

HSC

BIOLOGY

MODULES 1-4



Contents

CLASSROOM GUIDE

Teacher Support Materials.....	CG2
Meeting Key Competencies	CG3
The Contents: A Planning Tool.....	CG4
Introducing the Content.....	CG5
Finding Your Way Around	CG6
Support for Science Skills and Practical Investigations.....	CG8
Practical Investigations in Context	CG9
Teaching Strategies for Classroom Use	CG10
Support for the Depth Study	CG12
Differentiated Learning.....	CG13
Formative and Summative Assessments	CG14
Choosing Activities for Home Study	CG15
The Digital Teacher's Edition.....	CG16

First Edition 2022

Copyright © 2022 Richard Allan

Published by BIOZONE International Ltd

BIOZONE Learning Media Australia

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

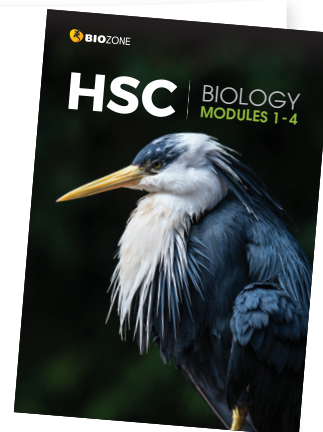
☎ 07 5535 4896

📠 07 5508 2432

✉ sales@biozone.com.au

www.**BIOZONE**.com.au

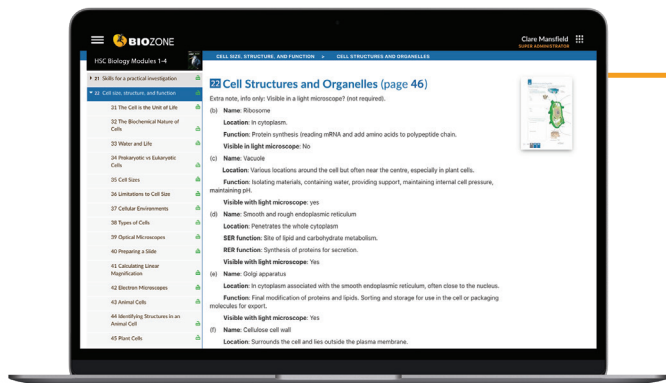
FAQs ABOUT HSC BIOLOGY MODULES 1-4



What resources are available to support teachers?	CG2, CG16
How can I teach and assess using BIOZONE?	CG3, CG14
How is HSC Biology Modules 1- 4 structured?	CG6
How can I plan my lessons?	CG3-CG4
Are there clear learning objectives for each topic?	CG5-CG6
Is there a suggested way to deliver content?	CG3, CG10
How do I evaluate student performance?	CG3, CG14
What types of assessment are there?	CG14
Does the worktext support practical investigations?	CG8-CG9
How do I use the student worktext in the classroom?	CG10- CG11
Is there support for the depth study?	CG12
Are there tools for differentiated instruction?	CG2, CG13
Where can I find the answers to questions and tasks?	CG2, CG16
What is the Digital Teacher's Edition?	CG16

Teacher Support Materials

BIOZONE's *HSC Biology, Modules 1-4* is supported by a suite of resources. These additional resources provide tools 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. Also find out more about the Digital Teacher's Edition on page CG16.



ONLINE MODEL ANSWERS

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

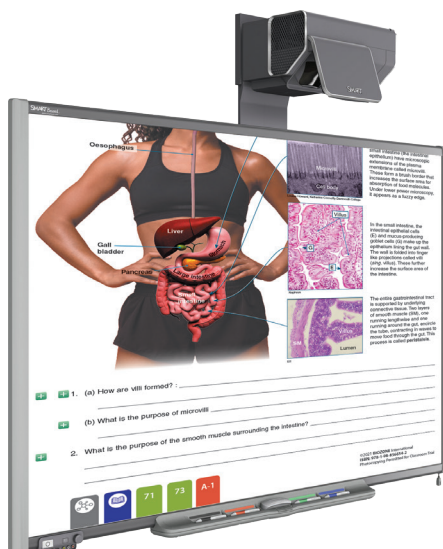
Online Model Answers are accessible via a login that is unique to your school. Your access as a teacher means you're able to control how much and when students can view individual answers, making it easier for you to support homework and revision. Controlled access to answers promotes deeper understanding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

EBOOK TEACHER EDITION

Our eBooks provide a digital replica of the printed pages for access in or out of the classroom.

The eBook TEACHER'S EDITION has the Classroom Guide and **answers in place** for each activity.

Visit: biozone.com.au/ebooks for more information



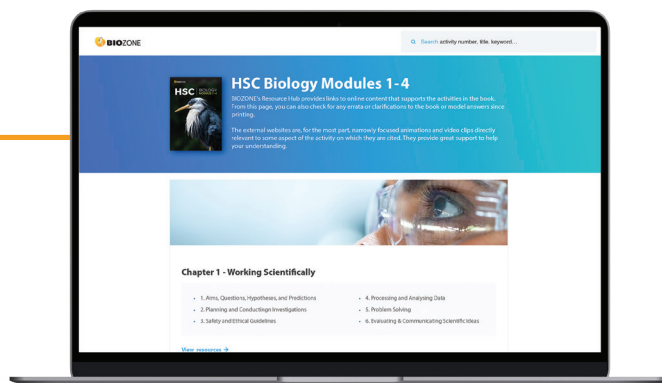
DIGITAL TEACHER'S EDITION

This teacher's resource features a non-printable PDF Teacher's Edition, with a useful feature allowing you to hide and display the suggested answers. It is ideal for introducing and reviewing activities using an interactive whiteboard. The Digital Teacher's Edition includes an introductory guide to using *HSC Biology, Modules 1-4* in the classroom and online. It is supplied as a direct download.

