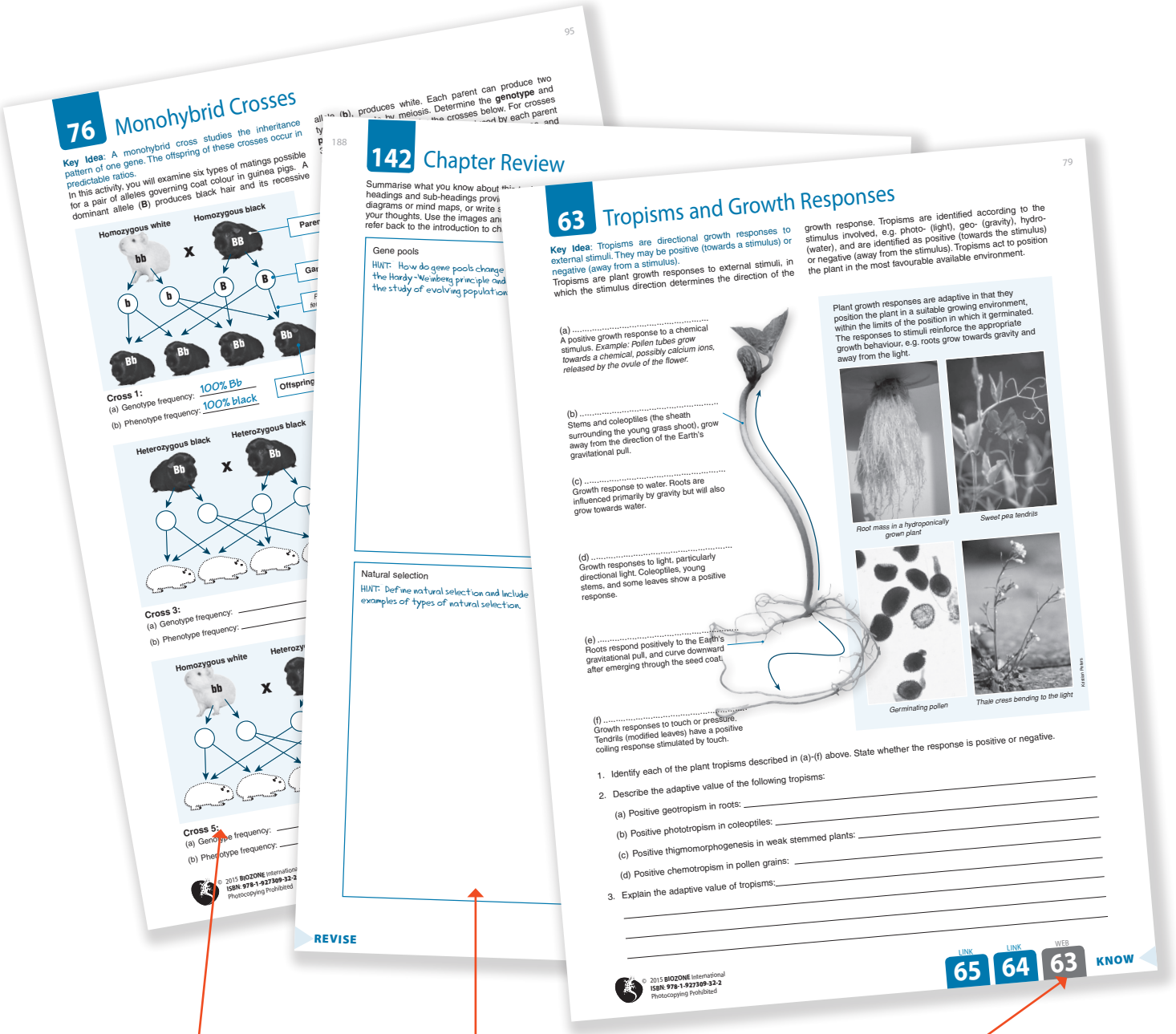






Choosing Activities for Home Study

Many of the workbook activities are ideal for homework or as vehicles for a quick synoptic assessment. Review activities are ideal as homework. They provide a way to review a topic that has recently been completed, while at the same time facilitating consolidation by presenting the material in a slightly different way. The information for review activities can be found within the chapter, although stronger students may not need to refer back to source material to complete the set work. Generally, homework activities should revise completed topics or provide a basic entry-level introduction.



