

HSC

BIOLOGY

MODULES 1-4



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BIOZONE Learning Media Australia

P.O. Box 2841, Burleigh BC,
QLD 4220, Australia

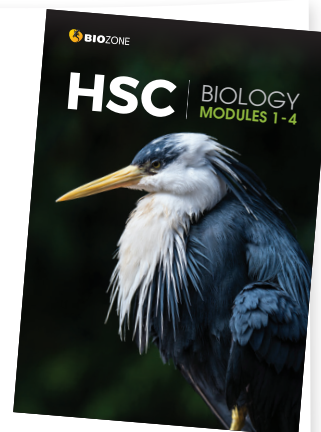
☎ 07 5535 4896

📠 07 5508 2432

✉ sales@biozone.com.au

www.**BIOZONE**.com.au

FAQs ABOUT HSC BIOLOGY MODULES 1-4



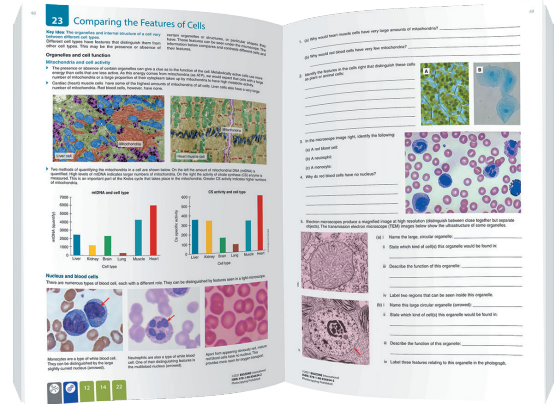
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BIOZONE's Pedagogy

A worktext approach

BIOZONE's delivery method is a departure from a traditional textbook. We combine the very best features of a textbook with the utility of a workbook, producing a worktext resource. Importantly, the worktext is owned by the student: it is their own resource to utilise. Whether they are using the print or digital version, students customise their worktext with notes and annotations, checking off their progress in the contents and chapter introductions, and input their answers on the pages as they work through the activities.

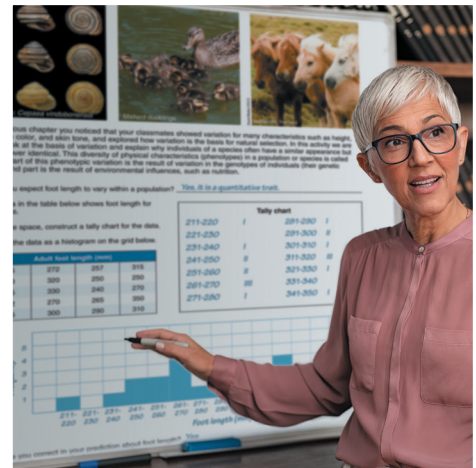
Using a highly graphical approach and short blocks of text, we deliver textbook quality information in an accessible and engaging way, ensuring students are not overwhelmed by large amounts of information. As students interact with the stimulus material and work through activities, they are encouraged to input their answers directly onto the page. This simple act reinforces the learning moment and forms a record of work as they progress through the material. Students find revision a breeze because the stimulus material, questions, and their answers are in one place.



We have included a wide range of activity types in this title. These include practical activities (experimental investigations, modelling, and simulations), research activities, and assessment tasks. The variety of activity types provides flexibility in the way teachers can assign them. For example, work can be assigned to be carried out as homework, completed in class, or set for revision. Teachers can assign students to work on activities individually or set work as a group. The activity based approach simplifies assigning work, and teachers can utilise this approach to set work for substitute teachers in their absence.

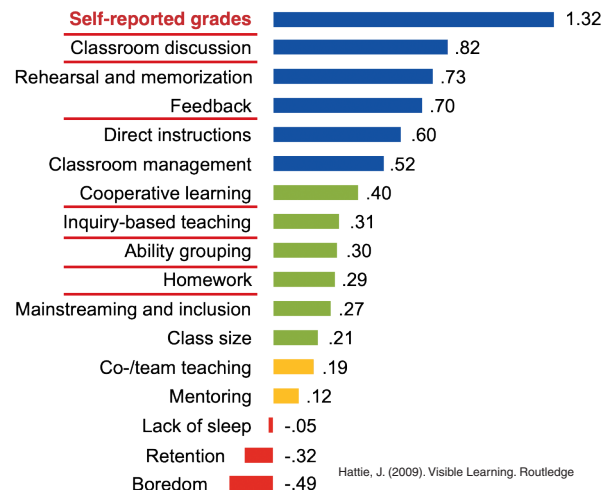
Not all answers need to be graded!

Within the activities, there are plenty of opportunities for students to record answers to the questions. This approach reinforces the learning moment, provides space for students to record their work, and acts as a revision tool when students are preparing for assessments. This approach does not mean that teachers are expected to review or grade all student responses. We suggest that only key activities or questions are graded. This might be assessment tasks at the end of each chapter or at the conclusion of a section. You may also choose to grade activities with content that students have traditionally found challenging, or where there is often a misunderstanding of the topic. Teachers can also choose to share answers with students. Sharing the model answers allows students to self report grades: an exercise known to be a powerful pedagogical learning tool (Hattie, 2009). Having access to model answers also allows students to refine their initial response if needed. This provides a powerful second learning moment to consolidate and extend understanding. Teachers can utilise the show/hide model answer feature in the digital platform to share answers.



Features to accelerate student learning

Student learning can be influenced by many factors. A synthesis of more than 1,400 meta studies by Hattie (2009) involving over 80,000 individual studies and 300 million students has revealed some of the major influences to student learning. Some factors negatively influence student learning (red, right) while others have positive effects (yellow, green, and blue, right). BIOZONE's approach incorporates many of the factors shown to positively influence student learning, these are underlined in red on the diagram (right). By utilising this resource, these factors are organically incorporated into content delivery and enhance the teacher and learner experience.



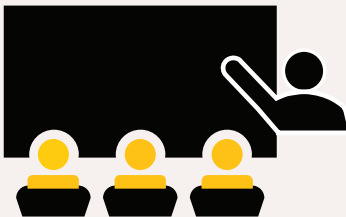
Meeting Key Competencies

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 *HSC Biology*, we have put the aims and structure of the **NSW Biology Stage 6 syllabus** first and foremost. This title fully supports scientific investigation, critical and creative thinking, and individual and collaborative approaches to scientific endeavour. An understanding of ethical behaviours, and acknowledgement of the knowledge and cultures of Aboriginal and Torres Strait Islander peoples, are integral to this title. This guide will highlight some of the strategies BIOZONE has used to meet the aims and scope of the study design.



Lesson planning

- The structure of *HSC Biology, Modules 1-4* follows the module structure specified in the **NSW Biology Stage 6 syllabus**. Teachers can be assured that all of the essential components of the syllabus are covered, ensuring easy and efficient lesson planning with no content gaps.
- Use the chapter introductions to assign students work for each lesson.
- Add interest to your lessons by utilising the FREE, curated resources on **BIOZONE's Resource Hub** in your planning. Resources for specific activities are identified on the Resource Hub, saving you time, and extending your range of tools. You can use these to prepare students for upcoming topics, or consolidate understanding after lessons.
- Use the contents pages to help with lesson planning too. A green bullet next to an activity in the contents pages identifies where there is a practical investigation. Incorporate these activities into your schedules.



Teaching

- Teach the content in the order presented in *HSC Biology, Modules 1-4*. This will ensure foundation knowledge is covered before students need to apply the information to more complex topics.
- Have students refer to *Chapter 1: Working Scientifically*, as the need arises, or before attempting an activity that addresses a specific skill (e.g. drawing a line graph). These activities can be assigned as homework, or they can be completed in class.
- Encourage peer-to-peer learning by assigning students into groups of mixed abilities when carrying out group research projects or practical investigations.
- Activities that manipulate data using formulas may be supported by spreadsheets on **BIOZONE's Resource Hub**. You can tailor how you use the spreadsheets and students can analyse the data sets provided (including graphs) to save time.
- Extend students' scientific vocabulary by encouraging them to look up unfamiliar words in the **glossary** (Appendix 1).
- Use BIOZONE WORLD to introduce an activity and give any direction required. It can be used to review answers in class or on-line quickly and efficiently. Choose when and how you reveal the answers. To promote student discussion, reveal answers only once the students have shared their ideas. Reveal all the answers if you want the students to self mark their own work.



Assessment

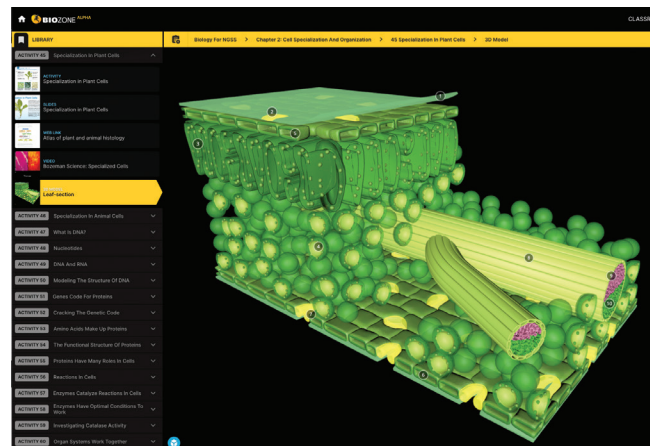
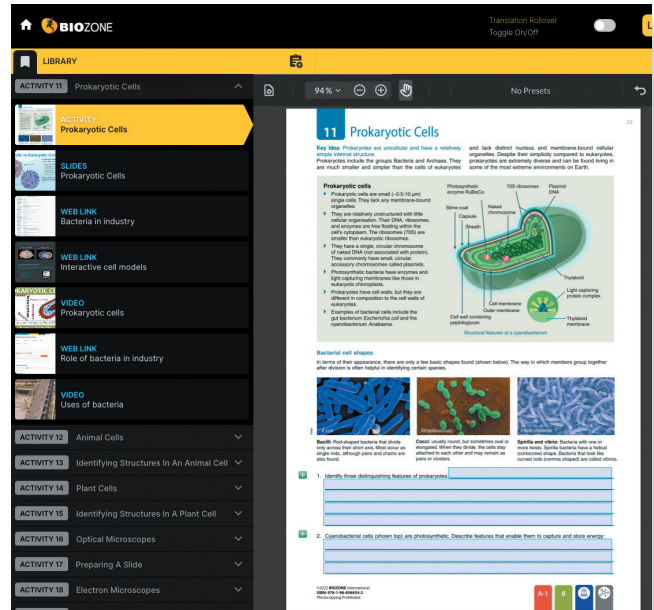
- Provide feedback (formative and summative) to students to update them on their progress. This can highlight areas of strength or areas needing work.
- Use formative assessment to identify areas the class needs to revisit before progressing to the next topic or unit. Methods of formative assessment include reviewing student answers on the chapter reviews, observing students carrying out practical work, or evaluating their contribution and understanding in practical work.
- Use the **Synoptic Assessments** at the end of each module to assess student understanding. This could be carried out as a test in class. Alternatively, you can set them as homework or open book assessments if you wish.