RESOURCE HUB

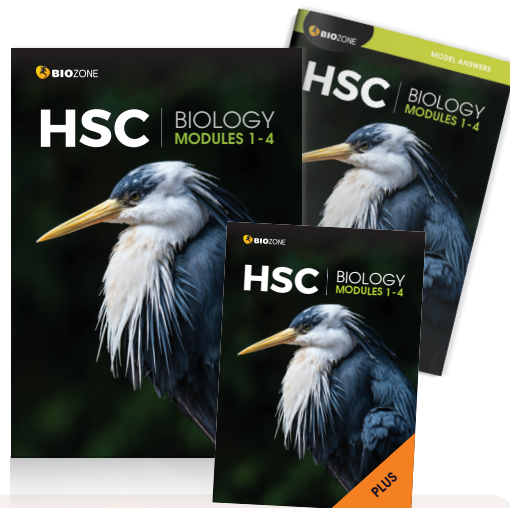
Be sure to visit **BIOZONE's Resource Hub**, which is fully accessible and free of charge to you and your students. It offers a curated collection of videos, animations, 3D models, and supporting content for the activities in this worktext.

Visit: www.BIOZONEhub.com Your code is **HSC11-1-6542**



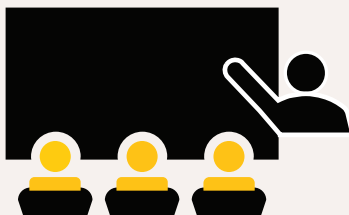
Meeting Key Competencies

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 the **Digital Teacher's Edition** 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.

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.

Contents

Using This Worktext	vi	<input type="checkbox"/> 43	Active and Passive Transport Summary.....	76
Using the Tab System.....	viii	<input type="checkbox"/> 44	Energy Inputs and Outputs	77
Using BIOZONE's Resource Hub.....	ix	<input type="checkbox"/> 45	Energy Transformations in Cells	79
Support for Depth Studies	x	<input type="checkbox"/> 46	The Role of ATP in Cells	80
		<input type="checkbox"/> 47	ATP and Enerav	82
Chapter 1: Working Scientifically				
<i>Key Skills and Knowledge.....</i> 1				
<input type="checkbox"/> 1	Aims, Questions, Hypotheses and Predictions	2		
<input type="checkbox"/> 2	Pla			
<input type="checkbox"/> 3	Sa			
<input type="checkbox"/> 4	Pro			
<input type="checkbox"/> 5	Pro			
<input type="checkbox"/> 6	Ev			
<input type="checkbox"/> 7	Ch			
MODULE 1				
Chapter 2: Cell Structure				
<i>Key Skills and Knowledge.....</i> 25				
<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		31		
<input type="checkbox"/> 13		32		
<input type="checkbox"/> 14		33		
<input type="checkbox"/> 15		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	O	44		
<input type="checkbox"/> 22	C	46		
<input type="checkbox"/> 23	C	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? Membrane Structure	54		
<input type="checkbox"/> 28	Modelling the Plasma Membrane	55		
<input checked="" type="checkbox"/> 29	Chapter Review: Did You Get It?	57		
Chapter 3: Cell Function				
<i>Key Skills and Knowledge.....</i> 58				
<input checked="" type="checkbox"/> 30				
<input checked="" type="checkbox"/> 31				
<input checked="" type="checkbox"/> 32				
<input checked="" type="checkbox"/> 33				
<input checked="" type="checkbox"/> 34				
<input checked="" type="checkbox"/> 35				
<input checked="" type="checkbox"/> 36				
<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		
Chapter 4: Cell Structure and Function				
<i>Key Skills and Knowledge.....</i> 131				
<input type="checkbox"/> 77	Autotrophs and Heterotrophs	132		
<input type="checkbox"/> 78	Plant Structure and Function	133		
<input type="checkbox"/> 79	Gas exchange in Plants.....	134		
<input type="checkbox"/> 80	Gas Exchange and Stomata.....	135		
<input type="checkbox"/> 81	Leaf and Stem Adaptations	137		
<input type="checkbox"/> 82	Analysis of Stomatal Density in Different Plants	139		
<input type="checkbox"/> 83	Excretion in Plants	141		
<input type="checkbox"/> 84	Gas Exchange	142		
<input type="checkbox"/> 85	Gas Exchange in Insects	144		
<input type="checkbox"/> 86	Gas Exchange in Fish.....	145		
<input type="checkbox"/> 87	Mammalian Gas Exchange System.....	147		
<input type="checkbox"/> 88	The Lungs	148		
<input checked="" type="checkbox"/> 89	Modelling Lung Ventilation	150		
<input type="checkbox"/> 90	Gas Transport in Mammals	151		

Activity is marked: ☐ to be done; ☒ when completed ☒ Includes practical investigation

Introducing the Content

Each chapter in *HSC Biology Modules 1-4* 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.

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.

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
cristae
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

- Describe and explain the effects of different solute concentrations on the rate and efficiency of diffusion.
- Investigate the effects of solutions of different solute concentration on plant cells. Use your results to estimate the osmolarity of a cell, e.g. a potato cell.
- 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

- Understand that cells exchange matter and energy with their environment. Describe the general requirements of cells, including but not limited to:
 - The need for energy, including light and chemical energy in complex molecules.
 - The need for matter, including nutrients, gases, and ions.
 - 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

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

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, which convert the energy from sunlight or inorganic molecules into organic molecules that can be used by other organisms. The energy flow into and out of each trophic (feeding) level can be represented as a diagram using arrows of different sizes to represent relative amounts of energy lost from different trophic levels.

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.

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 for function and response. The 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 + 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

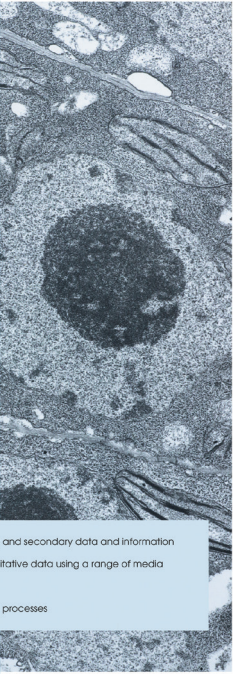
Finding Your Way Around

The content of the *HSC Biology Modules 1-4* is organised into 14 chapters, numbered sequentially and nested within their module (below). Each chapter begins with an introduction and most conclude with a student's self-test of understanding and vocabulary. Inviting, concept-based activities make up the bulk of each chapter, with each activity focussing on the student developing an understanding of a concept, applying that understanding to another scenario, and/or developing an essential skill, such as graphing or data analysis. The tabs for each activity identify the nature of the activity, and identify related material and external supporting resources. These features are explained further on the opposite page.

