

# VCE | BIOLOGY

## UNITS 3 & 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

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BIOZONE

**VCE** | BIOLOGY  
UNITS 3&4

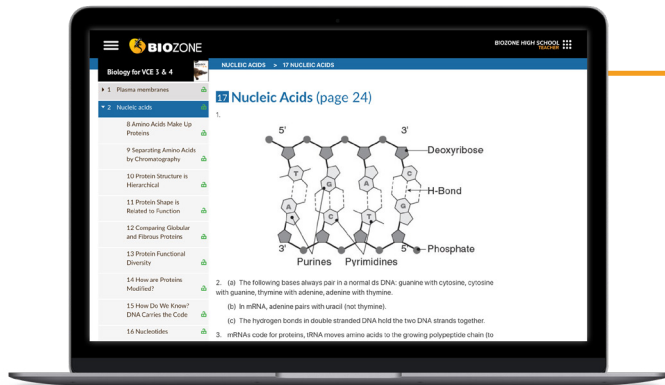


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# Teacher Support Materials

*VCE Biology, Units 3&4* is supported by a suite of resources that support the main book. These additional resources provide the tools for teaching and learning remotely or in the classroom, support your students in their self-assessment tasks with online answers, and use interactivity to promote class discussion and efficient review. Some features of these supporting resources are described below and you will find further information later in this guide.



## 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.

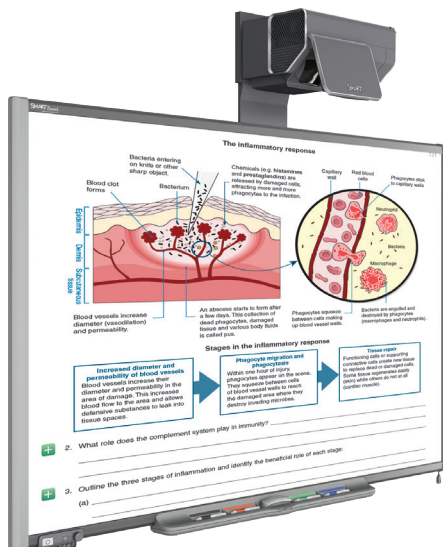
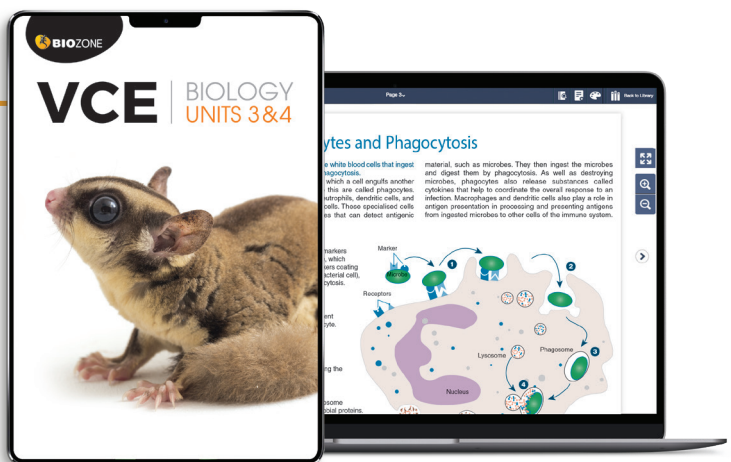
## EBOOK VERSION

Our eBooks provide a digital replica of the printed pages.

With our eBook PLUS on a School Managed Licence, students can answer most questions online, although a small number of questions require offline responses or a download. These are mostly associated with key skills, such as plotting and graphical representations.

The eBook TEACHER'S EDITION is also available with answers in place and some additional features.

Visit: [biozone.com.au/ebooks](http://biozone.com.au/ebooks) for more information



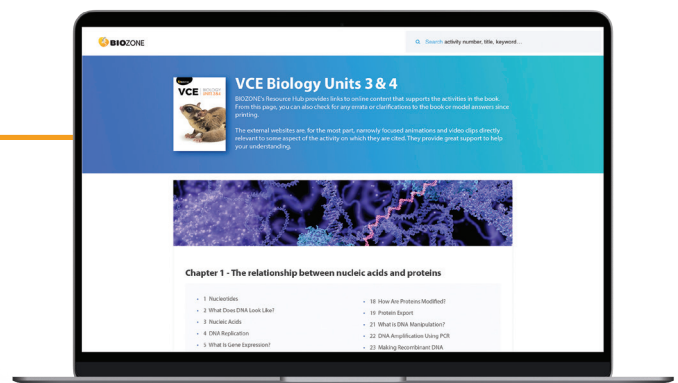
## DIGITAL TEACHER'S EDITION

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 *VCE Biology, Units 3&4* in the classroom and online, as well as a long answers section. 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 book.

Visit: [www.BIOZONEhub.com](http://www.BIOZONEhub.com) Your code is VCE12-2-6375





# 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 *VCE Biology*, we have put the aims and structure of the **VCE Biology Study design** (for accreditation 2021-2025) 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 strategies BIOZONE has used to meet the aims and scope of the study design.



## Lesson planning

- The structure of *VCE Biology, Units 3&4* follows the Unit-Area of Study structure specified in the **VCE Biology Study Design**. Teachers can be assured that all of the essential components of the Study Design 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**. A red bullet indicates an **assessment task**. Incorporate these activities into your schedules.



## Teaching

- Teach the content in the order presented in *VCE Biology, Units 3&4*. The content and skills covered in Outcomes 1 and 2 of each unit lay the foundation for tackling Outcome 3 with confidence.
- 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 Questions** at the end of each Area of Study 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 are 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 BIOZONE's Resource Hub ..... ?  
 Using This Workbook ..... ?  
 Using the Tab System ..... ?  
 Assessment Tasks and Key Science Skills ..... ?  
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☐ 39 Enzyme Inhibition ..... 72  
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☐ 41 Achieving Metabolic Efficiency ..... 74  
☐ 42 Chapter Review: Did You Get it? ..... 75

### UNIT 3: How do cells maintain life?

#### Area of Study 1: What is the role of nucleic acids and proteins in maintaining life?

##### Chapter 1: Nucleic Acids and Proteins

☐ 1 Nucleotides ..... 6  
☒ 2 What Does DNA Look Like? ..... 7  
☐ 3 ..... 8  
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☐ 7 What is the Genetic Code? ..... 17  
☐ 8 Transcription in Eukaryotes ..... 19  
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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.

##### Chapter 2: DNA Manipulation

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A green dot indicates a practical activity.  
 A red dot indicates an assessment task.

#### Area of Study 2: How are biochemical pathways regulated?

##### Chapter 3: Regulation of Biochemical Pathways

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#### Area of Study 1: What is the role of nucleic acids and proteins in maintaining life?

##### Chapter 1: Nucleic Acids and Proteins

*Key Skills and Knowledge* ..... 5  
☒ 1 Nucleotides ..... 6  
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☐ 11 Structural and Regulatory Genes ..... 23  
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The teacher can see at a glance how this student is progressing through this unit of work. Any concerns with progress can be addressed early.

*Key Skills and Knowledge* ..... 102  
☐ 59 Improving Productivity Using Technology ..... 103  
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### UNIT 4: How does life change and respond to challenges?

#### Area of Study 1: How do organisms respond to pathogens?

##### Chapter 7: Responding to Antigens

*Key Skills and Knowledge* ..... 115  
☒ 64 Pathogens and Antigens ..... 116  
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☐ 71 Recognising Antigens ..... 126  
☐ 72 Recognising Cellular and Non-Cellular Pathogens ..... 128  
☐ 73 Chapter Review: Did You Get it? ..... 129

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

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

# Introducing the Content

Each chapter in *VCE Biology Units 3&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 to expand their vocabulary.

For ease of navigation, chapters are numbered sequentially throughout the book, separated by Unit and Area of Study breaks (see following pages).

Students can use the list of **key terms** to create their own glossary, or they can look them up in the glossary at the back of the book. This encourages use of the correct terms when answering questions.

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

Activities that cover an assessment for the Area of Study are indicated by a red bookmark and text.