Teacher Support Materials: Teacher Toolkit

BIOZONE's HSC titles are supported by a suite of resources. These additional resources provide flexibility to help you teach remotely or in the classroom, provide online answers (which you can share with students for self assessment if you wish), and use interactively to promote class discussion and efficient review. Some features of these supporting resources are described below.

BIOZONE WORLD

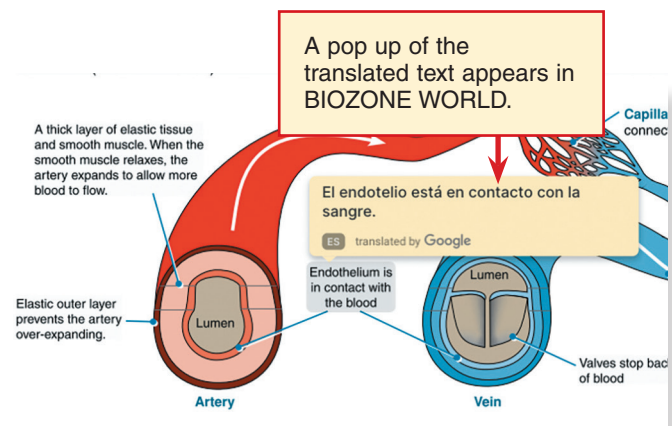
- BIOZONE WORLD, our digital science platform, brings our digital worktexts and rich collection of digital resources together in a single location for easy use. Click on an activity to access the additional resources provided. These include: presentation slides, interactive 3D models, and curated videos and weblinks. Educators can easily plan lessons, assign work, and grade student responses using BIOZONE WORLD.
- Students' access to BIOZONE WORLD allows them to use tools to markup, highlight, and bookmark content. They can also answer questions online, and submit their work for review or grading. Students have access to the curated collection of digital resources (presentation slides, 3D models, and curated videos and weblinks).
- Teacher access to BIOZONE WORLD includes the features available to students plus teacher-only additional features, including:
 - The ability to view, grade, and give feedback on submitted student work.
 - Forced hand-in feature.
 - Ability to display the content on a shared screen (e.g. interactive whiteboard) to introduce or review an activity, or highlight areas of particular importance, e.g. an important step in a practical investigation.
 - Model answers in place. Show/hide buttons toggle answers on and off; ideal for sharing data or answers with students. Students do not have access to model answers on BIOZONE WORLD.
- Find out more: biozone.com/us/biozone-world



Translation function

BIOZONE WORLD, our digital platform, provides a translation feature to support to students who have English as a second language. The content can be translated into 150 languages.

Simply activate the translation feature, select the language for translation, and roll the cursor over the text to be translated. A pop up box of the translated text appears on the page. The English text is still visible. Having both languages visible supports students with their English language development while having the reassurance of their first language accessible.



RESOURCE HUB

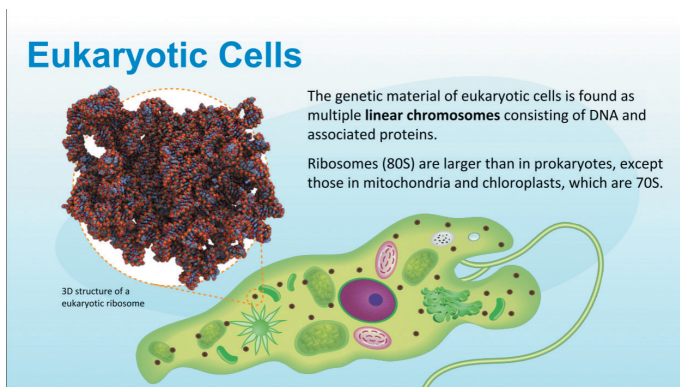
The BIOZONE **Resource Hub** is a **free resource**, available to both students and teachers. It offers a curated collection of Open Educational Resources (OER) specifically chosen to support the content of the worktext. Resources include videos, animations, games, 3D models, spreadsheets, and source material.

Content on the BIOZONE **Resource Hub** can be accessed by both print and digital users. **Print users** can access the material using the QR code in the worktext or bookmark the link provided (below right). For **BIOZONE WORLD users**, these same resources are ingested into the platform and automatically appear with the selected activity.

The BIOZONE **Resource Hub** is an effective tool to engage students of all abilities within a differentiated classroom. Most resources can be used by students of all abilities. 3D models, videos, games, and simulations are great tools for engaging students in a topic, or supporting striving students in their learning journey.

Some components have been tagged as extension material and can be used to extend more capable or gifted students. These types of resources may require more reading or synthesis of information. Our spreadsheet models can be used as is, or you can have students graph the information themselves. You may wish to challenge more capable students to build their own models, or manipulate the ones provided to observe the outcomes.

Some material is tagged as a teacher resource. Teacher resources often provide background or additional material to an activity. Capable students, or students with a particular interest in the topic can be assigned this material at your discretion.



ONLINE MODEL ANSWERS

Online Model Answers provide suggested answers to each of the activities, including working where appropriate (e.g. calculations).

Online Model Answers are accessible via a login that is unique to your school. Your access as a teacher means you're able to control how much and when students can view individual answers, making it easier for you to support homework and revision. Controlled access to answers promotes deeper understanding and encourages students to be self critical. The online model answers also provide an effective tool to support your students with remote learning.



www.BIOZONEhub.com

Then enter the code
in the text field

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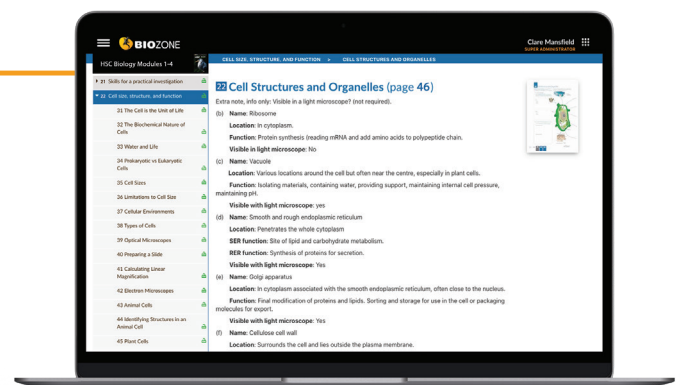
Or scan this QR code

PRESENTATION SLIDES

Presentation Slides are a very popular way for teachers to deliver a lesson in a presentation style format. Presentation Slides are a useful delivery tool in both face to face or remote teaching.

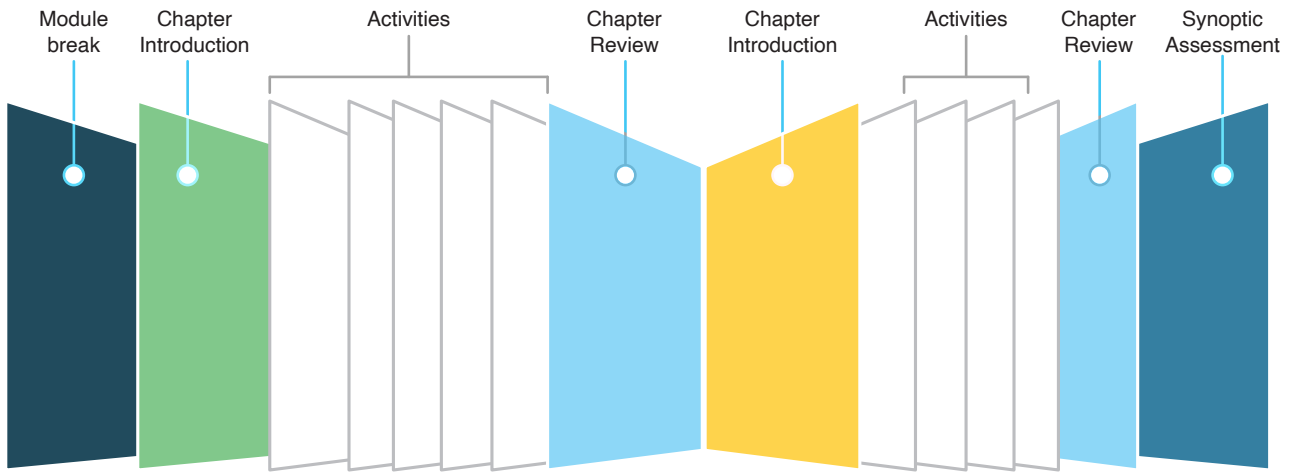
The Presentation Slides are a collection of slides specifically designed to support and enhance the content of the worktext.

The Presentation Slides are fully ingested into BIOZONE WORLD and automatically appear with the selected activity.



Structure of the Worktext

HSC Biology: Modules 1 - 4 has been specifically written to meet the content and skills requirements of the NSW Stage 6 syllabus (Modules 1 - 4). The worktext follows the structure outlined in the Stage 6 syllabus, so it is easy for you to know where you are in the course. The content is organised into 14 chapters, numbered sequentially and nested within their module (below). Module breaks divide the content into sections (the modules) and summarise the student outcomes for each module. Each chapter has an introduction page so you can see the key knowledge and skills requirements for each chapter. The graphic below illustrates the structure of a module and chapters. Use this structure to help navigate through the content.



Chapter introduction

- Inquiry questions are identified.
- A check list of key knowledge.
- A list of key terms.

Activity pages

- Contain essential knowledge.
- Questions review the content of the page.

Chapter review

- Test student understanding of the chapter content.
- Develop student scientific vocabulary.