MODULE

01

Cells as the basis of life



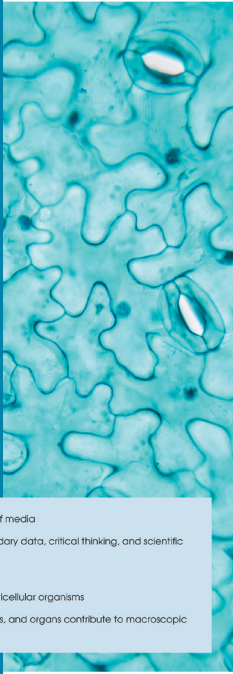
Student outcomes:

- 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



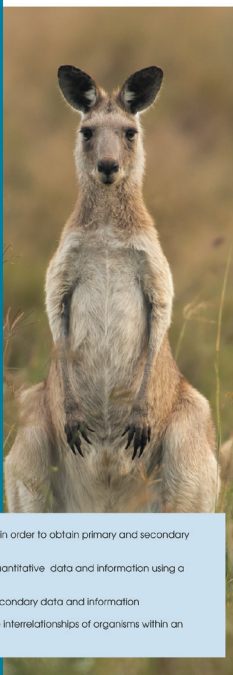
Student outcomes:

- 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 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.

198 Analysing Evidence for Ecosystem Change

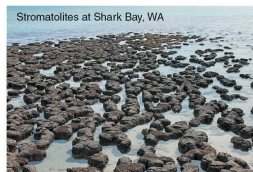
Key Idea: Palaeontological and geological data provides importance evidence of past environmental changes. Evidence for past biological and environmental change comes from many sources. Some may be relatively simple

to see e.g. different coloured layers in a rock profile (strata). Others may require much more in-depth research knowledge to apply, such as analysing gases trapped in ice cores, or radiometrically dating a rock sample.

Comparing living organisms with fossils

Fossils can provide valuable information about the organisms present and their past environment. The fossils can be compared to similar organisms alive today to give us clues about the past environment. For example, stromatolites are layered rocky structures formed in shallow water by the accumulation of sediment by microbial mats (particularly cyanobacteria). Stromatolites are found today at Shark Bay in Western Australia in shallow highly saline water. Stromatolite fossils have been found in many places around Australia indicating warm shallow seas were present over the early Australian continent. Stromatolites have been dated to 3.5 billion years old.

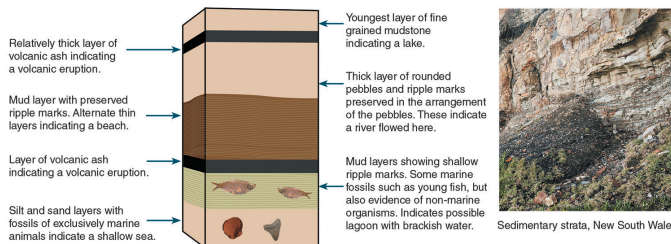
Locations of Australian stromatolite fossils



Cyanobacteria flourished in shallow waters throughout the world until ~1 bya after which their abundance and diversity declined. They were among the first bacteria to split water to produce oxygen during photosynthesis. The newly abundant oxygen reacted with iron ions dissolved in the seawater to form iron oxides that formed sediments on the sea floor producing **banded iron** formations. These are mostly dated between 2.4 and 1.9 billion years old and provide evidence for the rise in Earth's oxygen concentration called the Great Oxidation Event.

Interpreting rock strata

We have already seen that fossils provide evidence of change over time. Relatively simple fossils are found in deeper rock layers, whereas shallower layers have more complex fossils. While fossils can tell us much about the life and environment at certain times, the rock layers themselves can provide information about the environment. The composition of the rock strata hold clues that can be interpreted to provide information about past environments. The rock strata below illustrate how strata might change over time in a coastal area.



Sedimentary strata, New South Wales

©2022 BIOZONE International
ISBN: 978-1-98-856654-2
Photocopying Prohibited



198 Analysing Evidence for

Key Idea: Palaeontological and geological data provides importance evidence of past environmental changes. Evidence for past biological and environmental change comes from many sources. Some may be relatively simple

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

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

allow seas must have covered much of Australia in the distant past? _____

ation Event using an internet or literature search. Write a short paragraph on what caused it _____

he history of the area around the strata shown at the bottom of the previous page. Justify your _____ in the rocks: _____

A **colour-coded tab system** identifies:

- When an activity is supported with content on **BIOZONE's Resource Hub**
- The general capabilities covered within the activity
- The cross-curriculum priorities covered within the activity
- Other syllabus learning areas covered within the activity
- Related content
- Where referral to the relevant appendices is required (glossary term or equipment list)

For a full description of the tabs see page viii of the Student Edition.

Understanding of content is tested through questions, data handling, analysis, prediction, or summary. Students are often required to apply their understanding to a new scenario or make connections to related content. Students must interact with the information on the page in order to complete the activity. It is this interaction that provides the valuable learning experience, reinforcing and explaining the key idea. Students are frequently asked to work in small groups to discuss ideas and formulate responses.