Introduce the concept with a grounding activity

Follow with activities exploring that concept

The chapter title corresponds to the **Key Knowledge** headings under each **Outcome** for each **Area of Study**.

**For students:**

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

The activities relating to these key knowledge outcomes.

## CHAPTER 10

### Genetic Changes in a Population Over Time

#### Causes of changing allele frequencies

##### Key skills and knowledge

- 1 Recall the role of mutation in creating new alleles and sexual reproduction in producing new variants. Summarise how genotype, the environment, and epigenetic influences interact.
- 2 Recognise the effect of selection.
- 3 Explain the variability of selection.
- 4 Understand adaptation.
- 5 **PRAC** Use a spreadsheet model to explore how natural selection affects gene pools.

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



#### Consequences of changes in allele frequencies

##### Key skills and knowledge

- 6 Describe the biological consequences of changing allele frequencies. Which processes increase genetic diversity? Which decrease genetic diversity?
- 7 Explain the genetic and evolutionary consequences of the founder effect.
- 8 Explain the genetic and evolutionary consequences of the bottleneck effect.
- 9 Recognise genetic drift as an important process in evolution. Describe its consequences and the conditions under which it is important (see #6 and 7).
- 10 **PRAC** Use a spreadsheet model to explore how genetic drift affects gene pools.
- 11 Explain the biological consequences of different selection pressures on a phenotypic characteristic such as skin colour. How is human skin colour a consequence of a balanced response to opposing selection pressures?
- 12 **TEST** Analyse and evaluate heterozygous advantage in the distribution of human haemoglobin disorders. Why don't deleterious alleles disappear?

#### Manipulating gene pools through selective breeding

##### Key skills and knowledge

- 13 Explain how selective breeding (artificial selection) can manipulate and alter the allele frequencies of a gene pool and cause phenotypic and genotypic change.
- 14 Describe examples to show how selective breeding has created phenotypic and genotypic change in populations. Examples include the development of modern domestic livestock breeds and crop varieties from their wild ancestors.

#### Ongoing challenges from pathogens

##### Key skills and knowledge

- 15 Explain how antibiotic resistance can arise and spread in bacterial populations. Describe the challenges bacterial resistance presents to the treatment of disease.
- 16 Distinguish between antigenic drift and antigenic shift in viruses. Describe the challenges these forms of viral evolution pose for vaccination programmes, prevention of viral disease, and protection of public health.

#### 110 Selective Breeding in Animals

**Key Idea:** Selective breeding is the process of breeding together organisms with desirable qualities (e.g. high milk yield) so that the trait is reliably passed on to the next generation. **Selective breeding** (or **artificial selection**) is the process by which humans select organisms with desirable traits and breed them together so that the trait appears in the next generation. The process is repeated over many generations until the characteristic becomes common. Selective breeding often uses reproductive technologies, such as artificial insemination, so that the desirable characteristics of one male can be passed onto many offspring. This increases the rate at which the desirable trait is passed to progeny. These traits become more concentrated and some alleles may be lost. A reduction in genetic diversity may also decrease the ability of a species to adapt to changes in the environment.

**The origin of domestic animals**

**PIG**  
Wild ancestor: Wild boar (aurochs)  
Origin: Anatolia, 8000 years BP  
Now: More than 12 billion modern breeds, including the Berkshire (pink and white) and the Duroc (red).

**DOMESTIC FOWL**  
Wild ancestor: Red jungle fowl (gallus)  
Origin: India Valley, 4000 BP  
Now: More than 60 breeds including the Rhode Island Red (red) and the Leghorn (yellow).

**GOAT**  
Wild ancestor: Bezoar goat  
Origin: Iraq, 10,000 years BP  
Now: approx. 30 breeds including the Alpine (black and white) and the Nubian (black).

**SHEEP**  
Wild ancestor: Asiatic mouflon  
Origin: Iran, 10,000 years BP  
Now: More than 200 breeds including the Merino (white), Suffolk (black), Friesian (black), and East Angles (Dorset).

**CATTLE**  
Wild ancestor: Aurochs (aurochs)  
Origin: 100,000 years BP  
Now: 800 modern breeds including the Aberdeen Angus (black), Friesian (black), and the Shorthorn (red and white).

1. (a) What is selective breeding?
- (b) What are the advantages of selective breeding?
2. What effect would selective breeding have on the genetic diversity of a population?

#### 111 Selection in Livestock

**Key Idea:** The performance of livestock can be improved by selective breeding based on measurable physical traits. Most of the economically important traits in dairy cattle (below) are expressed only in females, but the male opportunity for selection is in males. Selection of the best bulls, and cows, in this way, the bulls and cows from their wild ancestors.

**The perfect dairy cow**

**Desirable traits:** high milk production, rapid growth and weight gain, fertility, easy calving, disease resistance.

**Undesirable traits:** low milk production, slow growth and weight gain, late calving, poor fertility, poor disease resistance.

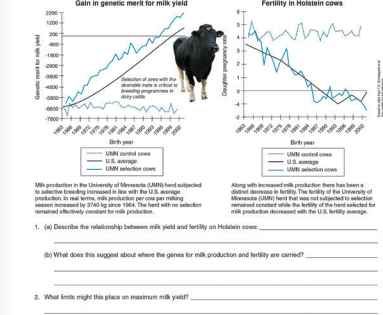
**Artificial selection:** Selection is based primarily on high milk production, but good health and fertility are also selected for. **Desirable traits:** high milk yield and good health and fertility. **Undesirable traits:** low milk yield, poor health, poor fertility, poor disease resistance.

**Special breeds:** Some cattle are bred for their ability to thrive in harsh conditions. Scottish Highland cattle (above) are a hardy, long-lived breed and produce well when other breeds cannot thrive.

1. Why can artificial selection produce changes in phenotype much more rapidly than natural selection?
2. Suggest why selective breeding has proceeded particularly rapidly in dairy cattle.

#### 112 Selective Breeding for Milk Production

**Key Idea:** Selective breeding is able to produce rapid change in the phenotypic characteristics of a population. **Selective breeding** (or **artificial selection**) is the process by which humans select organisms with desirable traits and breed them together so that the trait appears in the next generation. The process is repeated over many generations until the characteristic becomes common. Selective breeding often uses reproductive technologies, such as artificial insemination, so that the desirable characteristics of one male can be passed onto many offspring. This increases the rate at which the desirable trait is passed to progeny. These traits become more concentrated and some alleles may be lost. A reduction in genetic diversity may also decrease the ability of a species to adapt to changes in the environment.