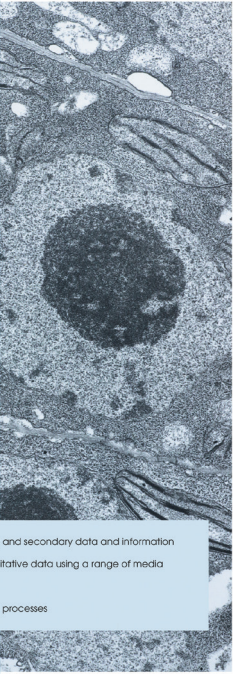
Synoptic assessment

- Synoptic assessments conclude the module of study covered in the workbook.
- Practise written exam skills.

Module Breaks

The content of the *HSC Biology Modules 1-4* is organised into four sections (modules). The module breaks divide the book into four sections covering related material. This structure provides students with a clear indication of where they are in the course. Each unit break summarises the student outcomes covered in each module, so students have a clear idea of what is coming up.

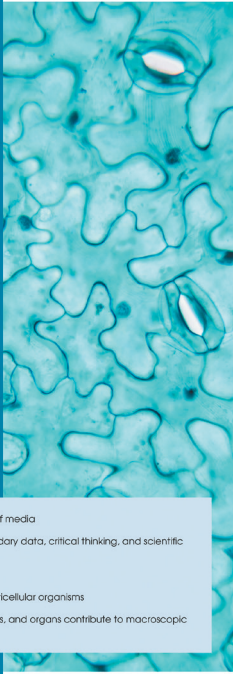
MODULE
01
Cells as the basis of life



Student outcomes:

- ▶ Carry out investigations to collect primary and secondary data and information
- ▶ Select and process qualitative and quantitative data using a range of media
- ▶ Describe cell structure and function
- ▶ Analyse and explain cellular features and processes


MODULE
02
Organisation of living things



Student outcomes:

- ▶ Select and process data using a range of media
- ▶ Solve problems using primary and secondary data, critical thinking, and scientific processes
- ▶ Communicate scientific understanding
- ▶ Explain the structure and function of multicellular organisms
- ▶ Describe how the activities of cells, tissues, and organs contribute to macroscopic processes in organisms

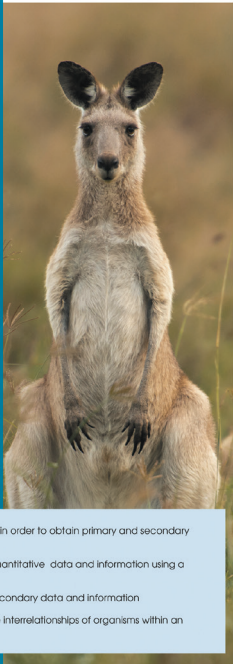
MODULE
03
Biological diversity



Student outcomes:

- ▶ Develop and evaluate questions and hypothesis for scientific investigation
- ▶ Design and evaluate investigations to collect primary and secondary data and information
- ▶ Communicate scientific understanding using appropriate language and terminology
- ▶ Describe biological diversity
- ▶ Explain relationships between organisms in terms of specialisation for habitat and evolution of species

MODULE
04
Ecosystem dynamics



Student outcomes:

- ▶ Conduct and evaluate investigations in order to obtain primary and secondary data and information
- ▶ Select and process qualitative and quantitative data and information using a range of appropriate media
- ▶ Analyse and evaluate primary and secondary data and information
- ▶ Analyse ecosystem dynamics and the interrelationships of organisms within an ecosystem

The Contents: A Planning Tool

The contents pages are not merely a list of the activities in the book. Encourage your students to use them as a planning tool for their programme of work. Students can identify the activities they need to complete and then tick them off when completed. Teachers can see at a glance how quickly the student is progressing through the assigned material.

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Membrane Structure 54 <input type="checkbox"/> 28 Modelling the Plasma Membrane 55 <input checked="" type="checkbox"/> 29 Chapter Review: Did You Get It? 57</p> <p>Chapter 3: Cell Function</p> <p><i>Key Skills and Knowledge</i> 58</p> <p><input checked="" type="checkbox"/> 30 Key Skills and Knowledge 58 <input checked="" type="checkbox"/> 31 Key Skills and Knowledge 59 <input checked="" type="checkbox"/> 32 Key Skills and Knowledge 60 <input checked="" type="checkbox"/> 33 Key Skills and Knowledge 61 <input checked="" type="checkbox"/> 34 Key Skills and Knowledge 62 <input checked="" type="checkbox"/> 35 Key Skills and Knowledge 63 <input checked="" type="checkbox"/> 36 Key Skills and Knowledge 64 <input checked="" type="checkbox"/> 37 Estimating Osmolarity of Cells 69 <input checked="" type="checkbox"/> 38 Water Relations in Plant Cells 70 <input checked="" type="checkbox"/> 39 Active Transport 71 <input checked="" type="checkbox"/> 40 Ion Pumps and Cotransport 72 <input checked="" type="checkbox"/> 41 Membranes and the Export of Proteins 73 <input checked="" type="checkbox"/> 42 Endocytosis 75</p>	<p><input type="checkbox"/> 43 Active and Passive Transport Summary 76 <input type="checkbox"/> 44 Energy Inputs and Outputs 77 <input type="checkbox"/> 45 Energy Transformations in Cells 79 <input type="checkbox"/> 46 The Role of ATP in Cells 80 <input type="checkbox"/> 47 ATP and Energy 82</p> <p>Chapter 2: Cell Structure</p> <p><i>Key Skills and Knowledge</i> 25</p> <p><input checked="" type="checkbox"/> 8 The Cell is the Unit of Life 26 <input checked="" type="checkbox"/> 9 Types of Cells 27 <input checked="" type="checkbox"/> 10 Cell Sizes 28 <input checked="" type="checkbox"/> 11 Prokaryotic Cells 29 <input checked="" type="checkbox"/> 12 Eukaryotic Cells 31 <input type="checkbox"/> 13 The Cell Membrane 32 <input type="checkbox"/> 14 The Plasma Membrane 33 <input type="checkbox"/> 15 The Cell Wall 34 <input type="checkbox"/> 16 Optical Microscopes 35 <input type="checkbox"/> 17 Preparing a Slide 37 <input type="checkbox"/> 18 Electron Microscopes 39 <input type="checkbox"/> 19 Calculating Linear Magnification 41 <input type="checkbox"/> 20 Biological Drawings 42 <input type="checkbox"/> 21 Observing and Drawing Cells 44 <input type="checkbox"/> 22 Cell Structures and Organelles 46 <input type="checkbox"/> 23 Comparing the Features of Cells 48 <input type="checkbox"/> 24 The Plasma Membrane 50 <input type="checkbox"/> 25 Phospholipids and the Properties of Membranes 51 <input type="checkbox"/> 26 The Structure of the Plasma Membrane 52 <input type="checkbox"/> 27 How Do We Know? 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Activity is marked: to be done; when completed ● Includes practical investigation

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.

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

A green dot indicates a practical activity.

The teacher has an alternative activity of their own they wish to use, so they indicate to the students to skip this activity.

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

Introducing the Chapter Content

Each chapter 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. Encourage your students to use the glossary (Appendix 1) to expand their scientific vocabulary.

For ease of navigation, chapters are numbered sequentially throughout the book.

58

CHAPTER
3

Cell Function

The chapter title corresponds to the section heading in each module.

Key terms

- acetyl coA
- activation energy
- active site
- active transport
- ATP
- ATP synthase
- Calvin cycle
- catalyst
- cellular respiration
- chlorophyll
- chloroplast
- crisate
- denaturation
- diffusion
- electron transport chain
- enzyme
- fermentation
- glucose
- glycolysis
- grana
- Krebs cycle
- light dependent phase
- light independent phase
- link reaction
- matrix
- metabolic pathway
- metabolism
- mitochondrion
- NAD/NADH
- NADP/NADPH
- osmosis
- oxidative phosphorylation
- passive transport
- photolysis
- photosynthesis
- photosystem
- pyruvate
- RubisCo
- stroma
- substrate level phosphorylation
- thylakoid discs
- triose phosphate

Inquiry question: How do cells coordinate activities within their environment?

The movement of materials into and out of cells

Key skills

- 1 Describe and compare the surface area to volume ratio of materials.
- 2 Explain the effect of temperature on the rate and efficiency of diffusion.
- 3 Investigate the effects of solutions of different solute concentration on plant cells. Use your results to estimate the osmolality of a cell, e.g. a potato cell.
- 4 Examine the role active transport (including ion pumps, cotransport, and exo- and endocytosis). What distinguishes active transport mechanisms from forms of passive transport and why is active transport important, despite its energetic costs.

Cell requirements

Key skills and knowledge

- 6 Understand that cells exchange matter and energy with their environment. Describe the general requirements of cells, including but not limited to:
 - i The need for energy, including light and chemical energy in complex molecules.
 - ii The need for matter, including nutrients, gases, and ions.
 - iii The need to remove waste materials. What types of waste materials are produced by cells, what is their origin, and how do cells get rid of them?

Investigating biochemical processes in cells

Key skills and knowledge

- 7 Explain the production and role of ATP in cells, including aerobic and anaerobic ATP production. Describe ATP's central role in biochemical processes.
- 8 Describe cellular respiration, including the inputs, outputs, and location of glycolysis, the Krebs cycle, and the electron transport chain, and the events occurring in those stages.
- 9 PRAC Use a simple respirometer to measure respiration in a simple organism.
- 10 PRAC Investigate the effect of different substrates on the rate of fermentation in yeast.
- 11 Describe photosynthesis, including the main inputs, outputs, and location of the light dependent and light independent reactions, and the events occurring in those phases.
- 12 PRAC Use a simple system to investigate factors affecting rate of photosynthesis.
- 13 PRAC Use simple chromatography to isolate and visualise photosynthetic pigments.
- 14 Describe how enzymes work to control biochemical processes in cells, including removal of cellular products and wastes, such as hydrogen peroxide.
- 15 PRAC Using turnip peroxidase, investigate factors affecting enzyme activity in cells.

The list of **key terms** highlights important terms to students. They can look them up in the glossary at the back of the book if they are unsure of what they mean. This encourages use of the correct terms when answering questions and builds scientific literacy.

Activities that cover practical skills are identified with a green bookmark and blue text.

The relevant inquiry question for each chapter is clearly stated. Encourage students to keep this in mind as they work through the content, and try to relate their learning back to it.

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

The activities relating to these key knowledge outcomes.