Tailor your programme so that simpler activities are most often set as homework exercises, especially for less able students who may be easily discouraged.

Review activities can be used as a revision tool before synoptic tests. The review gives students direction in the important areas of that section of work.

Most students will have access to the internet. If they are having trouble understanding a subject or visualising a process, encourage them to visit the assigned **weblinks** where these are provided.

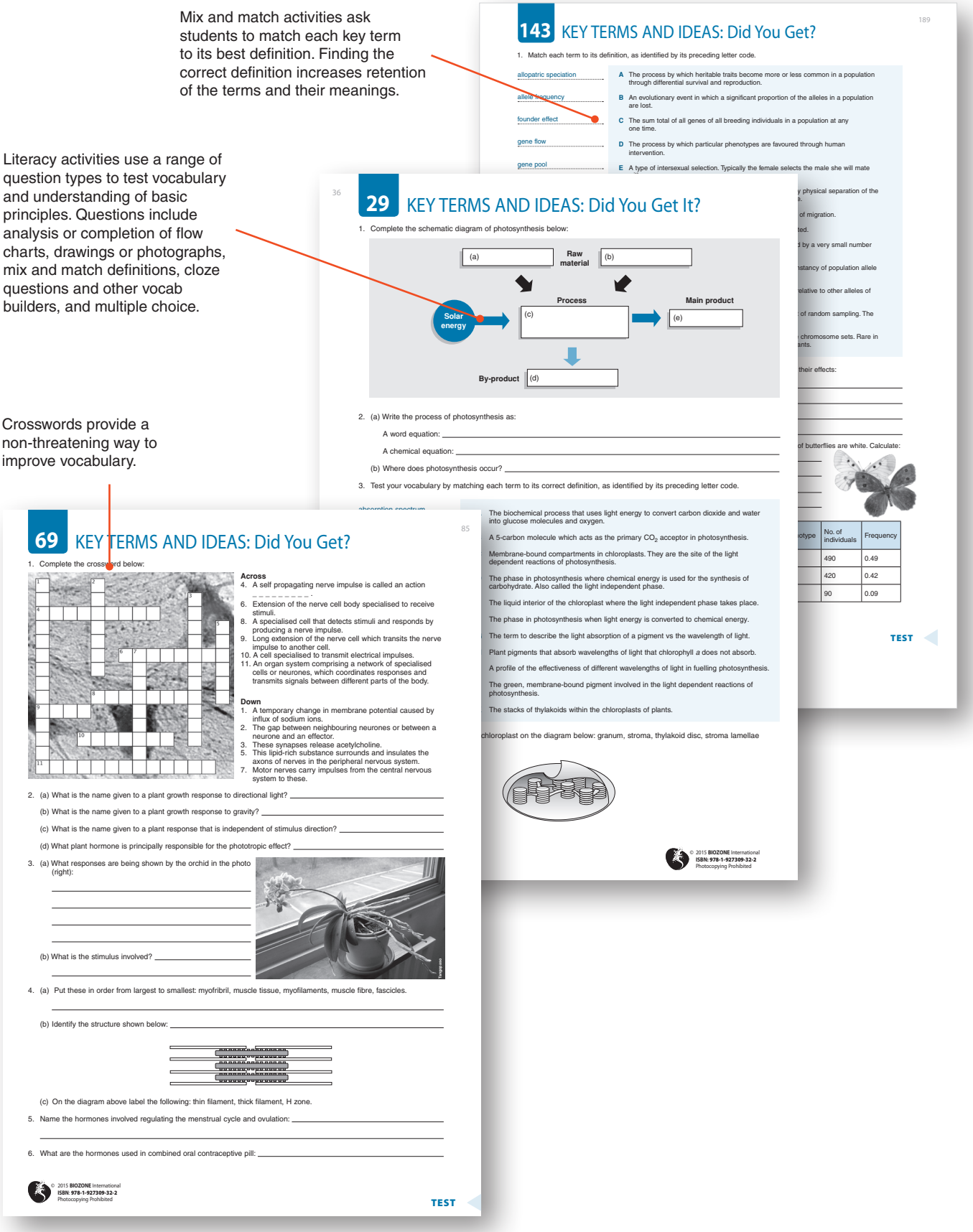
Focus on Literacy

Within all areas of science, scientific literacy is an important area of focus. With it, communication in the topic is more effective, more concise, and less cumbersome. BIOZONE's literacy and comprehension activities provide a vehicle for increasing the student's familiarity with the use of scientific terms in various contexts. Beginning with the list of KEY TERMS in the introduction to each chapter, students can create their own glossary of commonly used terms. They can learn to use these key terms appropriately by encountering them in context within the activities, and reinforce their understanding of the term by completing the literacy activities throughout the workbook. These take several forms:

Mix and match activities ask students to match each key term to its best definition. Finding the correct definition increases retention of the terms and their meanings.

Literacy activities use a range of question types to test vocabulary and understanding of basic principles. Questions include analysis or completion of flow charts, drawings or photographs, mix and match definitions, cloze questions and other vocab builders, and multiple choice.

Crosswords provide a non-threatening way to improve vocabulary.



143 KEY TERMS AND IDEAS: Did You Get?

1. Match each term to its definition, as identified by its preceding letter code.

allopatric speciation
allele frequency
founder effect
gene flow
gene pool

A The process by which heritable traits become more or less common in a population through differential survival and reproduction.
B An evolutionary event in which a significant proportion of the alleles in a population are lost.
C The sum total of all genes of all breeding individuals in a population at any one time.
D The process by which particular phenotypes are favoured through human intervention.
E A type of intersexual selection. Typically the female selects the male she will mate

29 KEY TERMS AND IDEAS: Did You Get It?

