

# HSC

# BIOLOGY

## MODULES 5-8



# Contents

## CLASSROOM GUIDE

|  |      |
|--|------|
| BIOZONE's Pedagogy .....                                     | CG3  |
| Meeting Key Competencies .....                               | CG4  |
| Teacher Support Materials: Teacher Toolkit .....             | CG5  |
| Structure of the Worktext .....                              | CG7  |
| Module Breaks .....  | CG8  |
| The Contents: A Planning Tool.....                           | CG9  |
| Introducing the Chapter Content.....                         | CG10 |
| Structure of an Activity Page.....                           | CG11 |
| Using the Tab System .....                                   | CG12 |
| Support for Science Skills and Practical Investigations..... | CG14 |
| Teaching Strategies for Classroom Use .....                  | CG16 |
| Support for the Depth Study .....                            | CG18 |
| Differentiated Learning.....                                 | CG19 |
| Formative and Summative Assessments .....                    | CG20 |
| Choosing Activities for Home Study .....                     | CG21 |

### BIOZONE Learning Media Australia

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

☎ 07 5535 4896

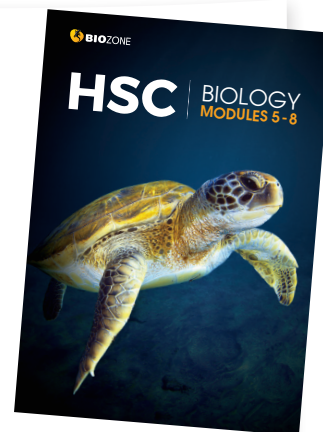
📠 07 5508 2432

✉ sales@biozone.com.au

www.**BIOZONE**.com.au

## FAQs

### ABOUT HSC BIOLOGY MODULES 5-8



|  |                  |
|--|------------------|
| What is BIOZONE's pedagogy?                          | CG3              |
| Tools to plan, teach, and assess.                    | CG4-CG6,<br>CG20 |
| What teacher support materials are there?            | CG5-CG6          |
| Is there a digital version of HSC?                   | CG5              |
| How does the translation tool work?                  | CG5              |
| What is the Resource Hub?                            | CG6              |
| Where do I find model answers?                       | CG6              |
| How is the book structured?                          | CG7-CG9          |
| Are there clear learning objectives for each topic?  | CG10             |
| How are the activities structured?                   | CG11             |
| What is the purpose of the QR codes?                 | CG12             |
| How can I use the tab system to identify components? | CG12             |
| How are the science skills incorporated?             | CG14             |
| Are practical investigations provided?               | CG14-<br>CG15    |
| Is there support for the depth study?                | CG18             |
| How can I provide differentiation?                   | CG19             |
| How do I evaluate student performance?               | CG4, CG20        |
| What types of assessment are there?                  | CG20             |
| How can I set homework?                              | CG21             |

# BIOZONE's Pedagogy

## A worktext approach

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

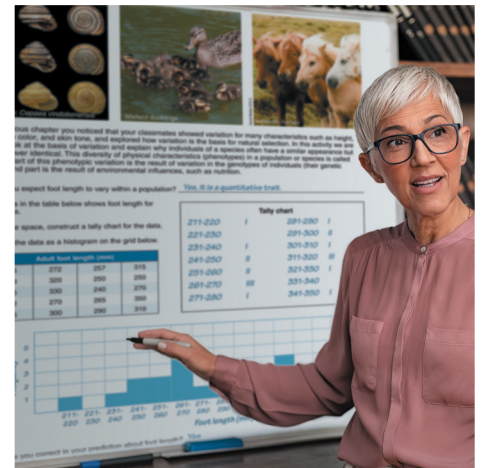
Using a highly graphical approach and short blocks of text, we deliver textbook quality information in an accessible and engaging way, ensuring students are not overwhelmed by large amounts of information. As students interact with the stimulus material and work through activities, they are encouraged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