Introduce the concept with a grounding activity

Follow with activities exploring that concept

44 Energy Inputs and Outputs

Key Idea: Organisms can be grouped according to how they obtain energy for metabolism. Autotrophs obtain energy from the Sun. Heterotrophs obtain energy from other organisms. Living things obtain their energy for metabolism in two main ways. **Autotrophs** (producers) use the energy in sunlight or inorganic molecules to make their own food. **Heterotrophs** (consumers) rely on other organisms as a source of energy and carbon. All other organisms depend on producers, when they do not consume them directly. The energy flow into and out of each trophic (feeding) level can be represented in a diagram using arrows of different sizes to represent relative amounts of energy lost from different trophic levels.

Photoautotrophs: Use energy from sunlight to manufacture their food from simple inorganic substances (e.g. CO₂). Examples: green plants, algae, some bacteria.

Chemoautotrophs: Are able to use chemical energy in the ocean. Most are bacteria or archaea restricted to extreme environments such as deep sea vents where they fix their own carbon.

Eaten by consumers: Some eat plants or herbivores and omnivores. Some eat other animals.

Respiration: Heat given off from metabolic activity. Metabolic waste products are released.

Waste: Metabolic waste products are released.

Reflected light: Solar radiation not absorbed by the organism is reflected off the surface of the organism.

Dead tissue: Available to decomposers and detritivores.

Respiration: Heat given off from metabolic activity. Metabolic waste products are released.

Nutrients assimilated by heterotrophic hosts: Some chemoautotrophs are found as symbionts. The organic molecules they produce are absorbed and assimilated by their hosts.

Chemotrophs obtain their energy from the oxidation of simple inorganic molecules such as hydrogen sulfide and ammonia (using oxygen) or iron(II) without oxygen.

45 Energy Transformation in Cells

Key Idea: The energy from sunlight is captured and stored as glucose, which powers the production of ATP in the process of cellular respiration. Hydrolysis of ATP provides the energy to power the chemical reactions in living systems.

Energy flow in the cell of an autotroph (a plant) is shown below. Note that ATP has a central role in acting as an energy carrier to power metabolic reactions. Some of the energy is lost as heat during these reactions.

Photosynthesis: A chemical process that captures light energy and uses it to convert water and carbon dioxide into glucose and oxygen.

Cellular respiration: The most common form of energy for most organisms, which rely on photosynthesis as producers.

ATP: The hydrolysis of ATP provides the energy for metabolic reactions. Each mole of ATP hydrolysed releases 30.7 kJ of energy. Some energy is stored in chemical bonds, while some is lost as heat.

Energy transformation: $A + B \rightarrow AB + \text{heat energy}$

ATP cycle: $ATP \rightarrow ADP + P_i$

- How does ATP act as a supplier of energy to power metabolic reactions?
- (a) Identify the ultimate source of energy for most autotrophs. (b) Identify a group of autotrophic organisms that do not use this source of energy.
- Identify the ultimate source of energy for most heterotrophs.
- In what way are the processes pictured above (photosynthesis and cellular respiration) connected?

46 The Role of ATP in Cells

Key Idea: ATP transports chemical energy within the cell for use in metabolic processes. All organisms require energy to perform the metabolic processes required to function and reproduce. This energy is obtained by cellular respiration, a set of metabolic reactions which 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. Adenine is derived from adenine (the 'A'). The structure of ATP is shown right.
- 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 hydrolysis. Typically, hydrolysis is coupled to another cellular reaction in 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 hydrolytic reaction, not the breaking of bonds between the phosphates (which requires energy input).

ATP powers metabolism

The energy released from the breakdown of glucose is used to produce ATP. Formation of the active site of an enzyme and chromosome separation both require the energy provided by ATP hydrolysis to occur.

Muscle: As seen in the stained cross-section of a muscle, ATP is required when bacteria divide by binary fission. ATP is required 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.

Exocytosis: ATP is required when bacteria divide by binary fission. ATP is required 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.

Cell wall: ATP is required when bacteria divide by binary fission. ATP is required 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.

- What process produces ATP in a cell?
- Identify the three distinct elements of the space-filling model of ATP, labelled (a)-(c) below right. (a) (b) (c)
- Which two of the elements you labelled in question 2 make up adenosine?
- Explain why thermoregulation requires the expenditure of energy.
- Describe one other process in a cell that requires ATP.

Structure of an Activity Page

The activity pages have been carefully designed to provide high quality information to students in an easily accessible format. They include a number of features designed to engage students and help them unpack and understand the information. Features include short blocks of text so that students do not feel overwhelmed with too much reading, high quality informative graphics, and links to 3D models that provide another dimension to student engagement and learning. Question and answer sections allow students to demonstrate their understanding of the content. By having the stimulus material and their answers in one place, students can easily revise for assessments. Teachers should guide students through the features of the activity pages to ensure that they make the most of the features on offer.

Key Idea: Summarises the primary focus of the activity and provides a clear take-home message.

Introductory paragraph: Provides background information and an introduction to the activity.

Diagrams: Full colour diagrams and photos help students visualise important information or concepts.

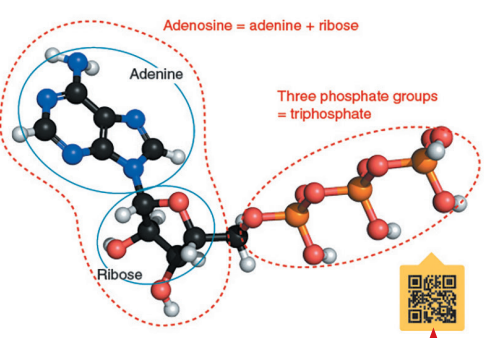
Key Terms: Words in **bold** are key terms. Definitions for these can be found in the glossary at the back of the worktext.

46 The Role of ATP in Cells

Key Idea: ATP transports chemical energy within the cell for use in metabolic processes. All organisms require energy to perform the metabolic processes required to function and reproduce. This energy is obtained by cellular respiration, a set of metabolic reactions which 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 mobility, 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. Adenine + ribose form adenosine (the "A" in ATP). The structure of ATP is shown right.
 - 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 (Pi).
 - 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).



ATP powers metabolism

Solid particle

The energy released from the removal of a phosphate group of ATP is used for active transport of molecules and substances across the plasma membrane e.g. **phagocytosis** (above) and other active transport processes.

Chromosomes separating

Mitosis, as seen in the stained onion cell above, requires ATP to proceed. Formation of the mitotic spindle and chromosome separation both require the energy provided by ATP hydrolysis to occur.

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

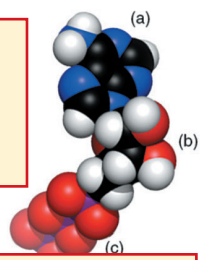
Not all of the energy released in the oxidation of glucose is captured in ATP. The rest is lost as heat. This heat energy can be used to maintain body temperature. Thermoregulatory mechanisms such as shivering and sweating also use ATP.

QR codes: Scanning the QR code takes students directly to a 3D model.

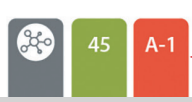
- What process produces ATP in a cell? _____
- Identify the three distinct elements of the space-filling model of ATP, labelled (a)-(c) below right:
(a) _____ (b) _____ (c) _____
- Which two of the elements you labelled in question 2 make up adenosine? _____
- Explain why thermoregulation requires the expenditure of energy:

- Describe one other process in a cell that requires ATP. _____

Questions: Students input their answers directly onto the page to help reinforce the learning moment. This approach also makes revision easy because the stimulus material and answers are in one place.



Tab system: The tab system provides valuable information about supporting resources and syllabus components for an activity. The tab system is explained in full on the following pages.



200

Logistic growth
 $dN/dt = rN(K-N)/K$

The population tends to stabilize around carrying capacity (K). Any fluctuations (blue dashed line) are caused by variations in the birth rate and death rate as a result of the population density slightly exceeding or falling below carrying capacity.

Logistic growth is characterized by a brief, early phase of exponential growth, followed by a slowing in growth as the population reaches carrying capacity. Logistic growth produces a S-shaped (sigmoidal) growth curve. Populations may fluctuate around K but these fluctuations tend to become less pronounced over time.

Logistic growth is expressed mathematically as: $dN/dt = rN(K-N)/K$

Carrying capacity (K)
 Environmental resistance increases as the population approaches carrying capacity.

Logistic (S) curve
 As N approaches K, the population encounters environmental resistance to growth. The population reaches equilibrium around K. This is the population size that can be supported by the environment.

Populations of large mammals (above) show logistic growth and their populations exist at or near carrying capacity, which is usually determined by primary production (the amount of biomass produced by plants).

2. A population started with a total number of 100 individuals. Over the following year, population data were collected. Calculate birth rates, death rates, net migration rate, and rate of population change for the data below (as percentages):
 (a) Births = 14; Birth rate = _____ (b) Net migration = +2; Net migration rate = _____
 (c) Deaths = 20; Death rate = _____ (d) Rate of population change = _____
 (e) State whether the population is increasing or declining: _____

3. (a) What are the features of exponential growth? _____
 (b) Why don't populations continue to increase exponentially in an environment? _____
 (c) Describe the features of logistic growth: _____
 (d) What is environmental resistance and what role does it have in limiting population growth? _____
 (e) Explain why a population might overshoot carrying capacity before stabilizing around carrying capacity. _____

5. What happens to population growth rate as $K-N/K$ approaches 0? _____

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Encourage students to scan the **QR codes** on the activity pages. These link directly to informative and engaging 3D models. All models can be rotated and zoomed, and some contain informative annotations.



Using the Tab System

The tab system helps you identify important parts of the HSC Biology course (general capabilities, cross-curriculum priorities, and other curriculum learning areas). The tabs also allow you to see at a glance if online support is provided on BIOZONE's **Resource Hub**, and if there are content links with other activities. A summary of the icon tabs is provided below and a full description is provided on the following page.

Green tabs link to related content.

Orange tabs indicate where other syllabus learning areas are covered within an activity.








The activity is supported with content on **BIOZONE's Resource Hub**

Red tabs are used to refer to relevant appendices (glossary term or equipment list).




Purple tabs identify cross-curriculum priorities.

Blue tabs indicate the general capabilities covered within the activity.