European Project for the Core of Activities

1260.47	33728	456.60
1286.47	35417	467.63
1337.80	38258	488.11
1365.07	39433	423.15
1403.97	41378	443.35
1489.88	46719	469.20
1601.65	53264	491.10
1680.64	58176	538.28
1760.37	63448	468.08
1860.22	71706	470.32
1949.26	78706	480.43
2065.88	89241	493.35

©2022 BIOZONE International
ISBN: 978-1-98-856654-2
Photocopying Prohibited

Plan and conduct investigations

[illegible]

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

Processing and analysing data

11

Presenting data in graphs

- Graphs are a good way to share trends, patterns, and relationships visually without taking on too much space. Complete data sets can be presented as graphs after one table, although the use case can sometimes be indicated as an appendix.
- Presenting graphically requires attention to be a basic data table, including correct orientation and labeling of the axes, accurate plotting of points, and an appropriate title.
- Before representing data graphically, it is important to identify the kind of data you have. Common graphs include scatter plots, bar graphs for comparative data, and line graphs for trends. For comparative data with tabulated means, points are

Left Graph: Mean growth rate vs. Temperature

Temperature (°C)	Mean growth rate (mL/hr)
8	0.0
10	0.0
12	0.0
14	0.0
16	0.0
18	0.0
20	0.0
22	0.0
24	0.0
26	0.0
28	0.0
30	0.0
32	0.0
34	0.0
36	0.0
38	0.0
40	0.0
42	0.0
44	0.0
46	0.0
48	0.0
50	0.0
52	0.0
54	0.0
56	0.0
58	0.0
60	0.0
62	0.0
64	0.0
66	0.0
68	0.0
70	0.0
72	0.0
74	0.0
76	0.0
78	0.0
80	0.0
82	0.0
84	0.0
86	0.0
88	0.0
90	0.0
92	0.0
94	0.0
96	0.0
98	0.0
100	0.0

Right Graph: Average household annual water consumption

City	Average household annual water consumption (liters)
Albuquerque	4.5
Atlanta	3.5
Boston	3.0
Chicago	3.5
Denver	3.0
Houston	3.0
Los Angeles	3.0
Minneapolis	3.0
New York	3.0
Philadelphia	3.0
Portland	3.0
San Francisco	3.0
Seattle	3.0
Wash. DC	3.0

Guidelines for line graphs

- Line graphs** are used when one variable (the independent variable in treatment) affects another: the dependent variable the response variable.
- The data must be continuous for both variables. The relationship between the variables can be represented continuously and the plotted data points are connected directly (smooth curve) to form a line.
- A double axis allows two independent variables to be plotted on the same graph. One axis is plotted on the same scale as the other.

- Use the **left** y-axis for the small scale and a frequency histogram on the **right** y-axis.
- Use the **right** y-axis for the large scale and the counts are entered on the **left** axis.

What of information is provided by a frequency histogram?

- What are the data? (2 graphs). Explain your answer.
- What sort of graph would you choose to display the data in Table 2 (optional). Explain your answer.

- What are the data? (2 graphs). Explain your answer.
- What sort of graph would you choose to display the data in Table 2 (optional). Explain your answer.

- The total mass calculated for fertilizer concentration 12.0 g/L (mean) and the mean mass calculated from 4 values. Explain why.

Guidelines for scatter graphs

- A **scatter graph** is used to plot categorical data when the two affects/another: the dependent variable the response variable.
- There is no independent relationship between the variables. But the variables are often correlated in a way that together a prediction can be made.
- The data points are plotted on a coordinate web, but a line of best fit (trend line) is drawn through the points to show the relationship between the variables.

- Use the **left** y-axis for the small scale and a frequency histogram on the **right** y-axis.
- Use the **right** y-axis for the large scale and the counts are entered on the **left** axis.

What of information is provided by a frequency histogram?

- What are the data? (2 graphs). Explain your answer.
- What sort of graph would you choose to display the data in Table 2 (optional). Explain your answer.

- What are the data? (2 graphs). Explain your answer.
- What sort of graph would you choose to display the data in Table 2 (optional). Explain your answer.

- The total mass calculated for fertilizer concentration 12.0 g/L (mean) and the mean mass calculated from 4 values. Explain why.

Guidelines for bar-column graphs

- Column graphs** (also known as bar graphs) are used when the two affects/another: the dependent variable the response variable.
- Multiple data sets are displayed side-by-side for comparison using a bar for each category (bars are isolated).
- A **bar-column** is especially useful to a column graph but is used when one variable is continuous and the other is a frequency histogram. These plots produce a frequency distribution.

- Use the **left** y-axis for the small scale and a frequency histogram on the **right** y-axis.
- Use the **right** y-axis for the large scale and the counts are entered on the **left** axis.

What of information is provided by a frequency histogram?

- What are the data? (2 graphs). Explain your answer.
- What sort of graph would you choose to display the data in Table 2 (optional). Explain your answer.

- What are the data? (2 graphs). Explain your answer.
- What sort of graph would you choose to display the data in Table 2 (optional). Explain your answer.

- The total mass calculated for fertilizer concentration 12.0 g/L (mean) and the mean mass calculated from 4 values. Explain why.

©2015 BIOZONE International
 All Rights Reserved
 Photocopying Prohibited

Problem solving

5 Problem Solving

Key Idea: Solving problems may require modelling in the form of physical or mathematical models.

Solving problems is an important part of science and biology. Many problems may be solved by using a model. The best way to solve a problem is to use a model of the problem. The model should be simple enough to be solved, but it should also be accurate enough to be useful. To solve a problem, you need to use a model that is both simple and accurate.

Modelling data

There are many different ways to model data. One way is to use a graph. Another way is to use a table. A third way is to use a diagram. The choice of which way to model data depends on the problem and the data.

Visual models

Visual models can include drawings, such as those of plant cells. They can also include diagrams, such as those of the water cycle. Visual models are useful for showing the structure of a system and for illustrating the relationships between different parts of a system.

Mathematical models

Mathematical models are graphs or other mathematical representations of a system. They are useful for showing the relationships between different parts of a system and for predicting the behavior of a system.

Analogy

An analogy is a comparison between two things. It is useful for helping us to understand a new concept by comparing it to something we already know. For example, we can compare the flow of water in a pipe to the flow of electricity in a wire.

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 and the amount of carbon dioxide taken up by plants. How do climate change models help us predict future climate change?