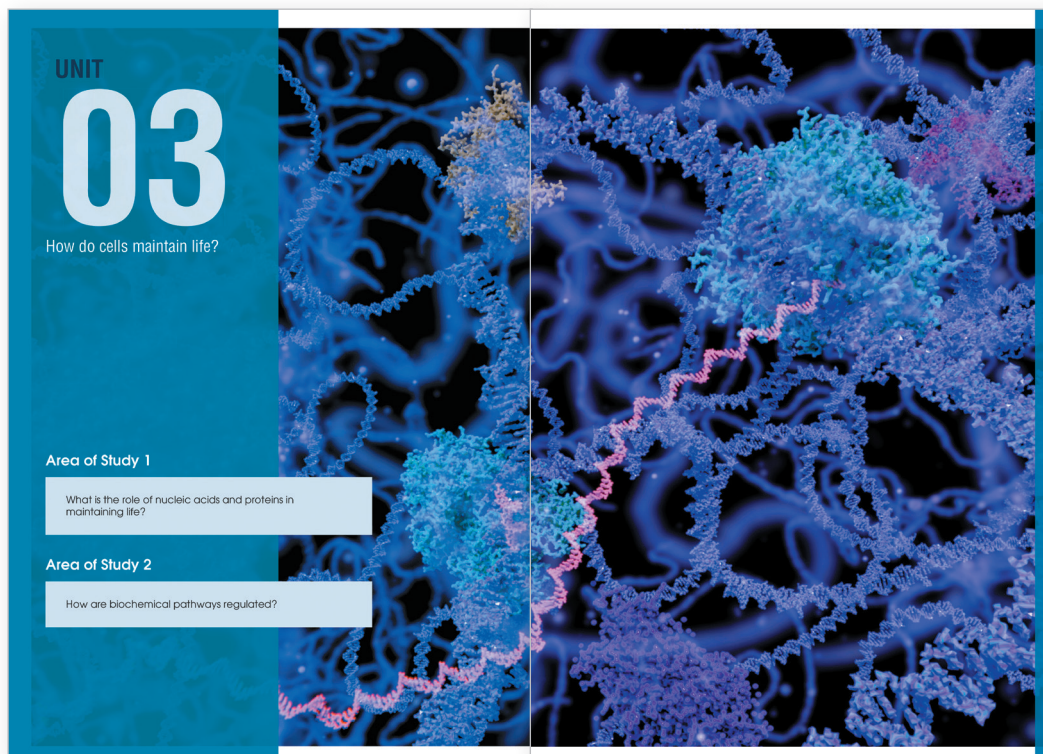


1. (a) Describe the relationship between milk yield and fertility in Holstein cows.
- (b) What does this suggest about where the genes for milk production and fertility are carried?
2. What limits might this place on maximum milk yield?
3. Why is sex selection important in selective breeding, even if the characters involved are expressed only in the female?
4. Natural selection is the mechanism by which organisms with favourable traits become proportionally more common in the population. How does selective breeding mimic natural selection? How does the example of the Holstein cattle show that reproductive success is a compromise between many competing traits?

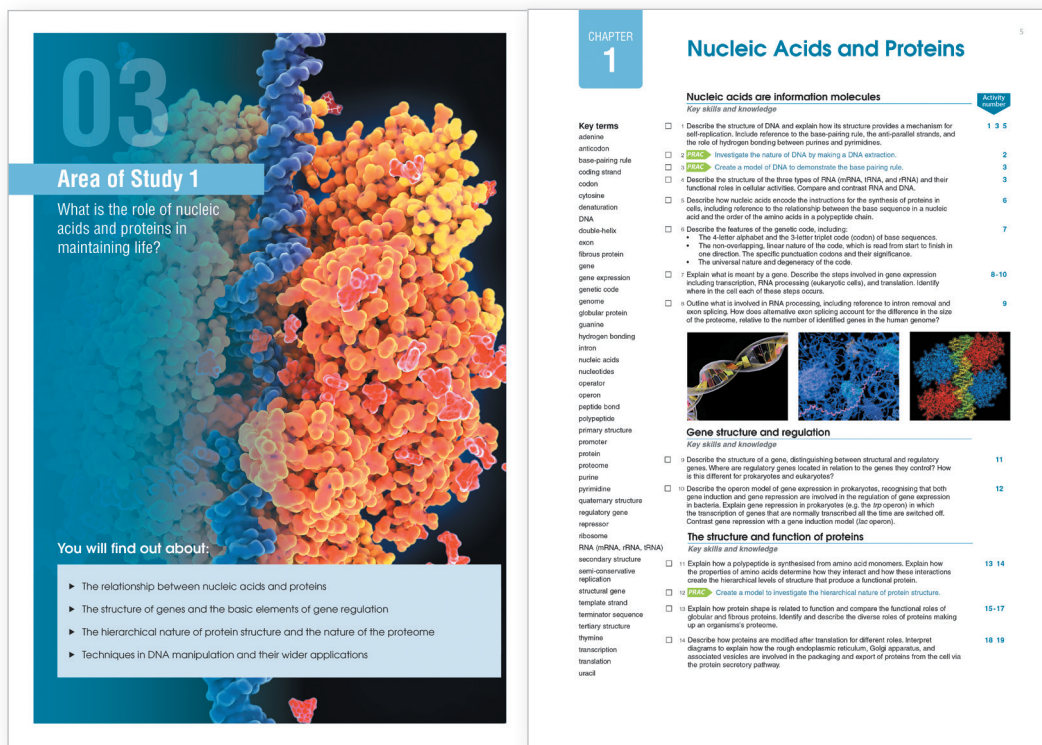


# Finding Your Way Around

The content of the *VCE Biology Units 3&4* is organised into 14 chapters, numbered sequentially and nested within their Unit and Area of Study (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.



The two *Unit* breaks divide the book into two halves, providing students with a clear indication of where they are in the course. Each unit break summarises the topics to be covered in each *Area of Study*, so students have a clear idea of what is coming up.



The *Area of Study* breaks demarcate each group of related topics within the Study Design. Each one provides a short list of what the student will find out about in that section, which helps to prepare them for the upcoming content. An *Area of Study* may include anything from one to three chapters (*Key Knowledge* areas).

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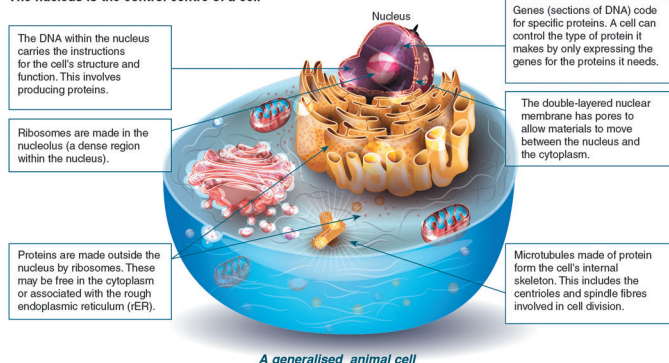
## 17 Protein Functional Diversity

**Key Idea:** Proteins carry out the essential functions of life and have structural, catalytic, and regulatory roles.

In eukaryotic cells, most of a cell's genetic information (DNA) is found in a large membrane-bound organelle called the nucleus. DNA provides the instructions that code for the formation of proteins and the nucleus directs all cellular activities by controlling the synthesis of proteins, which carry out most of a cell's work. A cell produces many different types

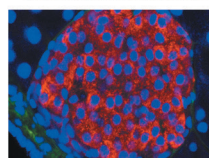
proteins, each with a specific task. Proteins have roles in structure, function, and regulation of the body's cells, tissues, and organs. Without a full complement of functional proteins, a cell can not carry out its specialised role. All of the proteins encoded by an organism's DNA is called its **proteome**. The proteome is larger than the genome because, as you saw earlier, cells are able to produce many different proteins from one set of instructions.

**The nucleus is the control centre of a cell**

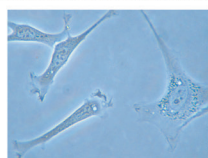


*A generalised animal cell*

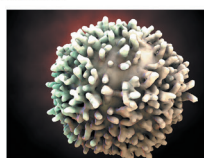
► While a generalised cell produces a range of proteins, some cells in the body are highly specialised to produce large amounts of a specific protein. This specialisation defines their functional role. Three examples are pictured below.



Cells within specialised regions of the pancreas produce and release the protein hormone insulin. Insulin (red in photo) helps to regulate blood glucose.



Fibroblasts are specialised cells that continuously produce and secrete the materials that form connective tissue, including the protein collagen.



B lymphocytes (B cells) are white blood cells that are specialised to produce and secrete proteins called antibodies, which protect the body against diseases.

1. Suggest what might happen to a protein's functionality if it was incorrectly encoded by the DNA. Explain your answer:

---



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2. The opposite page shows six pictograms of proteins in action, six protein functions, six protein examples, and six photographs. These are not in any matched order. Cut out the 24 boxes and paste or tape them into the grid on the next page so that each pictogram is matched with its correct function, example, and illustrative photograph.



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**Key Idea:** Proteins carry out the essential functions of life and have structural, catalytic, and regulatory roles.

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

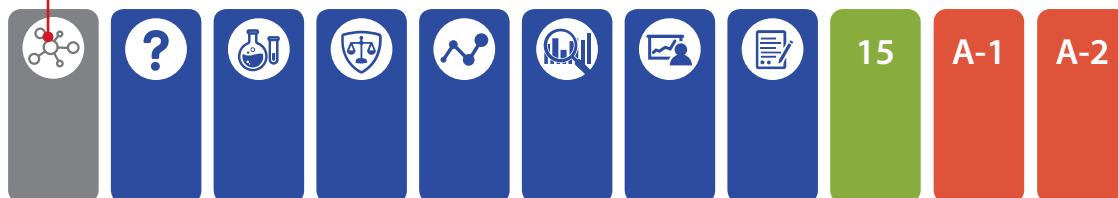
Annotated diagrams, sometimes including photo panels, explain the content of the page, providing the information necessary to complete the activity.