General capabilities

	Critical & creative thinking: Develop critical and creative thinking skills through asking questions, making predictions, engaging in practical and secondary-sourced investigations, and analysing and evaluating evidence.
	Ethical understanding: Apply ethical values and principles to your studies and investigations. Understand the implications of these to others and the environment. Understand reasoning can assist making ethical judgements.
	Information & communication technology capability: Use ICT to access information, collect, analyse, and represent data, model and interpret concepts and relationships, process information, and communicate ideas.
	Intercultural understanding: Appreciate and respect diverse cultures (yours and others) and understand how cultural perspectives have impacted the developments, breadth and diversity of scientific knowledge and applications.
	Literacy: Literacy is the ability to identify, understand, interpret, create and communicate effectively using written, visual, oral, and digital formats. Apply these skills to communicate scientific concepts and findings.
	Numeracy: Numeracy involves recognising and understanding the role of mathematics in the world. Develop numeracy skills through measuring, recording, representing, and analysing data.
	Personal & social capability: Establish positive relationships, make responsible decisions, work effectively (alone and with others) and constructively handle challenging situations during your scientific endeavours.





Cross-curriculum priorities

	Aboriginal & Torres Strait Islander histories & cultures: The traditional knowledge and cultural practices of Aboriginal & Torres Strait Islander peoples provide insight into how the environment and natural world work. Traditional knowledge and Western scientific knowledge can be used together in a complementary way.
	Asia & Australia's engagement with Asia: The diverse environments of Australia and Asia provide opportunities to study interactions within and between the two environments, including how human activity influences the region, and the significance of these to the rest of the world.
	Sustainability: Sustainability is concerned with the ongoing capacity of the Earth to maintain all life. It provides contexts for exploring, investigating, and understanding the interrelatedness and sustainability of Earth's systems, including both natural and human-made environments.

Other learning across curriculum areas

	Civics & citizenship: Understand how civics, the understanding of Australian society, and citizenship can be applied to scientific ideas and technological advances.
	Difference & diversity: Australian society is diverse in terms of gender, race, and socio-economic circumstances. Working collaboratively provides opportunities to develop an appreciation of the values and ideas of others.
	Work & enterprise: Develop and use safe working practices. Identify risks and carry out hazard assessments when working in the laboratory or field.

Other tabs

	Grey hub tabs indicate the activity is supported by content on BIOZONE's Resource Hub. See page ix for details about BIOZONE's Resource Hub.
	Green tabs show connections to related activities and content elsewhere in the book.
	Appendix 1: Glossary of key terms and their definitions
	Appendix 2: Equipment list for the practical investigations

Support for Science Skills and Practical Investigations

The *Working Scientifically Skills* are well supported throughout the worktext. Chapter 1 provides students with a refresher on general science skills they will find useful during their science studies. Throughout the HSC Biology course students practise these skills by applying them in practical situations (opposite). As students work through the content, there are many opportunities for them to develop skills in science practices and apply them within the context of an activity. Regular practise helps students become proficient in using these skills when they encounter them in their assessments.

Working Scientifically: Checklist

CHAPTER 1 Working Scientifically

Working scientifically skills
Background in the activities manual. Covered in context in following chapters.

Key terms
accuracy
precision
error
repeatability

Understanding science

Observations, hypotheses, and predictions

Planning and conducting investigations

Processing and analysing data

Health and safety

Communicating

Assessing and reducing risk

Presenting data in graphs

Guidelines for line graphs

Guidelines for scatter graphs

Guidelines for bar/outline graphs

Aims, questions, hypotheses and predictions

1 Aims, Questions, Hypotheses, and Predictions

Key Idea: Hypotheses are testable, falsifiable statements about a phenomenon. Hypotheses can be used to generate predictions about the results of an experiment.

Understanding science

Observations, hypotheses, and predictions

Planning and conducting investigations

Processing and analysing data

Health and safety

Communicating

Assessing and reducing risk

Presenting data in graphs

Guidelines for line graphs

Guidelines for scatter graphs

Guidelines for bar/outline graphs

Plan and conduct investigations

2 Planning and Conducting Investigations

Key Idea: Carefully recorded, well-planned investigations are more likely to produce reliable, valid data.

Understanding science

Observations, hypotheses, and predictions

Planning and conducting investigations

Processing and analysing data

Health and safety

Communicating

Assessing and reducing risk

Presenting data in graphs

Guidelines for line graphs

Guidelines for scatter graphs

Guidelines for bar/outline graphs

The Chapter 1 introduction provides an overview of the Working Scientifically Skills required in HSC Biology. This checklist will help students ensure they understand the skill requirements.

This activity helps students to identify and construct aims and questions for the investigation, formulate hypotheses, and make predictions.

This activity focuses on how to plan and conduct investigations. Information includes selecting equipment, identifying variables, and recording data.

Comply with safety & ethical guidelines

3 Safety and Ethical Guidelines

Key Idea: In practical work, research, and reporting you should act in accordance with safety and ethical guidelines.

Health and safety in the laboratory

Assessing and reducing risk in the lab

Presenting data in graphs

Guidelines for line graphs

Guidelines for scatter graphs

Guidelines for bar/outline graphs

Processing and analysing data

4 Processing and Analysing Data

Key Idea: Raw data can be processed and analysed to help show any patterns or trends in the data.

Processing and analysing data

Presenting data in graphs

Guidelines for line graphs

Guidelines for scatter graphs

Guidelines for bar/outline graphs

Presenting data in graphs

Presenting data in graphs

Key Idea: Graphs are a good way to show trends, patterns, and relationships visually without taking up too much space.

Guidelines for line graphs

Guidelines for scatter graphs

Guidelines for bar/outline graphs

Assessing and reducing risk in the lab

Presenting data in graphs

Guidelines for line graphs

Guidelines for scatter graphs

Guidelines for bar/outline graphs

This activity covers basic considerations for ethical science practices, including risk assessment and the importance of honest reporting.

This longer activity covers commonly used data transformation methods students may be asked to carry out during HSC Biology. Information includes how to calculate rates, percentages, ratios, fractions, percentage change, and descriptions of central tendency (mean, median, and mode). Students learn about the reliability of their data, and how to test the reliability of the data themselves using some basic statistical analysis (standard deviation and 95% confidence interval). The value of presenting data in graphs and tables to summarise and identify trends is also covered.

Problem solving

5 Problem Solving

Key Idea: Solving problems may require modelling in the form of practical or mathematical models. Solving problems is an important part of science and biology. These problems may be large and complex, e.g. what is the best way to conserve wildlife within a particular area of habitat? Or they can be simple, e.g. what is the most efficient and accurate way to measure 50 mL of water? To help solve these problems evidence in the form of data might need to be gathered. Modelling the data to create a model could provide a better understanding of the problem and so provide the best answer. Models are a representation of a system being studied. They can be simple, e.g. a ball and stick model of an organic molecule, or they can be complex, e.g. modelling the interactions of organisms in an ecosystem.

Modelling data
There are many different ways to model data. Often seeing data presented in different ways can help us to understand it better. Some common examples of models are shown here.

Visual models
Visual models can include drawings, such as those plant cells shown below for apple growth. Other types can be as simple as relationships between different parts of a system.

Mathematical models
Displaying data in a graph or as a mathematical equation, as shown below for apple growth, often helps us to see relationships between different parts of a system.

Carrying capacity (K)

$$N_t = N_0 e^{r(t - T)}$$

Analogy
An analogy is a comparison between two things. Comparing a biological system to an everyday object can sometimes help us to understand it better. For example, the heart pumps blood in blood vessels to reach the same way a fire truck pumps water from a fire hydrant through a hose. Similarly, the DNA in chromosomes is like a library. Extending that analogy further, the steps in building a code from a code book provide an analogy for the translation of DNA. The model are translated into a specific protein (see cells).

1. (a) What is a model?
 (b) Why do scientists often study one part of a system rather than the whole system?

2. Climate change is one of the major problems facing the environment today and in the future. Climate change models developed over the last few decades include many inputs that influence the climate, such as the amount of carbon dioxide produced by industry each year. How do climate change models help us predict future effects of various human actions and therefore help us solve the problem of climate change?

Evaluating and communicating scientific ideas

6 Evaluating & Communicating Scientific Ideas

Key Idea: The analysis, evaluation, and communication of scientific information are skills requiring an understanding of the science and a critical approach to the claims made. Some of your studies in biology involve your gathering, analysing and evaluating primary data, and then communicating your findings to others. However, you will also need to critically evaluate and interpret a range of published material, both in scientific publications and in popular media. To analyse and evaluate the science you read about or see online you must think critically and have a good understanding of the concepts, theories, and models involved. When communicating scientific ideas to others you must be able to express them clearly and concisely in a way that is appropriate to your audience.

Analysis and evaluation of scientific ideas
A text analysis and critique may involve:

- Describing the article
- Stating the main points in the article
- Describing the author's perspective and assumptions
- Identifying any claims made by the author and any evidence presented to justify them.
- Evaluating the article
- Identifying and describing any bias in the article. How might this have affected the article's accuracy?
- Describing the article's conclusions or claims.
- Describing the limitations of an investigative article.

What can be trusted?

- Biological science covers some controversial or sensitive topics. Many new ideas about biology may not be compatible with traditional views or people's own personal belief systems. As a result, people may have certain views that they invest in. This leads to people seeking both information to support their own view.
- When reading biological information, especially on the internet, it is important that the information comes from a source and whether it makes sense in a wider context. This will help you identify biased or flawed information.
- Note the site from which you obtained information. It is reputable or just someone's blog with their own unvetted ideas? Be cautious with video sites, which can present an unbalanced personal view. Commenters may identify errors.

Evaluating scientific information

- In order to communicate scientific ideas, you must be able to critically evaluate the information. Points to consider include:
 - Validity of the information.
 - Is the information up to date?
 - Is the information peer-reviewed? Has it been accepted by the scientific community?
 - Does the information present an unbiased view?
 - Is information presented in a fair, unbiased way? Is it based on fact and evidence?
 - Is the information presented divided by the attitudes, beliefs or ideas of the person, group or organisation supplying the information?
- Scientific journals are peer-reviewed, meaning the information is checked by experts in the area before publication. This makes the information much more reliable. However, journals are very technical, requiring a high level of in-area expertise to understand.
- Newspaper articles are a good starting point as a source of generally readable information, but beware of the newspaper's political slant. Scientific news items are often written with some newspapers may have left or right political leanings, which can skew the facts.
- Online sites that are specific for a topic need to be carefully scrutinised for validity. Good copywriting sites can help support the science. Government sites usually have correct and reliable data based on information from related agencies.