Evaluating and communicating scientific ideas

6 Evaluating & Communicating Scientific Ideas

Key Idea: The analysis, evaluation, and communication of scientific information are skills required in the study of science. These skills are used to evaluate the quality of scientific information and to communicate the results of scientific investigations.

Analysis and evaluation of scientific ideas

1. 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.

2. 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 complex or novel topics. Many new ideas about biology may not be supported by traditional views or people's own personal belief systems, as a result, people may have certain views that they have invested in. This leads to people seeing both information to support their views.
- When reading biological information, especially on the Internet, it is important to check the reliability of the information. This will help you identify bias or other problems. This will help you identify bias or other problems. This will help you identify bias or other problems.
- Note the site from which you obtained information. It is important to get your information from a reliable source. This will help you identify bias or other problems.

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 presented in a way that has been accepted by the scientific community?
- Does the information present an unbiased view?
- Is the information presented in a fair, unbiased way? Is it based on fact and not emotion?
- Is the information presented divided by the attitudes, beliefs or values of the press, public or organization reporting the information?
- Scientific journals are peer-reviewed, meaning the information is checked by experts in the area before publication. This makes the information more reliable. However, journals are not perfect. They can be biased, and they can be slow to publish new information.
- Newsprint articles are a good starting point as a source of generally reliable information, but beware of the newspaper's bias. Some newspapers may have left or right political leanings, which can affect the way they report the news.
- Online sites that are specific for a topic need to be carefully evaluated for reliability. Avoid copy-paste sites that copy information from other sources. Government sites usually have current and reliable data based on information from official sources.

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.

Practical investigation:

The aim of a practical investigation is to answer a biological question. You will need to plan the investigation, carry out the investigation, and then evaluate the results. You will also need to communicate your findings.

Secondary research investigation:

Secondary research involves looking at information that has already been collected by other people. This can be done by looking at books, articles, or websites. You will need to evaluate the reliability of the information and then use it to answer your question.

Feedback:

Feedback is information that is given to you about your work. It can be given by your teacher, your classmates, or yourself. Feedback is important because it helps you to improve your work.

Data analysis:

Data analysis involves looking at the data that you have collected and trying to find patterns or trends. You will need to use statistical methods to analyze the data.

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 cubes 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: volume ratios 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 your findings.

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 use them to test the relationship between cell size and rate of efficiency of diffusion.

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 pink colour and this indicates how far the NaOH has diffused (if light). By cutting 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
- Agar cubes infused with phenolphthalein
- Timer
- Sodium hydroxide (NaOH) solution
- Ruler
- Laboratory tongs

52 Investigating Yeast Fermentation

Key Idea: Brewer's yeast preferentially uses alcoholic fermentation when there is excess sugar. The CO₂ released can be collected 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 carbohydrate 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

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

- Make a yeast culture by dissolving 10 g of yeast into 50 mL of water at 25°C.
- In a conical flask fill 225 mL of tap water then add 10 mL of yeast culture. Measure the temperature (25°C). This mixture may be dissolved oxygen free when shaken.
- Add 25 g of substrate (glucose, maltose, sucrose, or none) stir carefully to dissolve (stirring too vigorously will cause oxygen to dissolve back into the water).
- Then add 25 mL of the yeast culture and stopper the conical flask.
- Add a thin layer of paraffin oil over the solution in the conical flask to create an anaerobic environment.
- Stopper the conical flask and set up a measuring cylinder to capture any gas at 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 complete the table below.

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

2. Using the final values (80 minutes) collected from the class, calculate the rate of CO₂ production per minute for each substrate.

(a) None

(b) Glucose

(c) Maltose

(d) Sucrose

(e) 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

Investigation 5.1 Comparing stomatal density

See appendix for equipment list

- Your teacher will have up to four leaf types from four different plant species 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 counting the stomata visible under a microscope. The clear nail varnish is painted 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 visible under a microscope using the field of view divided by the magnification of the eyepiece. For example if the eyepiece magnification is 15, the objective lens magnification is 10, and the field of view is 18, then 18/(15 × 10) = 0.12 mm diameter. The area visible is then 0.0144 mm².
- You could also use a micrometer to measure the diameter of the field of view or use a 10x 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 is it specific?)
- 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.

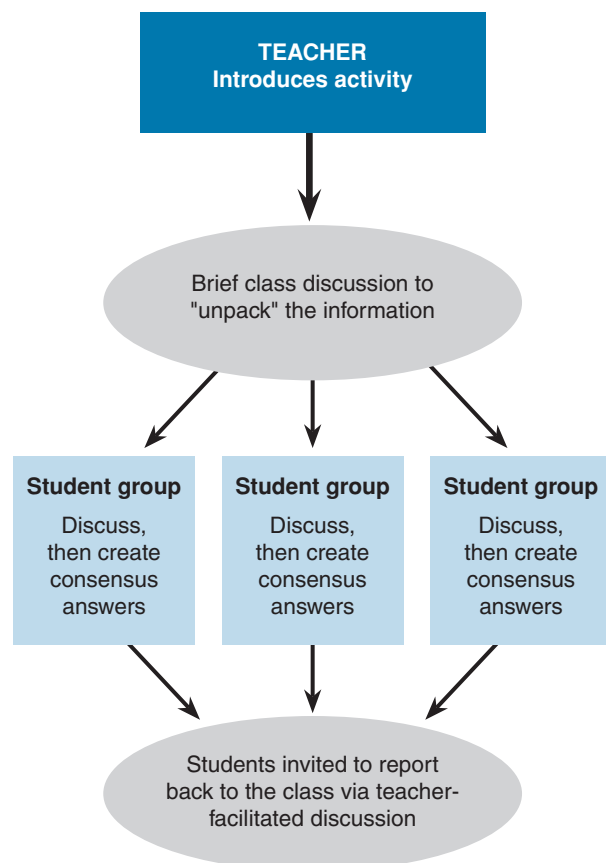
The practical investigations may involve setting up and carrying out an experiment (above), or could involve a paper practical or modelling activity (e.g. making a model of the plasma membrane).