1. Complete the schematic diagram of photosynthesis below:

(a) Raw material (b)
Solar energy
Process (c)
Main product (e)
By-product (d)

2. (a) Write the process of photosynthesis as:
A word equation:
A chemical equation:
(b) Where does photosynthesis occur?

3. Test your vocabulary by matching each term to its correct definition, as identified by its preceding letter code.

The biochemical process that uses light energy to convert carbon dioxide and water into glucose molecules and oxygen.
A 5-carbon molecule which acts as the primary CO_2 acceptor in photosynthesis.
Membrane-bound compartments in chloroplasts. They are the site of the light dependent reactions of photosynthesis.
The phase in photosynthesis where chemical energy is used for the synthesis of carbohydrate. Also called the light independent phase.
The liquid interior of the chloroplast where the light independent phase takes place.
The phase in photosynthesis when light energy is converted to chemical energy.
The term to describe the light absorption of a pigment vs the wavelength of light.
Plant pigments that absorb wavelengths of light that chlorophyll *a* does not absorb.
A profile of the effectiveness of different wavelengths of light in fuelling photosynthesis.
The green, membrane-bound pigment involved in the light dependent reactions of photosynthesis.
The stacks of thylakoids within the chloroplasts of plants.

chloroplast on the diagram below: granum, stroma, thylakoid disc, stroma lamellae

No. of individuals	Frequency
490	0.49
420	0.42
90	0.09

TEST

69 KEY TERMS AND IDEAS: Did You Get?

1. Complete the crossword below:

Across
4. A self propagating nerve impulse is called an action _ _ _ _ _ _ _ _ _.
6. Extension of the nerve cell body specialised to receive stimuli.
8. A specialised cell that detects stimuli and responds by producing a nerve impulse.
9. Long extension of the nerve cell which transits the nerve impulse to another cell.
10. A cell specialised to transmit electrical impulses.
11. An organ system comprising a network of specialised cells or neurones, which coordinates responses and transmits signals between different parts of the body.

Down
1. A temporary change in membrane potential caused by influx of sodium ions.
2. The gap between neighbouring neurones or between a neurone and an effector.
3. These synapses release acetylcholine.
5. This lipid-rich substance surrounds and insulates the axons of nerves in the peripheral nervous system.
7. Motor nerves carry impulses from the central nervous system to these.