Creating
Modelling is an important part of science and biology. For your depth study you may wish to create a model of a biological system. You could create a physical model, produce a mathematical equation, or a computer simulation that models the relationships between the parts of a biological system.

Feedback
Feedback allows you to carry out an investigation with a particular audience rather than yourself. For example, a study to analyse the effect of a new drug on the circulation of the cardiovascular system of the investment community would be carried out by both the drug company and their patients. Feedback is a way to make an experiment more reliable.

Chapter 14: Depth Studies: Guidance and Ideas

208 Depth Studies: Guidance and Ideas

Key Idea: A depth study is an investigation or activity allowing further development of an idea covered during your course of study. During the H2C course you will learn about many biological concepts, including biotechnology, organisms, and their adaptations for survival, and the environment. The depth study will provide you with an opportunity to explore one or more of these ideas in detail. Your study may take the form of a practical investigation, a secondary source investigation, library research, or fieldwork. In any case, you will need to propose a question to investigate, plan and carry out your investigation and clearly communicate your findings.

Practical investigation:
The aim is to test a hypothesis. You will need to propose a question, conduct a hypothesis, design, carry out, and analyse the results and produce conclusions. You may wish to investigate a practical element or how a device works and propose improvements.

Secondary source investigation:
You will conduct research to answer a biological question or complete a task. This will involve the gathering, analysis and critically evaluate data. This could include investigating historical aspects of a concept or completing a task. You will communicate your findings by writing or visual presentation, using your evidence to justify your conclusions.

Fieldwork:
Fieldwork allows you to carry out an investigation with a particular audience rather than yourself. For example, a study to analyse the effect of a new drug on the circulation of the investment community would be carried out by both the drug company and their patients. Feedback is a way to make an experiment more reliable.

Data analysis:
We will need to organise and analyse the data you collect. This may take the form of data tables, graphs, or diagrams.

Periodicals or technical magazines, e.g. National Geographic, Scientific American, or New Scientist, are useful sources of reliable information. As they are written for the general public they make understanding the individual information easier.

Breaking problems down into smaller components and tackling the more manageable pieces can be a useful strategy for solving complex problems. Models and representations can be used to visualise a problem and help solve problems and predict outcomes.

This skill requires students to think critically and communicate information to an audience in an appropriate way. Students are introduced to the basic principles here, and have the opportunity to implement them throughout the course and also in their depth study.

Chapter 14 is dedicated to helping students plan and carry out their depth study. Encourage students to refer to it often as they plan, execute, and report their findings for their chosen topic.



Practical Investigations and activities in Context

Practical investigations and hands on activities appear in context throughout the book. The practical investigations provide opportunities for students to develop many of their essential science skills. Working in groups promotes collaboration and the development of communication skills. Stronger students can mentor and support those who are less confident, providing benefit for both sets of students. A list of equipment for each investigation is provided in Appendix 2.

35 Investigating the Effect of Cell Size

Key Idea: The effect of cell size on the efficiency of diffusion can be investigated using model agar 'cells' of different sizes. As described in the previous activity, the efficiency of diffusion decreases as cell size increases. This can be demonstrated easily in a model system in this activity you will design an experiment to demonstrate the effect of surface area to volume ratio on diffusion in model cells. Think about how you will plan your investigation and analyse your data to obtain meaningful results. This will help you to make valid conclusions about cell size and rate of diffusion.

Background Information

Oxygen, water, cellular waste, and many nutrients are transported into and out of cells by diffusion. However, at a certain surface area to volume ratio, diffusion becomes inefficient. In this activity you will create model cells of varying sizes from agar and then test the relationship between cell size and rate of diffusion.

The diffusion of molecules into a cell can be modelled by using agar cubes infused with phenolphthalein indicator and soaked in sodium hydroxide (NaOH). Phenolphthalein is an acid-base indicator and turns pink in the presence of a base. As the NaOH diffuses into the agar, the phenolphthalein changes to a pink colour and this indicates how far into the agar block the NaOH has diffused (right). By noting an agar block into cubes of various sizes, it is possible to investigate the effect of cell size on diffusion.

Equipment list

- Glass beaker
- Paper towel
- Timer
- Agar blocks infused with phenolphthalein
- Sodium hydroxide (NaOH) solution
- Laboratory tongs
- Scalpel
- Ruler

52 Investigating Yeast Fermentation

Key Idea: Brewer's yeast preferentially uses alcoholic fermentation when there is excess sugar. The CO₂ released can be measured as a measure of fermentation rate. Brewer's yeast is a facultative anaerobe (meaning it can respire aerobically or use fermentation). One would expect glucose to be the preferred substrate, as it is the starting molecule in cellular respiration, but brewer's yeast can use a variety of sugars, including disaccharides (two unit sugars), which can be broken down into single units. The rate at which yeast (Saccharomyces cerevisiae) metabolises carbohydrates substrates is influenced by temperature, solution pH, and type of carbohydrate available. High levels of sugars suppress aerobic respiration in yeast, so yeast will preferentially use fermentation in the presence of excess substrate.

Investigation 3.4 Investigating fermentation in yeast

See appendix for equipment list

Work in pairs for this activity. Your teacher will assign you a substrate to investigate.

- Make a yeast culture by dissolving 10 g of active yeast into 30 mL of water at 24°C.
- In a conical flask boil 225 mL of tap water then cool to room temperature (24°C). This removes any dissolved oxygen from the water.
- Add 25 g of substrate (glucose, maltose, sucrose, lactose, or none). Stir carefully to dissolve (stirring too vigorously will cause oxygen to dissolve back into the water).
- Then add 25 mL of the source yeast culture to the conical flask solution.
- Add a thin layer of paraffin oil over the solution in the conical flask to create an anaerobic environment.
- Shake the conical flask and set a measuring cylinder to capture any gas as in the diagram right.
- Start timing and record the change in gas volume every five minutes for 1 hour. Record the results for your substrate in the table. Plot data on a graph and use it to compare the table below.

Substrate	Cumulative volume of carbon dioxide collected (mL)				
Time (min)	None	Glucose	Maltose	Sucrose	Lactose
0					
5					
10					
15					
20					
25					
30					
35					
40					
45					
50					
55					
60					

1. Write the equation for the fermentation of glucose by yeast.

2. Using the final values (60 minutes) collected from the class, calculate the rate of CO₂ production per minute for each substrate:

- None:
- Glucose:
- Maltose:
- Sucrose:
- Lactose:

82 Investigating Stomatal Density

Key Idea: The density and distribution of leaf stomata in different plant species are related to the rate of water loss. Different plant species have different leaf shapes and structures and these can be correlated with the environment in which they are found. Comparing the leaf area and stomatal density of different plant species helps to explain observed differences in transpiration rate but factors in the environment, such as shading and wind, are also important.

Plant species show different leaf shapes and structures associated with their environments

- Aloe (succulent):** Thick, fleshy leaves to store water and reduce transpiration.
- Pine (conifer):** Needle-like leaves and a thick waxy cuticle to reduce water loss.
- Eucalyptus (Acacia gum tree):** Small, round, smooth leaves with a waxy cuticle.
- Sunflower (Asteraceae):** Large, flat leaves with a high surface area.

Investigation 5.1 Comparing stomatal density

See appendix for equipment list

- Your teacher will have up to four leaf types from four dicot plants adapted to different environments, or you may need to obtain samples of your own.
- The number of stomata per mm² on the surface of a leaf can be determined by covering the stomata with a clear nail varnish to leave a clear nail varnish print over the lower surface of a leaf. Leave it to dry. This creates a layer with impressions of the leaf surface.
- Carefully peel off the layer of nail varnish and place on a clean microscope slide.
- Calculate the diameter of the area viewable under a microscope using the magnification of the eyepiece multiplied by the magnification of the objective lens. For example if the eyepiece magnification is 10, the objective lens magnification is 40, and the field of view is 18 (18(10 × 40) = 0.045 mm diameter). The area viewable is then 17.
- You could also use a micrometer to measure the diameter of the field of view of use a thin clear ruler.
- Place the slide with the layer of nail varnish on it under the microscope and count the number of stomata you see. If there are too many stomata then count one quarter of the field of view and multiply by four. Do this in several places. Enter your results in the table and calculate a mean.
- You should also take note of where the stomata are on the leaf (are they scattered randomly or in specific places?).
- Repeat on the upper surface of the leaf.
- Repeat for the other leaf types.

* A digital microscope can be used to capture images on a computer which may improve counting.

Some "practical" activities are not investigations in the true sense, but give students a place to develop their skills in planning and designing an experiment.

Almost all investigations require students to use a number of science skills. They encourage collaboration, problem solving and attention to detail, as well as the analysis and evaluation of data.

The practical investigations may involve setting up and carrying out an experiment (above), or could involve a paper practical or modelling activity (e.g. making a model of the plasma membrane).

A-2 Appendix 2: Equipment List

The equipment list provides the material and equipment needed per student, pair, or group.