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

Related or supporting content is identified through the **colour-coded tab system** (below).

**Grey hub tabs** indicate the activity is supported on the Resource Hub. See page v for details.

**Green tabs** make connections to related activities elsewhere in the book



**Blue tabs** indicate the activity covers the following **key skills** (L → R):

- Develop aims and questions, formulate hypotheses, make predictions
- Plan and conduct investigations
- Comply with safety and ethical guidelines
- Generate, collate, and record data
- Analyse and evaluate data and investigation methods
- Construct evidence-based arguments and draw conclusions
- Analyse, evaluate and communicate scientific ideas

**Red tabs** indicate appendices (L → R):

- A-1: Glossary
- A-2: Equipment list

See pages 311-315



# Practical Investigations

- One of the best ways to engage students is through hands on activity. Numerous opportunities for practical work are presented throughout this book. These practical investigations are opportunities for students to develop competency in scientific procedures and to practise the *Key Science Skills* by applying them in practical situations.

The investigations provide an opportunity for collaborative work and will stimulate discussion and the sharing of ideas. Collaboration through paired practical work provides an excellent opportunity for students to interact in meaningful ways to extend their scientific vocabulary and improve communication skills.

The investigations have been designed using everyday materials and equipment easily found in most high school laboratories. No special kits are required. Where possible we have provided "typical" results.



Each investigation is clearly numbered (sequentially through the chapter).

- Ensure your students read through the procedure fully *before beginning* the investigation.
- Highlight any hazardous or important steps, and make sure the students follow your directions.

## 47 Investigating Photosynthetic Rate

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**Key idea:** Measuring the production of oxygen provides a simple way to measure the rate of photosynthesis. The rate of photosynthesis can be investigated by tracking the substances involved in photosynthesis. These include

measuring the uptake of carbon dioxide, the production of oxygen, or the change in biomass over time. Measuring the rate of oxygen production provides a good approximation of the photosynthetic rate and is relatively easy to carry out.

**Investigation 4.1 Investigating photosynthetic rate**

See appendix for equipment list.

1. Weigh 0.8–1.0 grams of *Cabomba aquatica* stem on a balance. Cut the stem underwater and invert to ensure a free flow of oxygen bubbles.
2. Place into a beaker filled (at approximately 20°C) with a solution containing 0.2 mol/L sodium hydrogen carbonate (to supply carbon dioxide).
3. Invert a funnel over the *Cabomba* and then invert a test tube filled with the sodium hydrogen carbonate solution on top to collect any gas produced.
4. Place the beaker at distances 20, 25, 30, 35, 40, 45, and 50 cm from a 60W light source. Measure the light intensity with a lux meter at each interval.
5. Leave the *Cabomba* stem to acclimatise to the new light level for 5 minutes before recording data. Count the bubbles for a period of three minutes at each distance and record.
6. Alternatively the volume of gas captured in the test tube can be measured and recorded.

Distance (cm)	Light intensity (lx)	Bubbles counted in three minutes	Bubbles per minute	Volume (mL)
50 cm				
45 cm				
40 cm				
35 cm				
30 cm				
25 cm				
20 cm				

## A-2 Appendix 2: Equipment List

315

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

### 1: Nucleic Acids and Proteins

#### INVESTIGATION 1.1

##### Extracting DNA

Per pair  
5 – 6 strawberries  
1 large zip-lock bag  
100 mL water  
5 mL detergent  
pinch of salt  
1 x filter paper  
1 x glass filter funnel  
1 x 250 mL glass beaker  
1 x glass rod  
~100 mL ethanol (for rinsing)  
2 x centrifuge tubes  
Centrifuge

#### INVESTIGATION 1.2

##### Creating a model of a DNA molecule

Per pair  
Scissors  
Tape or paste

#### INVESTIGATION 1.3

##### Modelling protein structure

Per pair  
Pipe cleaners (2 white, 2 pink, 2 purple, 4 blue)  
Sticky tape  
2 x binder clips or paper clips

### 3: Regulation of Biochemical pathways

#### INVESTIGATION 3.1

##### Investigating peroxidase activity

Per pair/group  
13 x boiling tubes  
42 mL distilled water  
1.8 mL 0.1%  $H_2O_2$  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

### 4: Photosynthesis

#### INVESTIGATION 4.1

##### Investigating photosynthetic rate

Per pair/group  
1.0 g *Cabomba aquatica*  
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

### 5: Cellular Respiration

#### INVESTIGATION 5.1

##### Measuring respiration in germinating seeds

Per group  
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  
3 x bent glass tubes or pipettes  
3 x tubes (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 5.2

##### Measuring Fermentation in yeast

Per pair  
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

### 9: Disease Challenges and Strategies

#### INVESTIGATION 9.1

##### Investigating the effectiveness of handwashing

Per class  
Warm water  
Soap  
Hand sanitiser  
Per individual  
1 x nutrient agar plates  
Marker pen  
Paper towels  
Incubator (if using)

#### INVESTIGATION 9.2

##### Modelling disease outbreak and spread

Per pair  
Computer  
Spreadsheet application (e.g. Excel)

### 10: Genetic Changes in a Population

#### INVESTIGATION 10.1

##### Investigating natural selection

Per student  
Computer  
Spreadsheet application (e.g. Excel)

#### INVESTIGATION 10.2

##### Modelling genetic drift

Per student  
Computer  
Spreadsheet application (e.g. Excel)

A list of the equipment and reagents required for each investigation is provided in appendix 2. Only standard equipment is used (no special kits are required).



A range of different types of practical activities have been included in the book (these are outlined below). Practical investigations are identified in the contents with a green circle, and in the chapter introduction with a green prac tab. In addition, chapter 14 has been designed to help students with the outcome 3 task of designing or adapting a lab or field-based investigation related to cellular processes and/or biological change and continuity over time. The chapter covers:

- Ethical considerations and safety
- Recording results in a log book
- Analysing and interpreting data
- Designing a practical investigation
- Presenting findings

**56 Investigating Yeast Fermentation**

**Key idea:** Brewer's yeast preferentially uses alcoholic fermentation when there is excess sugar. The CO<sub>2</sub> 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 5.2 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 50 mL of water at 24°C.
- In a conical flask (bell) 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.
- Stopper the conical flask and set up 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 as a class and use it to complete 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					

- Write the equation for the fermentation of glucose by yeast:
- Using the final values (60 minutes) collected from the class, calculate the rate of CO<sub>2</sub> production per minute for each substrate:
  - None:
  - Glucose:
  - Maltose:
  - Sucrose:
  - Lactose:

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**4 Creating a DNA Model**

**Key idea:** Nucleotides pair according to the base pairing rule. There are ten base pairs per turn of the DNA double helix. DNA is made up of structures called nucleotides. Two primary factors control the way in which these nucleotide building blocks are linked together: 1) the available space within the DNA double helix and 2) the hydrogen-bonding capability of the bases. These factors cause the nucleotides to join together in a predictable way, referred to as the **base pairing rule**. The strands of the DNA are antiparallel (they run in opposite directions) and there are 10 base pairs per 360° turn of the helix. The activity below will guide you through constructing a three dimensional model of DNA.

**Chargaff's rules**

Before Watson and Crick described the structure of DNA, an American chemist called Chargaff analysed the base composition of DNA from a number of organisms. He found that the base composition varies between species but that within a species the percentage of A and T bases are equal and the percentage of G and C bases are equal. Validation of Chargaff's rules was the basis of Watson and Crick's base pairs in the DNA double helix model.

DNA base pairing rule			
Adenine	always pairs with	Thymine	A ↔ T
Thymine	always pairs with	Adenine	T ↔ A
Cytosine	always pairs with	Guanine	C ↔ G
Guanine	always pairs with	Cytosine	G ↔ C

**Investigation 1.2 Creating a model of a DNA molecule**

See appendix for equipment list

Work in pairs for this activity.