2. (a) What is the name given to a plant growth response to directional light?
(b) What is the name given to a plant growth response to gravity?
(c) What is the name given to a plant response that is independent of stimulus direction?
(d) What plant hormone is principally responsible for the phototropic effect?

3. (a) What responses are being shown by the orchid in the photo (right):
(b) What is the stimulus involved?

4. (a) Put these in order from largest to smallest: myofibril, muscle tissue, myofilaments, muscle fibre, fascicles.
(b) Identify the structure shown below:
(c) On the diagram above label the following: thin filament, thick filament, H zone.

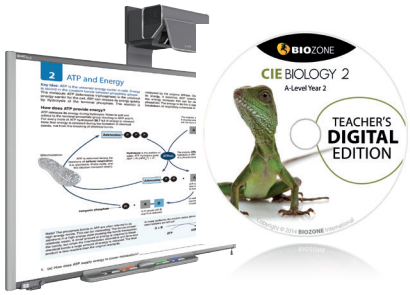
5. Name the hormones involved regulating the menstrual cycle and ovulation:

6. What are the hormones used in combined oral contraceptive pill:

TEST

The Teacher's Digital Edition

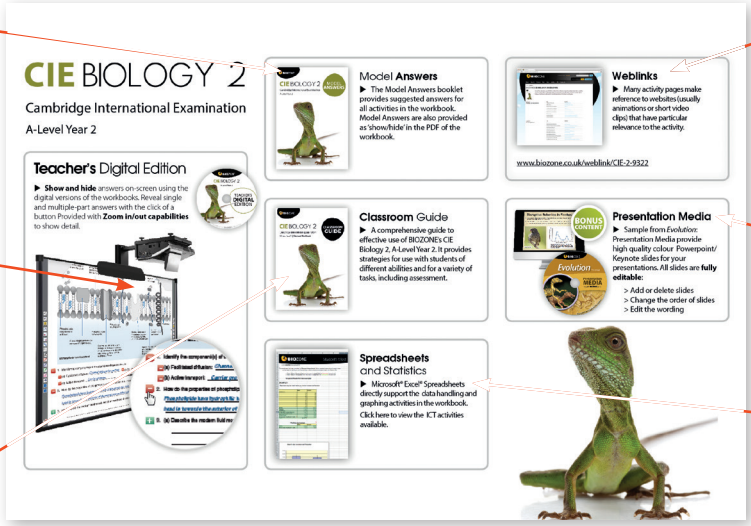
The *Teacher's Digital Edition* is aimed primarily at extending the pedagogical tools at a teacher's disposal. Many of the features of this resource have been developed in response to requests from teachers themselves.



Digital copy of the Model Answers (non-printable). Suggested answers are provided to all activities. Some include explanatory detail.

A digital (PDF) version of the workbook (non-printable). Use the interactive buttons to HIDE or SHOW the answers.

This **Classroom Guide** is provided as a printable PDF.



Access the *Weblinks* directly from this link for a range of animations and video clips to support the activities.

A **BONUS** sample from the Cell Biology and Biochemistry Presentation Media.

Link to ***Excel***® **spreadsheets** for all activities with a graphing or data analysis component.