Investigation	Equipment List
2: Cell Structure	<p>INVESTIGATION 2.1 Preparating an onion slide</p> <p>Per student/pair</p> <ul style="list-style-type: none"> Light microscope Onion/onion leaf Glass microscope slides Coverlips Scalpel or razor Iodine stain Filter paper/tissue paper <p>INVESTIGATION 2.2a/b Drawing onion peel cells using a microscope</p> <p>Per student/pair</p> <ul style="list-style-type: none"> Light microscope Onion/onion leaf Eloides or similar thin leafed plant Glass microscope slides Coverlips Scalpel or razor Iodine stain Filter paper/tissue paper
3: Cell Function	<p>INVESTIGATION 3.1 Simple diffusion across a membrane</p> <p>Per student/pair</p> <ul style="list-style-type: none"> 200 mL beaker 1 mL pipette Glucose dipsticks Lugol's iodine 4 x test tubes Dialysis tubing Thread or nylon line Distilled water 1% starch solution 10% glucose solution Timer or watch <p>INVESTIGATION 3.2 Estimating osmolarity</p> <p>Per student/pair</p> <ul style="list-style-type: none"> 6 x 500 mL beakers Balance and equipment to weigh sugar Table sugar or lab sucrose Potato Cork borer or scalpel Paper towels Marker pen
INVESTIGATION 3.3 Measuring respiration in germinating seeds <p>Per group</p> <ul style="list-style-type: none"> 3 x boiling tubes Marker pen 6 x cotton balls 15% KOH solution 2 x eye dropper or plastic pipette 3 x gauze pieces Germinated bean seeds (enough to fill one quarter of the boiling tube) Ungerminated bean seeds (enough to fill one quarter of the boiling tube) Glass beads (enough to fill one quarter of the boiling tube) 3 x 2-hole tube stoppers 2 x bent glass tubes or pipettes 3 x rubber bands (must be able to be clamped shut) 3 x screw clips A few drops of colored liquid 3 x syringes (must fit tube with screw clamp attached) 3 x clamp stands or rack Water bath (25°C) Ruler Timer 	
INVESTIGATION 3.4 Measuring fermentation in yeast <p>Per pair</p> <ul style="list-style-type: none"> 1 x 100 mL beaker 10 g of active yeast 50 mL tap water at 24°C 25 g of substrate (glucose, maltose, sucrose, or lactose) 1 x glass stirring rod 1 x conical flask (to hold 275 mL) Parafilm Single hole stopper Tubing 1 x 100 mL measuring cylinder 1 x small basin to hold inverted cylinder Stopwatch 	
INVESTIGATION 3.5 Investigating photosynthetic rate <p>Per pair/group</p> <ul style="list-style-type: none"> 1.0 g Cabomba aquatic Balance Scissors Water 1 x large beaker (large enough to hold the glass funnel) 1 x glass funnel 0.2 mol/L sodium hydrogen carbonate solution (enough to cover the plant) 1 x test tube 1 x lamp with a 60W bulb Lux meter Timer 1 x ruler or tape measure 	
INVESTIGATION 3.6 Separating photosynthetic pigments <p>Per pair/group</p> <ul style="list-style-type: none"> Leaves of silverbeet or spinach Toothpick Boiling tube or test tube Filter paper or chromatography paper Pencil Ethanol Chloroform or paraffin Mortar and pestle Sand Scissors 	
INVESTIGATION 3.7 Investigating peroxidase activity <p>Per pair/group</p> <ul style="list-style-type: none"> 13 x boiling tubes 42 mL distilled water 1.8 mL 0.1% H₂O₂ solution 1.2 mL prepared guaiacol solution Parafilm 6 mL of each pH buffered solution (pH 3, 5, 6, 7, 8, 10) 9 mL turnip peroxidase solution Test tube rack Timer 	
5: Nutrient and Gas Requirements	<p>INVESTIGATION 5.1 Comparing stomatal density</p> <p>Per pair/group</p> <ul style="list-style-type: none"> Variety of leaf types Clear nail varnish Microscope slide Light microscope (with eyepiece micrometer if available) <p>INVESTIGATION 5.2 Modelling lung ventilation</p> <ul style="list-style-type: none"> 500 mL plastic bottle Scissors 2 balloons Rubber band or tape

No kits are required for the investigations.

The investigations have been designed using everyday materials and equipment easily found in most high school laboratories.

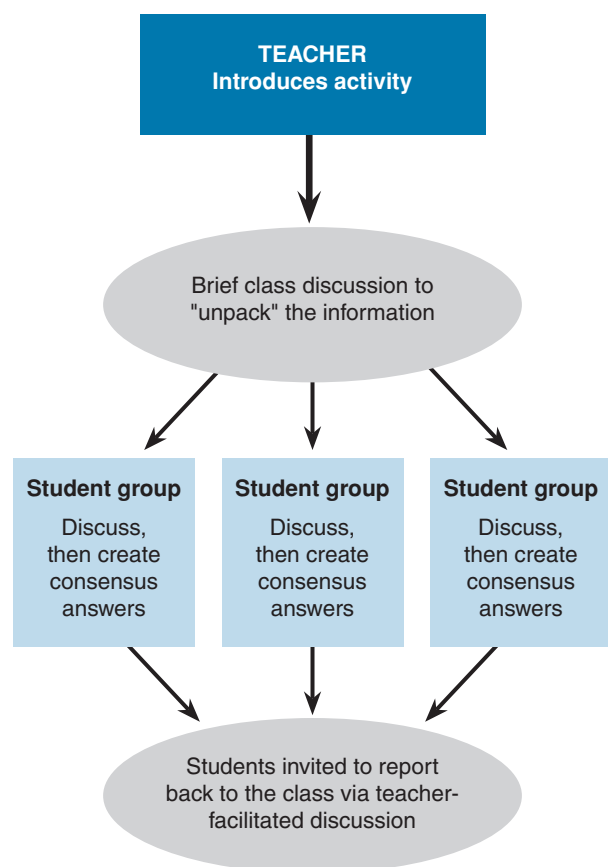
A list of the equipment and reagents required for each investigation is provided in appendix 2.

Teaching Strategies for Classroom Use

Achieving effective differentiated 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 student books and supporting resources can make teaching a mixed ability class easier. Here, we suggest some approaches for differentiated instruction.

MAKING A START

Regardless of which activity you might be attempting in class, a short introduction to the task by the teacher is a 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. Depending on the activity, the class may regroup at the end of the lesson for discussion.



Using collaboration to maximise learning outcomes

- The structure of *HSC Biology Modules 1-4* allows for a flexible approach to unpacking the content with your students.
- The content can be delivered in a way to support collaboration, where students work in small groups to share ideas and information to answer and gain a better understanding of a topic, or design a solution to a problem.
- By working together to ask questions and evaluate each other's ideas, students maximise their own and each other's learning opportunities. They are exposed to ideas and perspectives they may not have come up with on their own.
- Collaboration, listening to others, and voicing their own ideas is valuable for supporting English language learners and developing their English and scientific vocabularies.
- Use a short, informal collaborative learning session to get students to exchange ideas about the answer to a question. Alternatively, collaboration may take a more formal role that lasts for a longer period of time (e.g. assign groups to work together for a practical activity, to research an extension question, or design a solution to a problem).



The teacher introduces the topic. They provide structure to the session by providing background information and setting up discussion points and clear objectives. Collaboration is emphasised to encourage participation from the entire group. If necessary, students in a group can be assigned specific tasks.



Students work in small groups so that everyone's contribution is heard. They collaborate, share ideas, and engage in discourse. The emphasis is on sharing ideas, discussing questions, formulating answers. Students may even come up with additional questions and discussion points.



Students report back on their findings. Each student should have enough knowledge to report back on the group's findings. Reporting consists primarily of providing answers to questions, but may involve presenting a report, model, or slide show, or contributing to a debate. Students can revise their original answers providing a powerful second learning moment.



Peer to peer support

- **Peer-to-peer learning** is emphasised throughout the book, and is particularly valuable for more challenging activities in which the content is more complex or the questions require students to draw on several areas of their knowledge to solve a problem.
- **Practical activities, investigations and group research projects** are an ideal vehicle for peer-to-peer learning. Students can work together to review and discuss their results, ask and answer questions, and describe phenomena.

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89 Modelling Lung Ventilation

Key Idea: The lungs are ventilated by changes in the air pressure in chest cavity. Respiratory gases enter the body via the lungs. Breathing in is achieved by the diaphragm moving downwards and the ribcage moving upwards and outwards. This increases the volume of the chest cavity and causes the air pressure inside the cavity to become lower than the atmospheric air pressure. Air rushes into the lung and causes them to expand. When the diaphragm relaxes and the ribcage moves back downwards air is pushed back out of the lungs.

Investigation 5.2 Modelling lung ventilation

See appendix for equipment list.

Take care using a utility knife as they are very sharp. Cut on a flat firm surface or cutting board.

You can work in pairs for this activity if you wish.

1. Take a 500 mL (approximately) plastic bottle and use a utility knife to cut the bottom off.
2. Hang one of the balloons inside the neck end of the bottle and stretch the open end of the balloon over the neck of the bottle. It should fit tightly, but secure it with a rubber band if needed.
3. Cut the lower third off the second balloon and keep the two-thirds with the open end. Tie a knot in the neck of this balloon.
4. Stretch the wide opening of the cut balloon over the wide end of the cut bottle so that the knot hangs down. It should fit tightly over the bottle but secure it with a rubber band if needed.
5. Pull and release the knot. What happens? _____

What do you think happens to the pressure inside the bottle when you pull and release the knot? _____

How does this explain what happens in the model? _____

1. (a) What does the balloon in the bottle represent? _____

(b) _____

(c) _____

(d) _____

2. (a) _____

(b) _____

3. Use _____

4. When you breath in, what structure(s) in the lungs is/are actually expanding? _____

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Paper practical activities and modelling provide opportunities for students to work in pairs or small groups.

In this activity, students can work together to build a model to demonstrate lung ventilation.

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57 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).

Investigation 3.6 Separating photosynthetic pigments

See appendix for equipment list.

1. Tear leaves (e.g. spinach or silverbeet) into small sections and place in a pestle. Add a pinch of sand and 10 mL of ethanol. Grind up the leaves to form a dark green mixture.
2. Pour the mixture into a beaker or boiling tube, cover with cling film and leave for 5-10 minutes. This gives time for the chlorophyll pigments to better dissolve into the ethanol.
3. Cut a piece of filter paper or chromatography paper into a strip 1-2 cm wide. It should be long enough to reach from the top of a beaker or boiling tube to the bottom.
4. Use a pencil to draw a line across the width of the paper 1 cm from the bottom to mark the start position.
5. Use a micropipette to place a drop of the ground leaf mixture onto the middle of the line. You may need to do this a few times and air dry between each application to concentrate pigments on the spot.
6. Pour ethanol into a beaker or boiling tube to a depth of just over 1 cm. Set up the chromatography paper as in the diagram (below left).
7. Leave for long enough that the solvent front (ethanol) travels nearly to the top of the paper, or the pigments are well spread out. This may take up to 20 minutes.
8. Remove the paper and air dry. Calculate the R_f value for each pigment (below right).

Chromatography set up

Determining Rf values

This activity provides an ideal opportunity for students to work together to complete a multi-step activity. The results provide a good starting point for robust discussion, which will strengthen understanding and build skills in argumentation.

3. Staple your chromatography paper to this page.

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Collaboration and discovery

- BIOZONE's *HSC Biology Modules 1-4* allows for collaboration and discovery. By working together and sharing ideas, students are exposed to different perspectives and levels of knowledge about biological concepts.
- BIOZONE's *HSC Biology Modules 1-4* builds student understanding by providing a range of activities. These include getting students to think about and share what they already know and then build on this knowledge by exploring and explaining phenomena.



Student A is capable. He helps to lead the discussion and records the discussion in a structured way.