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

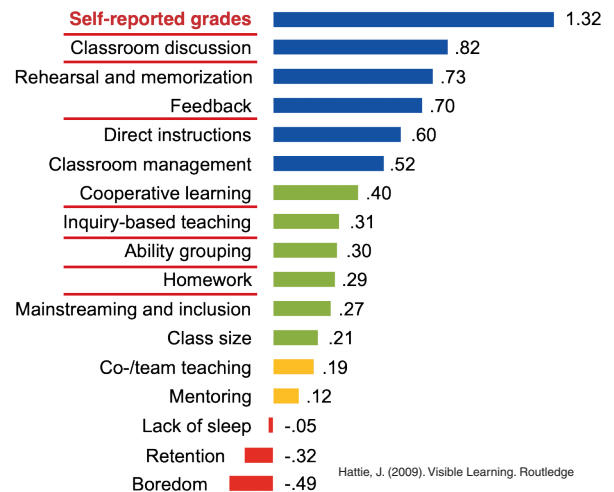
## Not all answers need to be graded!

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



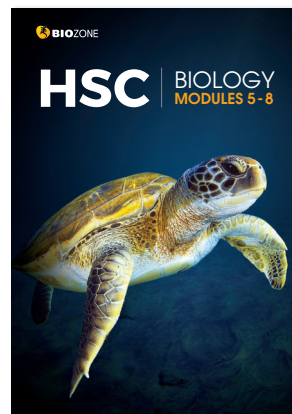
## Features to accelerate student learning

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



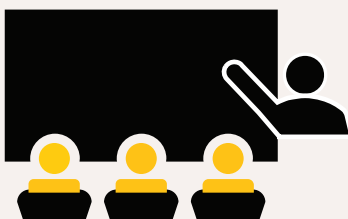
# Meeting Key Competencies

We want today's biology students to be self-motivated, lifelong learners. We want them 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 5-8* 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 work to students 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 5-8*. This will ensure foundation knowledge is covered before students need to apply the information to more complex topics.
- Encourage peer-to-peer learning by assigning students to groups of mixed abilities when carrying out group research projects or practical investigations.
- Activities that manipulate data using formulae may be supported by spreadsheets on **BIOZONE's Resource Hub**. You can tailor how you use the spreadsheets and students can analyse the data sets provided (including graphs) to save time.
- Extend students' scientific vocabulary by encouraging them to look up unfamiliar words in the **glossary** (Appendix 1).
- Use BIOZONE WORLD to introduce an activity and give any direction required. It can be used to review answers in class or on-line quickly and efficiently. Choose when and how you reveal the answers. To promote student discussion, reveal answers only once the students have shared their ideas. Reveal all the answers if you want the students to self mark their own work.



## Assessment

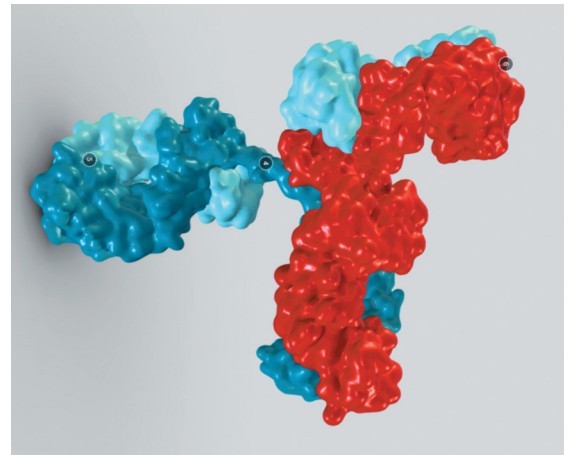
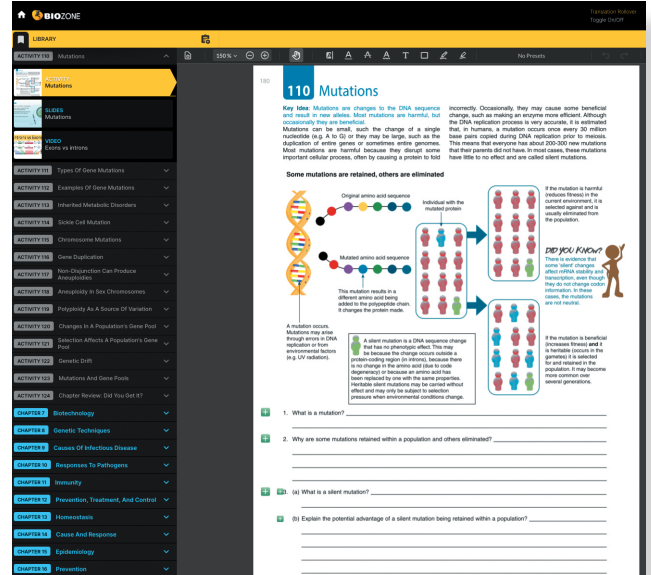
- Provide feedback (formative and summative) to students to update them on their progress. This can highlight areas of strength or areas needing work.
- Use formative assessment to identify areas the class needs to revisit before progressing to the next topic or unit. Methods of formative assessment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