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 everyone's contribution is heard. They collaborate, share ideas, and engage in discourse. The emphasis is on discussing questions and formulating a consensus answer, not just sharing ideas.



At the end of the session, 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.



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.

150

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. (b) _____

(b) _____

3. Use _____

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

©2022 BIOZONE International
ISBN: 978-1-98-856654-2
Photocopying Prohibited

97

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

Diagram showing a chromatography setup with a beaker, a boiling tube, and a piece of chromatography paper. Labels include: Boiling tube, Toothpick or pencil, Clingwrap (prevents ethanol evaporating), and Solvent level.

Determining R_f values

Diagram showing a chromatography plate with a solvent front and a starting line. Labels include: Solvent front, Starting line, and R_f 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.

1. _____

2. _____

3. Staple your chromatography paper to this page.

©2022 BIOZONE International
ISBN: 978-1-98-856654-2
Photocopying Prohibited

Collaboration and discovery

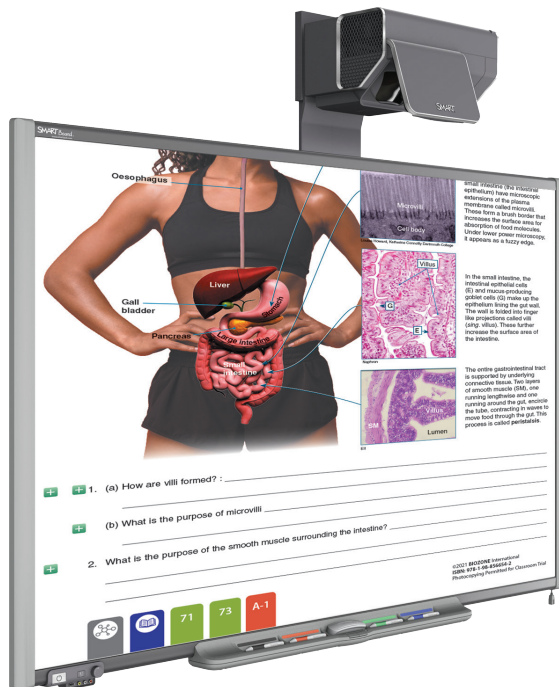
- BIOZONE's *HSC Biology Modules 1-4* allows for collaboration and discovery. By working together and sharing ideas, students are exposed to different perspectives and levels of knowledge about biological concepts.
- BIOZONE's *HSC Biology Modules 1-4* builds student understanding by providing a range 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

- The **Digital Teacher's Edition** provides a digital rights managed (DRM) version of the student book as PDF files. It features useful HIDE/SHOW answers, which can be used to review activities in class using a data projector or interactive whiteboard (left).
- 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?



Differentiated Learning

Tools for differentiated instruction within *HSC Biology Modules 1-4* help teachers to support students all skill levels. BIOZONE's collaborative approach to science inquiry encourages students to share their ideas and knowledge with their peers while reinforcing their own understanding. There are several ways to use *HSC Biology Modules 1-4* in a differentiated classroom:

278

166 Determining Relatedness Using DNA

Key Idea: DNA hybridisation compares DNA similarity between species and can be used to measure relatedness. DNA hybridisation is a technique used to quantify the DNA similarity between species. More closely related species have fewer genetic differences than more distantly related species. The method provides information only about how much of

the DNA is the same and cannot provide specific information about what the similarities or differences are. Although it has largely been replaced by DNA sequence analysis, DNA hybridisation is still used in molecular biology and has been used to determine the date of human divergence from apes, which has been estimated at 10 and 6 million years ago.

DNA hybridisation technique

1. DNA from the two species to be compared is extracted, purified and cut into short fragments.
2. The mixture is heated so the DNA separates. The DNA from the two species is mixed together.
3. As it cools, bonds form between compatible nucleotides, hybrid double-stranded DNA forms.
4. If species share low similarity, the hybrid DNA will have few bonds (and the strands will be weakly held together). The number of bonds (and therefore the strength of the hybrid DNA) increases with increasing similarity.
5. The similarity is measured by testing the hybrid DNA to see if it can form strands. The greater the similarity, the more heat that is required to break the hybrid DNA apart.

Human DNA
Chimpanzee DNA

Double

Strand

Strand

Strand

Strand

Strand

Strand

Strand

Strand

Strand

Strand

Strand

Strand

Strand

Strand

Strand

Strand

Strand

Strand

Strand

Strand

Strand

Strand

Strand

Strand

Strand

Strand

Strand

Strand

Strand

Strand

Strand

1. How can DNA hybridisation give a measure of genetic relatedness between species?

2. Why do the double strands of DNA break when they are heated?

3. What is responsible for the hybridisation between the DNA strands?

4. The graph below shows the results of a DNA hybridisation experiment between human and gorillas.

Similarity of human DNA to that of other primates

DNA similarity (%)

100

90

80

70

60

50

40

30

20

10

0

Human

Chimpanzee

Orangutan

Relevant monkey

Relevant monkey

Capable monkey

Group

90%

97.6%

86.2%

91.5%

95.1%

82.5%

74.2%

62.5%

50.0%

37.5%

25.0%

- (a) Which primate is most closely related to human?

- (b) Which primate is most distantly related to human?

5. Hybrid DNA from species A and B comes apart at a lower temperature than that of species A and C. Which species is A more closely related to?

© 2015 BIOZONE International
ISBN 978-0-947279-68-9
Photocopying prohibited

BIOZONE's Resource Hub provides curated content to support the activities in the book. Videos, animations, simulations, and 3D models support students of all abilities, while some resources (interactive spreadsheets, fact sheets, and reference papers) may be used as part of group work or extension.

A grey hub tab at the bottom of the page indicates the activity has online support.

90

52 Investigating Yeast Fermentation

Key Idea: Yeast preferentially uses alcoholic fermentation when there is excess sugar. The CO_2 released can be collected as a measurement 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) metabolizes carbohydrates substrates is influenced by fermentation rate. The amount of carbohydrate available. High levels of sugars suppress anaerobic respiration in yeast, so yeast will predominantly use fermentation in the presence of excess substrate.