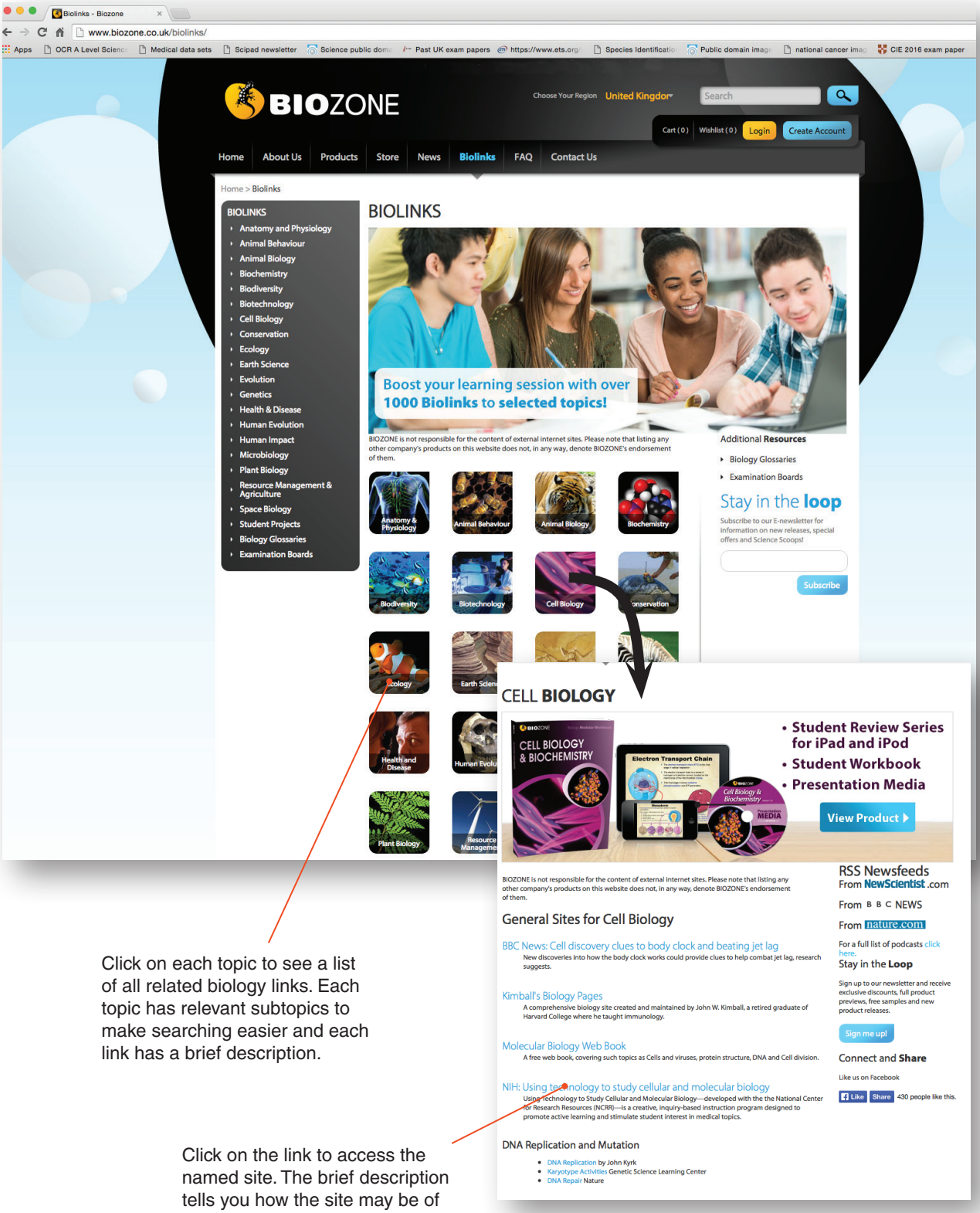
Use the interactive buttons to reveal the answers as you work through the activity on-screen.

The answer provided in the electronic answer is the minimum expected answer. Sometimes, further explanatory details is included in the Model Answers booklet.

Many activities with data handling are supported by working spreadsheets, which include all data and comments on graphical analysis.

Using BIOZONE's Website

BIOZONE's web site should be the first stop for biologists. As well as providing all our product information (including shipping dates) and updates, *www.biozone.co.uk* provides quick access to the latest RSS newsfeeds and podcasts from around the world. You can also quickly link to the websites of publishers of references cited in the workbooks. Perhaps of greatest value to students and teachers is the BIOLINKS area of BIOZONE's website. The BIOLINKS pages are distinct from *WebLinks* (which are specific to each workbook edition) and provide a database of well organised hyperlinks pertaining to topics of interest in biology and environmental science. The database is updated regularly, so that outdated, not operational, or no longer relevant sites are removed and new sites are added as they appear.



Click on each topic to see a list of all related biology links. Each topic has relevant subtopics to make searching easier and each link has a brief description.

Click on the link to access the named site. The brief description tells you how the site may be of interest, as well as any country specific bias, if this is relevant.