# Teacher Support Materials: Teacher Toolkit

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

## BIOZONE WORLD

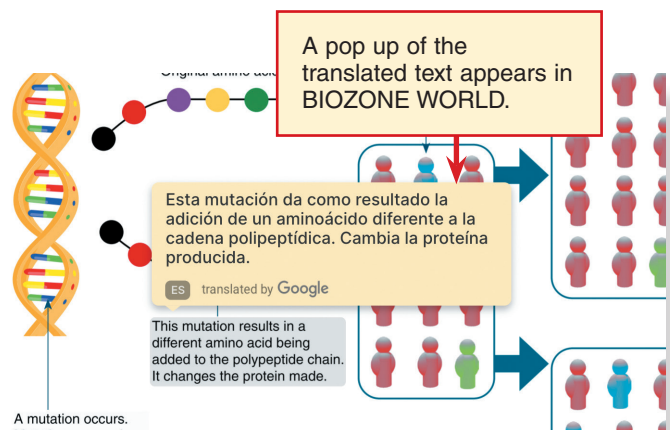
- BIOZONE WORLD, our digital science platform, brings our digital worktexts and rich collection of digital resources together in a single location for easy use. Click on an activity to access the additional resources provided. These include: presentation slides, interactive 3D models, and curated videos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



### Translation function

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

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



## RESOURCE HUB

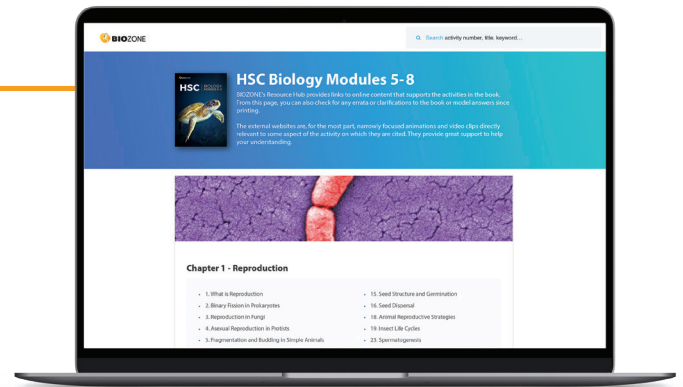
The BIOZONE **Resource Hub** is a **free resource**, available to both students and teachers. It offers a curated collection of Open Educational Resources (OER) specifically chosen to support the content of the worktext. Resources include videos, animations, games, 3D models, spreadsheets, and source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

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

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

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

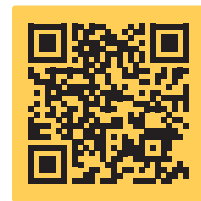
Some material is tagged as a teacher resource. Teacher resources often provide background or additional material to an activity. Capable students, or students with a particular interest in the topic can be assigned this material at your discretion.