Investigation 3-4 Investigating Fermentation in yeast

Materials for experiment list

Procedure: Prior to this activity, Your teacher will assign you a substrate to investigate.

1. Make yeast culture by dissolving 10 g of active yeast into 50 mL of water.

In a second 500 mL beaker, add 200 mL water than rack the yeast into the water. (20°C) This removes the yeast from the water.

2. Add 10 g of solid glucose, sucrose, lactose, maltose, or fructose (the substrate) to oxygen to dissolve.

3. Then add 25 mL culture to the flask.

4. Add a 10 mL layer solution to the anaerobic environment.

5. Stopper the container, making sure no air is in the diagram right.

6. Shaker the container every five minutes for 10 minutes.

7. Start timing and record the gas volume every five minutes for 10 minutes.

8. Record the results for your substrate in the table. Plot data as a class and use if complete the table below.

Substrate	Cumulative volume of carbon dioxide collected (mL)				
Time (min)	No.	Glucose	Maltose	Sucrose	Lactose
0	0				
5	5				
10	10				
15	15				
20	20				
25	25				
30	30				
35	35				
40	40				
45	45				
50	50				
55	55				
60	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 CO_2 production per minute for each substrate:

- (a) Glucose:
- (b) Maltose:
- (c) Sucrose:
- (d) Lactose:

©2012 Pearson Education, Inc. or its affiliate(s). All rights reserved. This material is intended solely for the personal use of the individual user and is not to be disseminated broadly.

A group symbol indicates where students can work together. Group work provides opportunities for student collaboration and peer-to-peer support to explore the principles and concepts they are engaged with in their course. Working in groups, students can experience the benefits of collaboration in the scientific process of discovery. By speaking and listening, they develop and extend their communication skills and scientific vocabulary.

[illegible]

Students requiring extra support with using the working scientifically skills should be encouraged to refer to Chapter 1 as often as they need to. Building familiarity with these skills will enable students to apply them confidently within the context of the activities.

178

179

166 Determining Relatedness

Key Idea: DNA hybridization compares DNA similarity between species and can be used to measure relatedness. DNA hybridization is a technique used to quantify the DNA similarity between species. More closely related species have fewer base-pair differences than more distantly related species. The method provides information only about how much of

DNA hybridization technique

DNA from the two species can be compared to estimate, purified and cut into short fragments.

The solution is heated so the DNA separates. The DNA from the two species is mixed together.

As the DNA cools, bonds form between compatible nucleotides. Hybrid double-stranded DNA forms.

If species differ, the amount of hybrid DNA will have few bonds (short the strands will be easily torn apart). The number of bonds (and therefore the strength of the hybrid DNA) increases with increasing similarity.

The similarity is measured by heating the hybrid DNA and measuring how much it falls to single strands. The greater the activity, the more heat that is required to break the hybrid DNA apart.

The diagram illustrates the DNA hybridization technique. It starts with a double-stranded DNA molecule. This is heated to separate into two single strands. These single strands are then mixed with single strands from another species. As the mixture cools, hybrid double-stranded DNA forms where compatible bases pair. The diagram shows the process from DNA extraction to the final hybrid DNA product.

A-1 Appendix 1: Glossary

A

absorb filter
A transparent, physical barrier that filters out specific wavelengths, typically used in microscopy.

absorption
A method of detecting a trace element by measuring the amount of visible or ultraviolet radiation that is absorbed by the sample.

absorption spectrum
The spectrum of light that is absorbed by a substance, typically used to identify elements.

absorption spectroscopy
A method of detecting a trace element by measuring the amount of visible or ultraviolet radiation that is absorbed by the sample.

absorption spectroscopy
A method of detecting a trace element by measuring the amount of visible or ultraviolet radiation that is absorbed by the sample.

absorption spectroscopy
A method of detecting a trace element by measuring the amount of visible or ultraviolet radiation that is absorbed by the sample.

absorption spectroscopy
A method of detecting a trace element by measuring the amount of visible or ultraviolet radiation that is absorbed by the sample.

absorption spectroscopy
A method of detecting a trace element by measuring the amount of visible or ultraviolet radiation that is absorbed by the sample.

absorption spectroscopy
A method of detecting a trace element by measuring the amount of visible or ultraviolet radiation that is absorbed by the sample.

absorption spectroscopy
A method of detecting a trace element by measuring the amount of visible or ultraviolet radiation that is absorbed by the sample.

absorption spectroscopy
A method of detecting a trace element by measuring the amount of visible or ultraviolet radiation that is absorbed by the sample.

absorption spectroscopy
A method of detecting a trace element by measuring the amount of visible or ultraviolet radiation that is absorbed by the sample.

absorption spectroscopy
A method of detecting a trace element by measuring the amount of visible or ultraviolet radiation that is absorbed by the sample.

absorption spectroscopy
A method of detecting a trace element by measuring the amount of visible or ultraviolet radiation that is absorbed by the sample.

absorption spectroscopy
A method of detecting a trace element by measuring the amount of visible or ultraviolet radiation that is absorbed by the sample.

absorption spectroscopy
A method of detecting a trace element by measuring the amount of visible or ultraviolet radiation that is absorbed by the sample.

absorption spectroscopy
A method of detecting a trace element by measuring the amount of visible or ultraviolet radiation that is absorbed by the sample.

absorption spectroscopy
A method of detecting a trace element by measuring the amount of visible or ultraviolet radiation that is absorbed by the sample.

absorption spectroscopy
A method of detecting a trace element by measuring the amount of visible or ultraviolet radiation that is absorbed by the sample.

absorption spectroscopy
A method of detecting a trace element by measuring the amount of visible or ultraviolet radiation that is absorbed by the sample.

absorption spectroscopy
A method of detecting a trace element by measuring the amount of visible or ultraviolet radiation that is absorbed by the sample.

absorption spectroscopy
A method of detecting a trace element by measuring the amount of visible or ultraviolet radiation that is absorbed by the sample.