- Cut out the opposite page. Cut out the template strand. Dark black lines should be cut. Make a slight fold on the red dashed line so that the grey surfaces are facing (a valley fold). Do not cut around the grey representations of hydrogen bonds on each base. These are to show you where you will join your bases.
- Cut out the complementary strand. The first base (G) is in position as a guide. Fold on the red dashed line so that the blue surfaces are facing each other.
- Fill in the table right to help you place the remaining bases in the correct order (5' to 3') on the complementary strand:
- Cut out the bases and slot them into the slots on the complementary strand using the order in the table above. Use short lengths of tape to fix them in position. Make sure the blue surfaces are facing and the base is in the same orientation as the guide (G).
- Line up the first base pairs (C and G) and stick them together with tape. The tape takes the place of the hydrogen bonds holding the strands together. Note that the bases are facing in opposite directions.
- Continue sticking base pairs together, working your way around the helix, to complete the DNA molecule.
- Together, or in groups, search online for at least three different representations of a DNA molecule. Evaluate your model against these representations. How are they similar? How are they different? If you wish, attach pictures of the DNA representations you selected to this page.

Template strand	Complementary strand
Cytosine (C)	Guanine (G)
Guanine (G)	(a)
Thymine (T)	(b)
Adenine (A)	(c)
Thymine (T)	(d)
Adenine (A)	(e)
Thymine (T)	(f)
Adenine (A)	(g)
Cytosine (C)	(h)
Guanine (G)	(i)

1. Describe your model in terms of the other representations you looked at. What are its strengths and deficiencies?

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## Experiments and investigations

## Paper practicals

**91 Modelling Disease Outbreak and Spread**

**Key idea:** Being able to model the spread of a disease can help predict when, where, and how it will spread. Modelling how a disease spreads can help preparation for an eventual outbreak. Elements of the model must account for how infectious a pathogen is and for how long, the density and mobility of the population, and even the level of mortality of infected people. These models can be used to test the effectiveness of public health measures.

**Modelling a disease**

- A spreadsheet can be used to model the spread of disease. There are also numerous online models that can be used.
- In the most simple model (right) whenever an infected person meets another, a new infection occurs. The number of infections at each infection cycle affects the spread of the disease.
- Using a spreadsheet, you will first model an infected person meeting (and infecting) two other people. In this model, once the infected person has infected two people they are no longer infectious.

**Investigation 9.2 Modelling disease outbreak and spread**

See appendix for equipment list

1. Working in pairs, enter the following into a spreadsheet:

	A	B
1. New infections		
2. Total infections		
3. Cycle 1		
4. Cycle 2		
5. Cycle 3		
6. Cycle 4		
7. Cycle 5		
8. Cycle 6		
9. Cycle 7		
10. Cycle 8		
11. Cycle 9		
12. Cycle 10		

One infection cycle. Copy this down to row 12 (10 cycles of infections).

- How many new infections are there per infection cycle after 10 infection cycles?
- How many infected people are there in total after 10 infection cycles?
- Now set the infections per infected person to 3 (A2\*3) and repeat the model.
- How many new infections are there per cycle of infection after 10 infection cycles?
- How many infected people are there after 10 cycles of infection?
- We can now extend the model by adding in a 50% randomness. The number of people infecting with each infected person may not always be the same. In our extended model, we shall randomise the number of people infecting to between 1 and 4.

New infections	People infected with per person	Total infected people
1	1	1
2	2	2
3	3	3
4	4	4
5	5	5
6	6	6
7	7	7
8	8	8
9	9	9
10	10	10
11	11	11
12	12	12

→ Add new infections to total from previous row (cycle) → Generates a random number between 1 and 4 → Calculates the total number of people infected

5. Run the model five times by recalculating the spreadsheet using the recalculate or calculate now option (depending on your spreadsheet). On average, how many people in total have been infected after ten cycles?

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## Spreadsheets and computational models

1. Describe the main features in the formation of each part of a protein's structure:

- Primary structure: \_\_\_\_\_
- Secondary structure: \_\_\_\_\_
- Tertiary structure: \_\_\_\_\_
- Quaternary structure: \_\_\_\_\_

2. How are proteins built up into a functional structure?

3. Strong chemicals and extremes of temperature or pH can disrupt the bonds in proteins. What would this do to the protein's function and why?

**Investigation 1.3 Modelling protein structure**

See appendix for equipment list

Work in pairs for this activity.

- You will need pipe cleaners with four colours. We have used 2 white, 2 pink, 2 purple, and 4 blue but you can swap out for the colours you have. Each colour represents a different amino acid.
- Twist a loop in the center of each pipe cleaner (Figure 1). The twist represents the amino acid's functional group.
- Join the amino acids together (Figure 2) by twisting their arms together in the following sequence: (1) white (2) pink (3) blue (4) purple (5) blue (6) pink (7) blue (8) white (9) blue (10) purple. What level of protein organisation does the structure in Figure 2 represent?
- Attach sticky tape to the loops of the purple pipe cleaners and to one arm of each of the blue pipe cleaners. These represent places where hydrogen bonding can occur.

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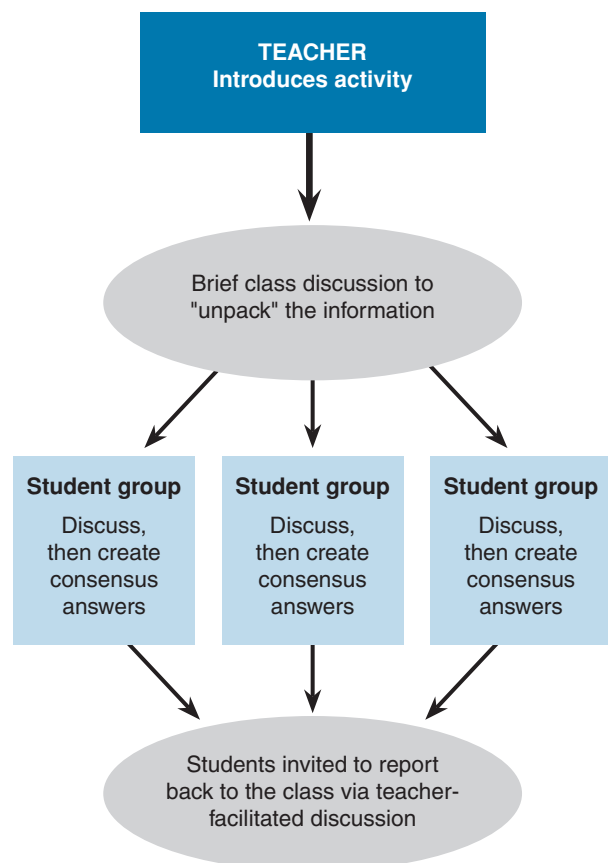
## Physical models

# 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 *VCE Biology Units 3&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.

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### 4 Creating a DNA Model

**Key idea:** Nucleotides pair according to the base pairing rule. There are ten base pairs per turn of the DNA double helix. DNA is made up of structures called nucleotides. Two primary factors control the way in which these nucleotide building blocks are linked together: 1) the available space within the DNA double helix and 2) the hydrogen-bonding capability of the bases. These factors cause the nucleotides to join together in a predictable way, referred to as the **base pairing rule**. The strands of the DNA are antiparallel (they run in opposite directions) and there are 10 base pairs per 360° turn of the helix. The activity below will guide you through constructing a three dimensional model of DNA.

**DID YOU KNOW?**

**Chargaff's rules**  
Before Watson and Crick described the structure of DNA, an Austrian chemist called Chargaff analysed the base composition of DNA from a number of organisms. He found that the base composition varies between species but that within a species the percentage of A and T bases are equal and the percentage of G and C bases are equal. Validation of Chargaff's rules was the basis of Watson and Crick's base pairs in the DNA double helix model.