[www.BIOZONEhub.com](http://www.BIOZONEhub.com)

Then enter the code  
in the text field

HSC12-1-6559

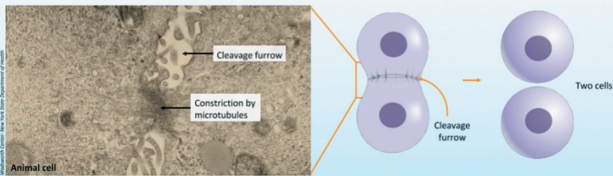


Or scan this QR code

### Cytokinesis in an Animal Cell

Cytokinesis in animal cells begins shortly after the sister chromatids have separated in **anaphase**.

- A ring of microtubules assembles in the middle of the cell, next to the plasma membrane, constricting it to form a cleavage furrow.
- In an energy-using process, the cleavage furrow moves inwards. This forms a region where the two cells will separate.



## PRESENTATION SLIDES

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

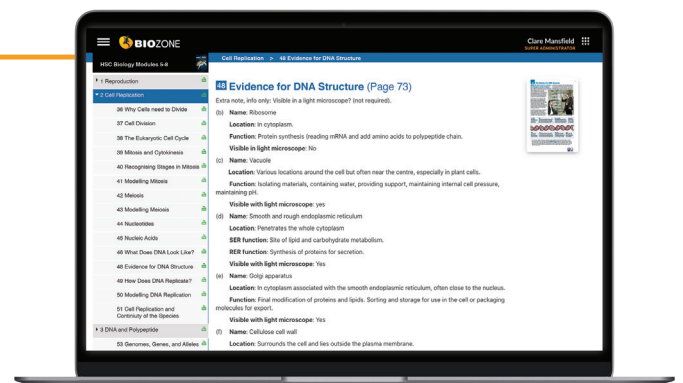
The Presentation Slides are a collection of slides specifically designed to support and enhance the content of the worktext.

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

## ONLINE MODEL ANSWERS

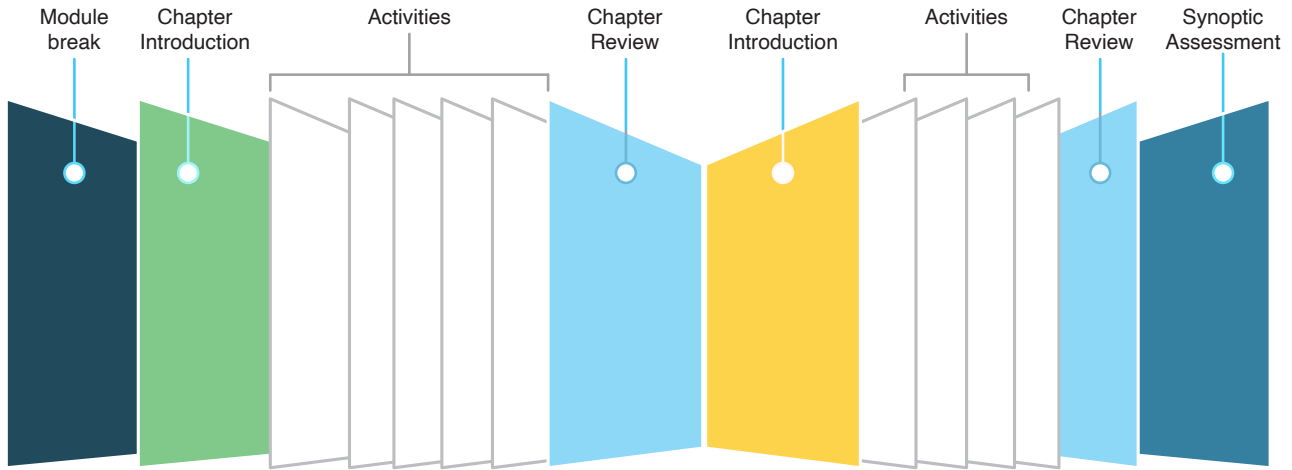
Online Model Answers provide suggested answers to each of the activities, including working where appropriate (e.g. calculations).