absorption spectroscopy
A method of detecting a trace element by measuring the amount of visible or ultraviolet radiation that is absorbed by the sample.

absorption spectroscopy
A method of detecting a trace element by measuring the amount of visible or ultraviolet radiation that is absorbed by the sample.

absorption spectroscopy
A method of detecting a trace element by measuring the amount of visible or ultraviolet radiation that is absorbed by the sample.

absorption spectroscopy
A method of detecting a trace element by measuring the amount of visible or ultraviolet radiation that is absorbed by the sample.

absorption spectroscopy
A method of detecting a trace element by measuring the amount of visible or ultraviolet radiation that is absorbed by the sample.

absorption spectroscopy
A method of detecting a trace element by measuring the amount of visible or ultraviolet radiation that is absorbed by the sample.

absorption spectroscopy
A method of detecting a trace element by measuring the amount of visible or ultraviolet radiation that is absorbed by the sample.

absorption spectroscopy
A method of detecting a trace element by measuring the amount of visible or ultraviolet radiation that is absorbed by the sample.

absorption spectroscopy
A method of detecting a trace element by measuring the amount of visible or ultraviolet radiation that is absorbed by the sample.

absorption spectroscopy
A method of detecting a trace element by measuring the amount of visible or ultraviolet radiation that is absorbed by the sample.

absorption spectroscopy
A method of detecting a trace element by measuring the amount of visible or ultraviolet radiation that is absorbed by the sample.

absorption spectroscopy
A method of detecting a trace element by measuring the amount of visible or ultraviolet radiation that is absorbed by the sample.

absorption spectroscopy
A method of detecting a trace element by measuring the amount of visible or ultraviolet radiation that is absorbed by the sample.

absorption spectroscopy
A method of detecting a trace element by measuring the amount of visible or ultraviolet radiation that is absorbed by the sample.

absorption spectroscopy
A method of detecting a trace element by measuring the amount of visible or ultraviolet radiation that is absorbed by the sample.

absorption spectroscopy
A method of detecting a trace element by measuring the amount of visible or ultraviolet radiation that is absorbed by the sample.

absorption spectroscopy
A method of detecting a trace element by measuring the amount of visible or ultraviolet radiation that is absorbed by the sample.

absorption spectroscopy
A method of detecting a trace element by measuring the amount of visible or ultraviolet radiation that is absorbed by the sample.

absorption spectroscopy
A method of detecting a trace element by measuring the amount of visible or ultraviolet radiation that is absorbed by the sample.

absorption spectroscopy
A method of detecting a trace element by measuring the amount of visible or ultraviolet radiation that is absorbed by the sample.

absorption spectroscopy
A method of detecting a trace element by measuring the amount of visible or ultraviolet radiation that is absorbed by the sample.

absorption spectroscopy
A method of detecting a trace element by measuring the amount of visible or ultraviolet radiation that is absorbed by the sample.

absorption spectroscopy
A method of detecting a trace element by measuring the amount of visible or ultraviolet radiation that is absorbed by the sample.

absorption spectroscopy
A method of detecting a trace element by measuring the amount of visible or ultraviolet radiation that is absorbed by the sample.

The list of key terms in the chapter introduction provides students with a list of scientific terms they should be familiar with. Encourage students to refer to the glossary (Appendix 1) when they are unsure about the meaning of a scientific term they are unfamiliar with. A glossary tab at the bottom of a page indicates where a term within the activity has been defined. These strategies build scientific literacy and encourage students to use scientific terms with confidence.

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	CHAPTER 2 Cell Structure	CHAPTER 3 Cell Function
No formal assessment required		
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

283

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 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.

DNA hybridisation B The evolutionary history or genealogy of a group of organisms.

molecular clock C DNA located in mitochondria.

mtDNA D A technique used to determine the percentage similarity between the DNA of two organisms.

phylogeny 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. Ravens and shorebirds:
(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?

© 2022 BIOZONE International
ISBN 978-0-947279-78-6
Photocopying Prohibited

Module 4: Ecosystem Dynamics			
CHAPTER 11 Population Dynamics	CHAPTER 12 Past Ecosystems	CHAPTER 13 Future Ecosystems	CHAPTER 14 Depth Studies: Guidance and Ideas
FORMATIVE Activity 197. Chapter Review	FORMATIVE Activity 202. Chapter Review	FORMATIVE Activity 206. Chapter Review SUMMATIVE Activity 207. Synoptic Assessment	Assessed by teacher

207 Synoptic Assessment: Module 4

1. In 1844, George 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

P. caudatum *P. aurelia* *P. bursaria*

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 (and/or) is competition occurring here? Explain:

© 2022 BIOZONE International
ISBN 978-0-947279-78-6
Photocopying Prohibited

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 organisms are to each other. More closely related species have greater similarities in DNA sequences.

Fossil record
Fossils, like this (left) are the remains of a dead organism. 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 proved a threat to Australian native species, and the cane toad is an aggressive invader. The cane toad was introduced into Queensland in 1935 to control sugarcane crops. However, this was for the wrong reasons, and instead cane toads have become a major pest.

Cane toads are very tough and can survive in a wide range 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 they die because of the cane toad's toxin, but some snakes with a smaller head size survive because the size of a snake's head limits its ability to swallow its prey, so snakes with smaller heads probably cannot swallow cane toads. The cane toad is providing a selection pressure, and those snakes with a larger head size 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
concentration gradient
diffusion
osmosis
passive transport

A The energy-requiring movement of substances across a biological membrane against a concentration gradient.
B Movement of substances across a biological membrane without energy expenditure.
C The passive movement of molecules from high to low concentration.
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.
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 (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 cubic cell $6\text{ }\mu\text{m} \times 6\text{ }\mu\text{m} \times 6\text{ }\mu\text{m}$: _____
(b) A cuboid cell $1\text{ }\mu\text{m} \times 12\text{ }\mu\text{m} \times 5\text{ }\mu\text{m}$: _____
(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: _____

© 2022 BIOZONE International
ISBN: 978-1-98-856654-2
Photocopying Prohibited

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.