DNA base pairing rule			
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Thymine	always pairs with	Adenine	T ↔ A
Cytosine	always pairs with	Guanine	C ↔ G
Guanine	always pairs with	Cytosine	G ↔ C

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

**In this activity, they can work together to explore the nucleotide base pairing rule and visualise the double helix structure of DNA.**

As the guide (G):

- Line up the first base pairs (C and G) and stick them together with tape. The tape takes the place of the hydrogen bonds holding the strands together. Note that the bases are facing in opposite directions.
- Continue sticking base pairs together, working your way around the helix, to complete the molecule.
- Together, or in groups, search online for at least three different representations of a DNA molecule. Evaluate your model against these representations. How are they similar? How are they different? If you wish, attach pictures of the DNA representations you selected to this page.

1. Describe your model in terms of the other representations you looked at. What are its strengths and deficiencies?

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### 38 Investigating Peroxidase Activity

**Key idea:** The factors affecting peroxidase activity can be measured using the indicator guaiacol. Enzymes control all the metabolic activities required to sustain life. Changes to environmental conditions (e.g. pH or temperature) may alter an enzyme's shape and functionality. This may result in a reduction or loss of activity. In this exercise you will use the information provided and your own understanding of enzymes to investigate the effect of pH on enzyme activity and then design an experiment to investigate the effect of inhibitors on enzyme function.

**Background**  
Hydrogen peroxide ( $H_2O_2$ ) is a toxic by-product of respiration and must be broken down in order to avoid cellular damage. **Peroxidase** acts in the presence of naturally occurring organic reducing agents (electron donors) to catalyse the breakdown of  $H_2O_2$  into water and oxidised organic substrates.

$$2H_2O_2 + 2AH_2 \xrightarrow{\text{Peroxidase}} 4H_2O + A_2$$

Like all enzymes, the activity of peroxidase is highest within specific ranges of pH and temperature, and activity drops off or is halted altogether when the conditions fall outside of the optimal range. The conversion of  $H_2O_2$  is also influenced by other factors such as the levels of substrate and enzyme.

Increasing levels of oxygen production over time (minutes)

A time-colour palette is shown above. You can use it as

**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 strength understanding and build skills in argumentation.**

5. You can take photos with your phones or keep a written record of the colour changes.

	Colour reference number						
	0 min	1 min	2 min	3 min	4 min	5 min	6 min
pH 3							
pH 5							
pH 6							
pH 7							
pH 8							
pH 10							

1. The colour palette (above) shows the relative amounts of tetraguaiacol formed when guaiacol is oxidised. How can this be used to determine enzyme activity?

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## Collaboration and discovery

- BIOZONE's *VCE Biology Units 3&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 *VCE Biology Units 3&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.

# Differentiated Learning

Tools for differentiated instruction within *VCE Biology Units 3&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 *VCE Biology Units 3&4* in a differentiated classroom:

[illegible]

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## 82 Identifying Pathogens and Their Sources

**Key take:** Pathogens can be identified by the symptoms they cause, by genetic analysis, by environmental testing, and by tracing online reports and social media.

As technology has advanced it has provided a new range of tools that can be used to identify potential new pathogens, their origins, and to track their initial spread. While traditional

disease surveillance relies on obtaining data through formal reporting systems, surveillance or online social networks (GDNs) can actually help researchers respond more quickly to potential disease outbreaks. Proactive testing of animal populations for potential pathogens is also helping to open up and plan for future scenarios.

### Identifying novel pathogens

Identifying pathogens is an important step in controlling or preventing the outbreak of disease. Because not all pathogens can be cultured and studied, modern molecular techniques are applied to identify new pathogens. Most of these come under anyogenes genetic methods (DNA or RNA) and sequencing to known sequences in public DNA databases.

Genetic material is isolated and amplified using PCR. The exact method depends on whether the pathogen is viral or bacterial. Amplified material is then sequenced and the results compared to genome databases.

Alphavirus DNA or RNA probe designed to bind to specific DNA or RNA sequences are used to identify genetic material from potential pathogens (Figure 82.1).

Novel pathogens will bind to the material to known pathogens, so the new pathogens can be identified at a low degree of sensitivity early on.

For example, SARS-CoV-2 was originally identified by the analysis of its genome sequence from an affected patient. The genome sequence was found to have a 79.3% match with the SARS-CoV genome which was already known from a 2003 outbreak.

Specific mutations and categorisation of the pathogen are then carried out.

The diagram illustrates the process of identifying novel pathogens using genetic methods. It is divided into two main parts: PCR amplification and sequencing, and probe-based identification.

- Top Path (PCR and Sequencing):**
  - 1** A pathogen (represented by a virus particle) is shown.
  - 2** The pathogen is subjected to **PCR amplification** using **genetic material** (indicated by a red arrow).
  - 3** The amplified material is **sequenced**, resulting in a sequence: **TGGTATAAAA**.
  - 4** The sequence is **compared with a database** (represented by a blue box).
- Bottom Path (Probe-based Identification):**
  - 5** A **DNA or RNA probe** (red line) **binds to its target** (blue line).
  - 6** The probe and target are **sequenced**, resulting in a sequence: **TGGTATAAAA**.

### The hunt for new viruses

**PROJECT 1** – SARS-CoV-2 surveillance project. This allows researchers in which researchers go in field looking for new animal viruses. These are also a new reservoir. The mouse caught SARS, MERS, and probably CoV-2, is originated in bats, as having bats to viral them leading for new viruses.

Blood samples are taken from bats kept and analyzed for a wide range of potential infectious microbes. An error in the analysis can be confirmed if there is a match.

Viruses that have been found, and there is already evidence available to identify residents and identify possible locations of an outbreak have

potential techniques?

RNA?

3. What is the difference between a virus and a bacterial pathogen?

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## 17 Investigating Photosynthesis

**Key Idea:** Measuring the rate of photosynthesis is a simple way to measure the rate of photosynthesis. The rate of photosynthesis can be investigated by tracking the substances involved in photosynthesis. These include

measuring the uptake of carbon dioxide, the production of oxygen, or the change in biomass over time. Measuring the rate of oxygen production provides a good approximation of the photosynthetic rate and is relatively easy to carry out.

### Investigation 4.1 Investigating photosynthetic rate

See [Investigation 4.1](#) for equipment list.

Wipe the inside of a 1.0 litre of Colson's aquarium tank with a solution of sodium bicarbonate and pour it into a beaker of free-flowing water.

2. Place into a beaker of water (at room temperature) a 1.0 litre of Colson's aquarium tank supply carbon dioxide.

3. Insert a funnel over the beaker filled with the solution to collect any gas.

4. Place the beaker of water in a 1.0 litre of Colson's aquarium tank with a 1.0 litre of water.

5. Leave the Colson's aquarium tank for 3 minutes before for a period of three minutes.

6. Alternatively, the volume of

Oxygen bubbles

Test tube with  $\text{NaHCO}_3$  solution

Inverted funnel

Beaker with  $\text{NaHCO}_3$  solution at 30°C

Colson's tank

measured.

Distance (m)	Bubbles per minute	Volume (mL)
50 cm		
45 cm		
40 cm		
35 cm		
30 cm		
25 cm		
20 cm		

- Use the data to draw a graph of the bubble produced per minute vs light intensity.
- Why is measuring light intensity directly in the beaker better than inferring light intensity from the measured distance?

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

- The sample of gas collected during the experiment was tested with a glowing splint. The splint reignited when placed in the gas. What does the colour of the gas produced?

- Why is measuring gas collected rather than bubbles produced a more accurate way of recording data?

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Encourage students to use the glossary (Appendix 1) when they come across a new word or a word whose definition they are unsure of. This will build their scientific literacy and knowledge of key terms.

**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.

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.

# 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.

## 131 Evidence for the Relatedness of Species

**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 (e.g. the bones in the arms in the bat and the wings in the bird) to indicate descent from a common ancestor.

**DNA comparisons**  
DNA can be used to determine how closely organisms are related to each other. The greater the similarities between the DNA sequences of species, the more closely related the species are.

**Fossil record**  
Fossils, like this (left) are the remains of dead organisms, a record of the extinction of or

**Biogeography**  
The geographical distribution of living organisms provides evidence of common ancestry. The biogeography of islands can be explained by speciation, and the biogeography of the Galapagos Islands, provides evidence of speciation when separated from the population on the mainland.