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



# Structure of the Worktext

HSC Biology: Modules 5 - 8 has been specifically written to meet the content and skills requirements of the NSW Stage 6 syllabus (Modules 5 - 8). The worktext follows the structure outlined in the Stage 6 syllabus, so it is easy for you to know where you are in the course. The content is organised into 18 chapters, numbered sequentially and nested within their module (below). Module breaks divide the content into sections (the modules) and summarise the student outcomes for each module. Each chapter has an introduction page so you can see the key knowledge and skills requirements for each chapter. The graphic below illustrates the structure of a module and chapters. Use this structure to help navigate through the content.



## Chapter introduction

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

## Activity pages

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

## Chapter review

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

## Synoptic assessment

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

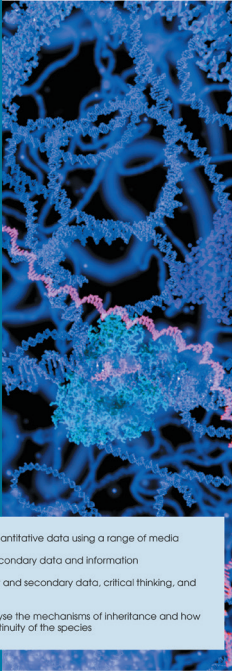
# Module Breaks

The content of the *HSC Biology Modules 5-8* is organised into four sections (modules). The module breaks divide the book into four sections covering related material. This structure provides students with a clear indication of where they are in the course. Each unit break summarises the student outcomes covered in each module, so students have a clear idea of what is coming up.

MODULE

# 05

Heredity



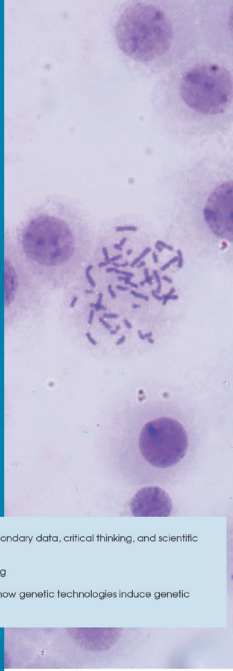
**Student outcomes:**

- ▶ Select and process qualitative and quantitative data using a range of media
- ▶ Analyse and evaluate primary and secondary data and information
- ▶ Solve scientific problems using primary and secondary data, critical thinking, and scientific processes
- ▶ Explain the structure of DNA and analyse the mechanisms of inheritance and how processes of reproduction ensure continuity of the species

MODULE

# 06

Genetic Change



**Student outcomes:**

- ▶ Solve problems using primary and secondary data, critical thinking, and scientific processes
- ▶ Communicate scientific understanding
- ▶ Explain natural genetic change and how genetic technologies induce genetic change

MODULE

# 07

Infectious Disease




**Student outcomes:**

- ▶ Develop and evaluate questions and hypotheses for scientific investigation.
- ▶ Design and evaluate investigations to obtain primary and secondary data.
- ▶ Collect valid and reliable primary and secondary data from an investigation.
- ▶ Select and process qualitative and quantitative data using appropriate media.
- ▶ Analyse the cause, transmission, and management of infectious disease.
- ▶ Understand an organism's response to infectious disease.
- ▶ Understand the role of the human immune system in response to infectious disease.

MODULE

# 08

Non-infectious Disease and Disorders



**Student outcomes:**

- ▶ Analyse and evaluate primary and secondary data and information.
- ▶ Solve scientific problems using primary and secondary data, critical thinking skills, and scientific processes.
- ▶ Communicate scientific understanding using suitable language and terminology.
- ▶ Explain non-infectious disease and disorders, and describe a range of technologies and methods used to assist, control, prevent, and treat non-infectious diseases.