Students B and C are also capable but less willing to lead discussion. They will add ideas to the discussion but need a little direction from A to do so.

Student D is less able but gains ideas and understanding from the discussion of students A, B, and C. She may add to the discussion as she gains confidence in the material being studied.

Interactive revision of tasks in class

Review answers in class via BIOZONE WORLD

The teacher view in BIOZONE WORLD has model answers which can be toggled on and off using the show/hide buttons on an activity page.

View activities in BIOZONE WORLD on a shared screen and reveal the answers as required. This is ideal for:

- Providing a concise model answer after a group or class discussion.
- Self marking by students. Students can amend their answer if necessary, providing a powerful secondary learning moment.
- Providing a quick review of answers if time is short.

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.



Support for the Depth Study

The depth study is an important and exciting component of the HSC syllabus for students, allowing them to explore in detail a topic which interests them. However, it can also be overwhelming for them as they decide (with your guidance) which topic area to study and how best to carry out their investigation. While teacher input is very important to ensure students choose a suitable topic which meets all of the assessment requirements, we have provided resources to help students plan and carry out their depth study with confidence.

Chapter 14 is dedicated to helping students with their depth study. The material has been designed to get students thinking about their study and what exactly they will need to do to be successful. Topics include:

Choosing a depth study

- What types of studies, projects, or investigations can be used for a depth study?
- What type of study is most appropriate for the topic the student wants to study?
- What are the differences between a primary practical investigation and a secondary-sourced investigation?

Planning a depth study

- What does the planning process look like?
- What needs to be considered when planning a depth study?
- What does the student want to find out from their study?
- What type of data should be collected and how will it be analysed?
- What equipment is needed? Is the equipment available?
- Can the study be completed within the time frame?

Sharing findings

- What style of communication should be used to share the findings?
- What structure should be used when the student delivers their findings?
- How is the work of others acknowledged?



Formative and Summative Assessments

BIOZONE's *HSC Biology Modules 1-4* provides many opportunities to assess your students' progress as they work through the course. The *Contents* check-box list provides a list of activities completed, and the students' own self-tests in the review activities at the end of each chapter provide opportunity to address any misconceptions or lack of understanding. A summary of formative and summative assessments is provided in the tables below. You may also choose to assess practical work as you move through the course.

Module 1: Cells as the Basis of Life		
CHAPTER 1 Working Scientifically No formal assessment required	CHAPTER 2 Cell Structure	CHAPTER 3 Cell Function
FORMATIVE Activity 7. Chapter Review	FORMATIVE Activity 29. Chapter Review	FORMATIVE Activity 66. Chapter Review SUMMATIVE Activity 67. Synoptic Assessment

Module 2: Organisation of Living Things		
CHAPTER 4 Organisation of Cells	CHAPTER 5 Nutrient and Gas Requirements	CHAPTER 6 Transport
FORMATIVE Activity 76. Chapter Review	FORMATIVE Activity 96. Chapter Review	FORMATIVE Activity 115. Chapter Review SUMMATIVE Activity 116. Synoptic Assessment

Module 3: Biological Diversity			
CHAPTER 7 Effects of the Environment on Organisms	CHAPTER 8 Adaptations	CHAPTER 9 Theory of Evolution by Natural Selection	CHAPTER 10 Evolution - The Evidence
FORMATIVE Activity 122. Chapter Review	FORMATIVE Activity 133. Chapter Review	FORMATIVE Activity 150. Chapter Review	FORMATIVE Activity 170. Chapter Review SUMMATIVE Activity 141. Synoptic Assessment

170 Chapter Review: Did You Get It?

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

common ancestor
DNA hybridisation
molecular clock
mtDNA
phylogeny

A A technique in molecular evolution that uses molecular change to deduce the time in geological history when two species or other taxa diverged. Can be used to establish phylogenies.
B The evolutionary history or genealogy of a group of organisms.
C DNA located in mitochondria.
D A technique used to determine the percentage similarity between the DNA of two organisms.
E The individual from which all organisms in a taxon are directly descended.

2. Compare and contrast DNA hybridisation and DNA sequence comparison as methods for generating phylogenies:

3. The diagram (left) shows the evolutionary relationship of a group of birds based on DNA similarities:

(a) Place an X to the last common ancestor of all the birds:
(b) How many years ago did storks diverge from vultures?
(c) What are the most closely related birds?
(d) What is the difference in DNA (score) between:
i. Storks and vultures:
ii. Bie and chouhli:
(e) Which of the birds is the least related to vultures?

4. Insects are extremely adaptable and have a wide range of body forms. Consider the wing structure of the insects below:

(a) Use the letters to identify the wing structures that are homologous on the images above:
(b) What does the homology of these structures indicate?

Module 4: Ecosystem Dynamics		
CHAPTER 11 Population Dynamics	CHAPTER 12 Past Ecosystems	CHAPTER 13 Future Ecosystems
FORMATIVE Activity 197. Chapter Review	FORMATIVE Activity 202. Chapter Review	FORMATIVE Activity 206. Chapter Review SUMMATIVE Activity 207. Synoptic Assessment

207 Synoptic Assessment: Module 4

1. In 1834, Georg Gause, a Russian biologist, carried out a series of experiments on *Paramecium*. The results led him to propose the **competitive exclusion principle**, a fundamental idea in ecology. In the first stage of the experiments, he grew three species of *Paramecium* in isolation in a nutritive medium containing their essential resource (bacterial food). Their growth curves are shown below:

Paramecium grown in isolation

In the second stage of the experiment, Gause grew *P. aurelia* and *P. caudatum* together. He found that *P. caudatum* was always out-competed and became extinct from the culture. Gause then grew *P. caudatum* with *P. bursaria*. He found they were able to exist together (but at lower numbers). Investigation found that *P. caudatum* occupied the oxygen rich top half of the culture tube, whereas *P. bursaria* retreated to the lower, poorly oxygenated region. *P. bursaria* contains symbiotic algae, which release oxygen in photosynthesis. This allows *P. bursaria* to remain in the anoxic zone.

Paramecium grown in competition

(a) What is meant by the "competitive exclusion principle"?
(b) What type of growth curve do the *Paramecium* species show when grown in isolation?
(c) Why could *P. caudatum* and *P. aurelia* not exist together but *P. caudatum* and *P. bursaria* could?
(d) Do the experiments support Gause's competitive exclusion principle?
(e) Why kind(s) of competition is occurring here? Explain:

Choosing Activities for Home Study

Many of the book's activities are ideal for homework or as vehicles for a quick formative assessment. End of chapter 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.

151 The Evidence for Evolution
 Key Idea: Evidence for the fact that populations evolve from a common ancestor comes from many fields of science. Evolution is simply the heritable genetic changes occurring in a population over time. There are two important points to take from this definition: that evolution refers to populations, not individuals, and that the changes must be inherited.

Comparative anatomy
 Comparative anatomy examines the similarities and differences in the anatomy of different species. Similarities in anatomy (e.g. the bones forming the arms in humans, and the wings in birds and bats) indicate descent from a common ancestor.

DNA comparisons
 DNA can be used to determine how closely related species are to each other. More closely related species have greater similarities in DNA sequences.

Fossil record
 Fossils, like this (left) are the remains of dead organisms and provide a record of the extinction of...

Biogeography
 The geographical distribution of living organisms provides evidence of continental drift. The biogeography of the Galapagos Islands, provides evidence of how species evolve when separated from the mainland.

121 The Influence of Cane Toads on Native Species
 Key Idea: Cane toads were introduced into Australia to control sugar cane beetles. Instead they preyed on Australian native species, and... The cane toad is an aggressive invader. It was introduced into Queensland in 1935 to sugarcane crops. However, this is for various reasons, and instead cane...

Cane toads are very tough and can survive in a variety of habitats. They are now found in several Australian states.

Cane toads act as a selection pressure
 Red-bellied black snakes will eat cane toads, but some die because of the cane toad's toxin, but some found that larger snakes with a smaller head and overall body length were less likely to die. They survived because the size of a snake's head is proportional to the size of its prey, so snakes with smaller heads probably couldn't eat large enough cane toads to be poisoned by its toxin. This is providing a selection pressure, and those with a more advantageous body shape have a selective advantage.

66 Chapter Review: Did You Get It?
 1. Match each term to its definition, as identified by its preceding letter code.
 active transport _____ A The energy-requiring movement of substances across a biological membrane against a concentration gradient.
 concentration gradient _____ B Movement of substances across a biological membrane without energy expenditure.
 diffusion _____ C The passive movement of molecules from high to low concentration.
 osmosis _____ D The gradual difference in the concentration of solutes in a solution between two regions. In biology, this usually results from unequal distribution of ions across a membrane.
 passive transport _____ E Passive movement of water molecules across a partially permeable membrane down a concentration gradient.

2. The diagrams below depict what happens when a red blood cell is placed into three solutions with differing concentrations of solutes. Describe the tonicity of the solution (in relation to the cell) and describe what is happening:
 A B C
 (a) _____ (b) _____ (c) _____

3. Explain how the properties of the phospholipid molecule result in the bilayer structure of membranes:

4. Using the formulae: cuboid SA = 2(lh + lw + hw), cuboid volume = lwh, calculate the surface area to volume ratio of the following cell shapes:
 (a) A cuboid cell 6 μm x 6 μm x 6 μm: _____
 (b) A cuboid cell 1 μm x 12 μm x 5 μm: _____
 (c) Which of these cells would exchange substances with its environment most efficiently and why: _____

5. Identify the labels (a - d) on the graph, right, using the following labels: Reactants, products, activation energy, transition state.

 (a) _____ (b) _____
 (c) _____ (d) _____

6. (a) Where does glycolysis occur in the cell? _____
 (b) Where does the Krebs cycle occur in the cell? _____
 (c) Where is the electron transport chain located in a cell? _____

7. Write the process of photosynthesis as:
 (a) A word equation: _____
 (b) A chemical equation: _____

The first few pages of an activity can be useful to set the scene for a chapter. In this activity, students are introduced to the many lines of evidence for evolution. As the progress through the chapter, they analyse specific examples.

Most students will have access to the internet. Sometimes a homework activity might involve the student reviewing the resources on **BIOZONE's Resource Hub** for the next day's activity.

Review activities are ideal as homework because they involve a self-test of the student's own understanding of completed work. In this activity, students apply their understanding of cell function to complete the activity. Such activities allow the teacher to address any misconceptions before formal assessment.