## 96 Chapter Review: Did You

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

epidemic	A Indirect protection from an inf because most of the population
herd immunity	B The occurrence of a disease
incidence	C The status of a person with
immunised	D The delivery of antigenic m
pandemic	E A period or place of isolati
quarantine	F The widespread occurrence
vaccination	G The rate of occurrence of

2. Study the graphs of the 2014-2015 West Africa Ebola outbreak

Weekly cases

Guinea

23 Mar 2014 3 Jan 2015 23 Mar 2015

(a) In which country did Ebola first appear?  
(b) Which country had the greatest number of cases?  
(c) What was the highest number of new cases?  
(d) When and where did this occur?

3. Various health intelligence networks e.g. the GISAID in order to determine if a disease outbreak is for 2015 searches including the word 'influenza' for 2015

Google searches

Apr

How would monitoring the number of internet potential outbreaks?

## 176 Presenting Your Findings

**Key Idea:** A well designed scientific poster summarises key information in a clear, easy to follow format. At the conclusion of your practical investigation you will present your findings as a scientific poster. A poster is a visual summary of your research. Every piece of information on the poster provides key information to your audience so that they have an overview of your findings. Getting the

right balance of information is crucial. Too much information can make the poster busy and hard to read, but too little of the work. The example below shows an effective poster presentation, although deliberately on a topic you would be unlikely to choose. The message is focussed, it uses graphics with minimal text, and presents material in a clear sequence.

### Leaf breakdown in streams

Adapted from a poster by Brendan J. Hicks & J. Lee Laboyrie, Dept of Biological Sciences, University of Waikato, NZ. Modified with permission.

#### Introduction

Fallen leaves can provide a major energy source for forest stream ecosystems, but decomposition by microbes is necessary to lower the C:N ratio and increase the food value of leaves to aquatic invertebrates.

The aims of this investigation were to:  
(1) compare rates of mass loss between leaves of different tree species,  
(2) determine changes in C:N ratio during the conditioning process,  
(3) make preliminary estimates of invertebrate colonisation.

If leaf litter provides food and habitat for stream invertebrates, they will colonise in-stream leaf bags. Breakdown rates vary, so colonisation will be influenced by leaf type.

#### Methods

- Fallen leaves were collected from the forest floor, and placed in mesh bags after drying and weighing.
- The leaf bags were strung onto a wire and left in the Mangapoua Stream, Waikato. The mean water temperature was 14.5°C.

#### Results

1. Food quality of the leaves was increased. Mean C:N ratio fell from 45:1 to 35:1 with incubation.

2. These aquatic insects were commonly found in the leaf bags:

Mayfly larva, *Chironomus* (collector-browser)  
Beetle larva (Elmidae) (collector-browser)  
Caddisfly larva, *Oligoneuria* (generalist feeder)

3. Mahoe and silver birch leaves broke down fast compared to rewarewa and tawa (Fig. 1).

4. There were more aquatic insects on the leaves with intermediate rates of breakdown than on those with very fast or very slow rates (Fig. 2).

#### Fig. 1

Net loss rate (kg/kg)

#### Fig. 2

Invertebrate biomass (mg/m²)

#### Conclusions

- Leaves of different tree species showed a range of breakdown rates. Progression of leaf breakdown determined the colonisation of leaves by aquatic insects. Slower breakdown provides habitat. Faster breakdown provides energy quickly.
- The food quality (C:N ratio) of leaves was improved by breakdown.
- The hypothesis was supported. Further research will investigate suitable mixes of tree species to maximise invertebrate community diversity.

#### References

Hicks, B.J., Laboyrie, J.L. 1999. Preliminary estimates of mass-loss rates, changes in stable isotope composition, and invertebrate colonisation of evergreen and deciduous leaves in a Waikato, New Zealand, stream. *NZ Journal of Marine and Freshwater Research* 33.

Introductory activities can be useful to set the scene for a chapter or concept. Use this activity as an overview into the different lines of evidence scientists use to show relatedness between species. Subsequent activities will go into more detail about each point.

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 biodiversity and ecological interdependencies to complete the activity. Such activities allow the teacher to address any misconceptions before formal assessment.

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. Here, reviewing the resources on the Hub can help students plan how to present the results for Outcome 3.

# Formative and Summative Assessments

BIOZONE's *VCE Biology Units 3&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 table below. You may also choose to assess practical work as you move through the course.

UNIT 3: How do cells maintain life?					
AREA OF STUDY 1 What is the role of nucleic acids and proteins in maintain life?		AREA OF STUDY 2 How are biochemical pathways regulated?			
CHAPTER 1 Nucleic Acids and Proteins	CHAPTER 2 DNA Manipulation	CHAPTER 3 Regulation of Biochemical Pathways	CHAPTER 4 Photosynthesis	CHAPTER 5 Cellular Respiration	CHAPTER 6 Applications of Biochemical Pathways
FORMATIVE Activity 20. Chapter Review	FORMATIVE Activity 31. Chapter Review  SUMMATIVE Activity 27. Assessment task: Area of Study 1 <i>Case study analysis</i>  Activity 32. Synoptic Questions	FORMATIVE Activity 42. Chapter Review	FORMATIVE Activity 50. Chapter Review	FORMATIVE Activity 58. Chapter Review	FORMATIVE Activity 62. Chapter Review  SUMMATIVE Activity 61. Assessment task: Area of Study 2 <i>Analysis and evaluation of a contemporary bioethical issue</i>  Activity 63. Synoptic Questions

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20 Chapter Review: Did You Get It?

This diagram provides a visual overview of gene expression. It combines information from the previous activities. Each of the major steps in the process are numbered, whereas structures are identified with letters.

1. Briefly describe each of the numbered processes in the diagram above:

(a) Process 1: \_\_\_\_\_

(b) Process 2: \_\_\_\_\_

(c) Process 3: \_\_\_\_\_

(d) Process 4: \_\_\_\_\_

(e) Process 5: \_\_\_\_\_

(f) Process 6: \_\_\_\_\_

(g) Process 7: \_\_\_\_\_

(h) Process 8: \_\_\_\_\_

(i) Process 9: \_\_\_\_\_

2. Identify each of the structures marked with a letter and write their names below in the spaces provided:

(a) Structure A: \_\_\_\_\_ (f) Structure F: \_\_\_\_\_

(b) Structure B: \_\_\_\_\_ (g) Structure G: \_\_\_\_\_

(c) Structure C: \_\_\_\_\_ (h) Structure H: \_\_\_\_\_

(d) Structure D: \_\_\_\_\_ (i) Structure I: \_\_\_\_\_

(e) Structure E: \_\_\_\_\_ (j) Structure J: \_\_\_\_\_

3. Describe two factors that would determine whether or not a particular protein is produced in the cell:

(a) \_\_\_\_\_

(b) \_\_\_\_\_

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27 A Case Study in DNA Profiling Success

**Assessment Task, Outcome 1: Analysis and evaluation of a selected biological case study**

DNA profiling to identify an offender at a crime scene is an important aspect of forensic investigations. To cope with the large number of samples analysed in Australia, investigators are continually improving their processes to increase throughput but still maintain the accuracy and reliability of the data produced.

Throughput cannot be increased at the expense of reliability. Identifying the wrong person could mean they are convicted for a crime they didn't commit, while the person who committed the crime goes unpunished (and may offend again). Several factors increase the chances of obtaining a successful profile. One factor is the type of sample used to obtain the DNA (below).

**How does sample type affect profiling success?**

Between 2012 and 2013, new DNA analysis kits were introduced into forensic laboratories in Australia. The new kits analysed more DNA markers than the old kits. A project was carried out to compare the results from the old kits with those from the new kits.

One of the study areas examined how sample type affected the success rate. These results are shown in Table 1. The criterion for a successful match was matching more than 6 alleles. When fewer than 6 alleles matches were obtained, the match was recorded as unsuccessful. DNA analysis was carried out using blood, saliva, and trace DNA samples. Trace DNA is any sample that falls below the recommended thresholds for the analysis, and cannot be defined by a precise picogram amount.