# 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 do 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  
 Using the Tab System .....viii  
 Using BIOZONE's Resource Hub .....ix  
 Practical Investigations .....x  
 Support for Depth Studies .....xi  
 Answering Exam Questions.....xii

|                                     |   |  |
|-------------------------------------|---|--|
| <input type="checkbox"/>            | 45 Nucleic Acids .....67                                  |  |
| <input checked="" type="checkbox"/> | 46 What Does DNA Look Like? .....69                       |  |
| <input checked="" type="checkbox"/> | 47 Creating a DNA Model .....70                           |  |
| <input type="checkbox"/>            | 48 The Evidence of DNA Structure.....73                   |  |
| <input type="checkbox"/>            | 49 How Does DNA Replicate? .....74                        |  |
| <input type="checkbox"/>            | 50 Modelling DNA Replication .....76                      |  |
| <input type="checkbox"/>            | 51 Cell Replication and the Continuity of Species .....79 |  |

### MODULE 5: Heredity

**Chapter 1: Reproduction**

|                                     |   |
|-------------------------------------|---|
| <input type="checkbox"/>            | 1 What is Reproduction?.....3                       |
| <input type="checkbox"/>            | 2 Binary Fission in Prokaryotes .....4              |
| <input type="checkbox"/>            | 3 Reproduction in Fungi.....5                       |
| <input type="checkbox"/>            | 4 Reproduction in Plants.....8                      |
| <input type="checkbox"/>            | 5 Reproduction in Animals.....8                     |
| <input type="checkbox"/>            | 6 Asexual Reproduction in Plants.....9              |
| <input checked="" type="checkbox"/> | 7 Investigation into Plant Propagation.....11       |
| <input type="checkbox"/>            | 8 Features of Plant Sexual Reproduction .....12     |
| <input type="checkbox"/>            | 9 Reproduction in Ferns.....13                      |
| <input type="checkbox"/>            | 10 Reproduction in Angiosperms.....14               |
| <input type="checkbox"/>            | 11 Reproduction in Gymnosperms .....15              |
| <input type="checkbox"/>            | 12 Insect Pollination .....16                       |
| <input type="checkbox"/>            | 13 Wind Pollination .....18                         |
| <input type="checkbox"/>            | 14 Pollination and Fertilisation .....20            |
| <input checked="" type="checkbox"/> | 15 Seed Structure and Germination .....22           |
| <input type="checkbox"/>            | 16 Seed Dispersal.....24                            |
| <input type="checkbox"/>            | 17 Animal Sexual Reproduction.....25                |
| <input type="checkbox"/>            | 18 Animal Reproductive Strategies.....27            |
| <input type="checkbox"/>            | 19 Insect Life Cycles.....30                        |
| <input type="checkbox"/>            | 20 Mammalian Reproduction .....32                   |
| <input type="checkbox"/>            | 21 Gestational Development.....33                   |
| <input type="checkbox"/>            | 22 Gametes .....34                                  |
| <input type="checkbox"/>            | 23 Spermatogenesis.....35                           |
| <input type="checkbox"/>            | 24 Oogenesis.....36                                 |
| <input type="checkbox"/>            | 25 The Menstrual Cycle .....37                      |
| <input type="checkbox"/>            | 26 Control of the Menstrual Cycle.....38            |
| <input type="checkbox"/>            | 27 The Placenta.....39                              |
| <input type="checkbox"/>            | 28 Fertilisation and Early Growth.....40            |
| <input type="checkbox"/>            | 29 The Hormones of Pregnancy.....42                 |
| <input type="checkbox"/>            | 30 Birth and Lactation .....43                      |
| <input type="checkbox"/>            | 31 Manipulating Reproduction in Agriculture .....45 |
| <input type="checkbox"/>            | 32 Grafting .....47                                 |
| <input type="checkbox"/>            | 33 Micropropagation .....48                         |
| <input type="checkbox"/>            | 34 Case Study: Cloning in Horticulture .....49      |
| <input type="checkbox"/>            | 35 Chapter Review: Did You Get It? .....51          |