**Table 1. DNA profile success rates from different samples using two different types of DNA analysis kits, the older Profiler Plus and newer Powerplex 21.**

Sample type	Profiler plus kit Number of items	Successful profiles (%)	Powerplex 21 kit Number of items	Successful profiles (%)
Swab	43	92.8	20	90.4
Blood	3	100.0	6	100.0
Clothing	53	71.1	9	66.6
Cigarette butt	54	68.5	1	100.0
Mouthrim bottle	50	70.0	57	50.8
Clothing	16	37.5	41	48.7
Items: Probable friction	27	55.5	133	46.6

Source: DNA Profiling success rates on various crime scenes to determine the optimal number and type of samples that should be analysed per case. Copyright © 2013, Peter Taggart, and Simon Taggart. Published by the DNA Profiling Centre for Forensic Science, 31/10/2013.

1. Explain why it is important that a fast analysis time is balanced with high accuracy rate: \_\_\_\_\_

2. Table 1 shows the successful rates of DNA profiles obtained from a number of different sample types.

(a) Identify the sample type with the highest successful profiles: \_\_\_\_\_

(b) Identify which sample type is the least likely to produce a successful profile: \_\_\_\_\_

(c) Explain why the sample you named in (b) is the less likely to produce a successful profile: \_\_\_\_\_

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UNIT 4: How does life change and respond to challenges?							
AREA OF STUDY 1 How do organisms respond to pathogens?			AREA OF STUDY 2 How are species related over time?			AREA OF STUDY 3	
CHAPTER 7 Responding to Pathogens	CHAPTER 8 Acquiring Immunity	CHAPTER 9 Disease Challenges and Strategies	CHAPTER 10 Genetic Changes in a Population Over Time	CHAPTER 11 Changes in Species Over Time	CHAPTER 12 Determining Species Relatedness	CHAPTER 13 Human Change Over Time	CHAPTER 14 Investigating Cellular Processes or Biological Change
FORMATIVE Activity 73. Chapter Review	FORMATIVE Activity 79. Chapter Review	FORMATIVE Activity 96. Chapter Review  SUMMATIVE Activity 86. Assessment task: Area of Study 1 <i>Data analysis of generated primary/secondary data</i>  SUMMATIVE Activity 97. Synoptic Questions	FORMATIVE Activity 117. Chapter Review  SUMMATIVE Activity 109. Assessment task: Area of Study 2 <i>Case study analysis</i>	FORMATIVE Activity 130. Chapter Review	FORMATIVE Activity 144. Chapter Review	FORMATIVE Activity 170. Chapter Review  Activity 171. Synoptic Questions	ASSESSMENT Design and conduct a scientific investigation  Supported with Activity 175. Designing a Practical Investigation

170 **97 Synoptic Questions: Unit 4, Area of Study 1**

1. Over their lifetime, a person can develop resistance to specific pathogens. This is called acquired immunity. Acquired immunity can be obtained through natural or artificial means, and by active or passive processes.

- Use examples to describe the differences between naturally and artificially acquired immunity.
- Discuss the differences and similarities between passive immunity and active immunity.

2. The graph right shows a primary and secondary immune response to an artificially introduced antigen.

(a) What type of immunity is this? \_\_\_\_\_

(b) What has occurred at point A? \_\_\_\_\_

(c) What has occurred at point B? \_\_\_\_\_

(d) Describe and explain the differences in the amount of antibody detected after each of the two events: \_\_\_\_\_

3. Pertussis, commonly known as whooping cough, is a highly contagious respiratory infection caused by the bacterium *Bordetella pertussis*. In Australia, the vaccine is given at two, four and six months of age. Booster doses are given at 18 months, four years and between 10-15 years. Epidemics occur in Australia every 3-4 years, but between 2008-2012 there has been a significant increase in cases of whooping cough. Most of the people contracting whooping cough have been adults who had been immunised in childhood.

(a) Suggest why many adults are contracting whooping cough (even though they were vaccinated as children): \_\_\_\_\_

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### End of Area of Study synoptic assessments

152 **86 The Effectiveness of Hand Washing**

**Assessment Task, Outcome 1: Analysis and evaluation of primary and secondary data**

▶ We as humans spend much of our time manipulating objects with our hands, so it follows that our hands are covered with the microorganisms found in our environment. These microbes can then be easily transferred by touch to our mouths, such as when eating, or to other people, such as when we hand them an object. Hand washing after contact with potentially contaminated material reduces the chance of transmitting microbes to our internal environment or to others.

▶ In the practical below you will obtain data on the effectiveness of handwashing.

**Investigation 9.1 Investigating the effectiveness of handwashing**

See appendix for equipment list.

- The class will be divided into thirds. One third will wash their hands with warm water. One third will wash their hands with soap and warm water and one third will use hand sanitiser. Your teacher will place you into one of these groups. **Do not wash your hands until step 5!**
- Each person in the group should take a nutrient agar plate and use a marker pen to label the edge of the lid of the plate with name, the incubation temperature (e.g. 30°C), and which group you are in.
- Then use the marker pen to divide the plate lid into quarters and label them as shown below:

- Open the lid and press the tips of your middle and fore fingers from your left hand in the 'Left hand before' quarter. Hold them there for 5 seconds. Then press the tips of your middle and fore fingers from your right hand in the 'Right hand before' quarter. Hold them there for 5 seconds. Close the lid.
- Now wash your hands using the regime assigned to your group (water, soap and water; hand sanitiser). Dry your hands if needed with a clean paper towel.
- Open the lid of the agar plate again and press the tips of your middle and fore fingers from your left hand in the 'Left hand after' quarter. Hold them there for 5 seconds. Then press the tips of your middle and fore fingers from your right hand in the 'Right hand after' quarter. Hold them there for 5 seconds. Close the lid and seal it with clear tape.
- Incubate the plate at your chosen incubation temperature, lid down, for 24 hours.
- Retrieve the agar plates and observe the four different quarters. Count and record the number of bacterial colonies on the plate in each half (before and after). Do this for all the plates in your assigned group. If you only have a small number in your group, just enter the data you have. Calculate the mean number the colonies before and after (below).
- Compare your means with means from the other groups in the class.

1. (a) Your technique: \_\_\_\_\_ Plate number: \_\_\_\_\_ Mean: \_\_\_\_\_

Technique	Plate number	Mean
Number of colonies before washing hands		
Number of colonies after washing hands		

(b) Handwashing technique: \_\_\_\_\_ Mean colonies before: \_\_\_\_\_ Mean colonies after: \_\_\_\_\_

(c) Handwashing technique: \_\_\_\_\_ Mean colonies before: \_\_\_\_\_ Mean colonies after: \_\_\_\_\_

2. Which technique appears to have the greater ability to remove bacteria from your hands? Explain why: \_\_\_\_\_

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### Area of Study Assessment Task: Data analysis

# The Digital Teacher's Edition

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

**VCE | BIOLOGY UNITS 3 & 4**

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Enter code: **VCE12-2-6375**

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Link to **Excel®** spreadsheets for selected activities with a data analysis or computer modelling component.

Access **BIOZONE's Resource Hub** directly from this link for a range of resources to support the activities.

**6 What is Gene Expression?**

**Key Idea:** Genes are sections of DNA that code for proteins. Genes are expressed when they are transcribed into messenger RNA (mRNA) and then translated into a protein. **Gene expression** is the process by which the information in a gene is used to synthesise a protein. It involves **transcription** of the DNA into mRNA and **translation** of the mRNA into the protein.

**A summary of eukaryotic gene expression**

**Transcription**

**Key Idea:** Transcription is the first stage of gene expression. It involves the enzyme RNA polymerase, which synthesises a primary RNA transcript using a single template strand of DNA.

**Transcription is carried out**

RNA polymerase (RNAP) adds nucleotides to the 3' end of the strand in a 5' to 3' direction.

RNA polymerase binds at the upstream promoter region. This region is not transcribed.

**Modelling genetic drift**

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

Activities that manipulate data of perform statistical tests are supported by spreadsheets. These include all data and comments on analysis.