**Chapter 2: Cell Replication**

|   |  |
|---|--|
| <i>Key Skills and Knowledge</i> .....52 |  |
| <input type="checkbox"/>                | 36 Why Cells Need to Divide .....53    |
| <input type="checkbox"/>                | 37 Cell Division .....55               |
| <input type="checkbox"/>                | 38 The Cell Cycle in Eukaryotes.....57 |
| <input type="checkbox"/>                | 39 Mitosis and Cytokinesis .....58     |
| <input type="checkbox"/>                | 40 Meiosis .....60                     |
| <input checked="" type="checkbox"/>     | 41 Modelling Meiosis .....61           |
| <input type="checkbox"/>                | 42 Meiosis .....62                     |
| <input checked="" type="checkbox"/>     | 43 Modelling Meiosis .....64           |
| <input type="checkbox"/>                | 44 Nucleotides .....66                 |

**Chapter 1: Reproduction**

|  |   |
|--|---|
| <i>Key Skills and Knowledge</i> .....1 |   |
| <input checked="" type="checkbox"/>    | 1 What is Reproduction?.....3                       |
| <input checked="" type="checkbox"/>    | 2 Binary Fission in Prokaryotes .....4              |
| <input checked="" type="checkbox"/>    | 3 Reproduction in Fungi.....5                       |
| <input checked="" type="checkbox"/>    | 4 Reproduction in Plants.....8                      |
| <input checked="" type="checkbox"/>    | 5 Reproduction in Animals.....8                     |
| <input type="checkbox"/>               | 6 Asexual Reproduction in Plants.....9              |
| <input type="checkbox"/>               | 7 Investigation into Plant Propagation.....11       |
| <input type="checkbox"/>               | 8 Features of Plant Sexual Reproduction .....12     |
| <input type="checkbox"/>               | 9 Reproduction in Ferns.....13                      |
| <input type="checkbox"/>               | 10 Reproduction in Angiosperms.....14               |
| <input type="checkbox"/>               | 11 Reproduction in Gymnosperms .....15              |
| <input type="checkbox"/>               | 12 Insect Pollination .....16                       |
| <input type="checkbox"/>               | 13 Wind Pollination .....18                         |
| <input type="checkbox"/>               | 14 Pollination and Fertilisation .....20            |
| <input checked="" type="checkbox"/>    | 15 Seed Structure and Germination .....22           |
| <input type="checkbox"/>               | 16 Seed Dispersal.....24                            |
| <input type="checkbox"/>               | 17 Animal Sexual Reproduction.....25                |
| <input type="checkbox"/>               | 18 Animal Reproductive Strategies.....27            |
| <input type="checkbox"/>               | 19 Insect Life Cycles.....30                        |
| <input type="checkbox"/>               | 20 Mammalian Reproduction .....32                   |
| <input type="checkbox"/>               | 21 Gestational Development.....33                   |
| <input type="checkbox"/>               | 22 Gametes .....34                                  |
| <input type="checkbox"/>               | 23 Spermatogenesis.....35                           |
| <input type="checkbox"/>               | 24 Oogenesis.....36                                 |
| <input type="checkbox"/>               | 25 The Menstrual Cycle .....37                      |
| <input type="checkbox"/>               | 26 Control of the Menstrual Cycle.....38            |
| <input type="checkbox"/>               | 27 The Placenta.....39                              |
| <input type="checkbox"/>               | 28 Fertilisation and Early Growth.....40            |
| <input type="checkbox"/>               | 29 The Hormones of Pregnancy.....42                 |
| <input type="checkbox"/>               | 30 Birth and Lactation .....43                      |
| <input type="checkbox"/>               | 31 Manipulating Reproduction in Agriculture .....45 |
| <input type="checkbox"/>               | 32 Grafting .....47                                 |
| <input type="checkbox"/>               | 33 Micropropagation .....48                         |
| <input type="checkbox"/>               | 34 Case Study: Cloning in Horticulture .....49      |
| <input type="checkbox"/>               | 35 Chapter Review: Did You Get It? .....51          |

**Chapter 3: DNA and Genomes**

|                                     |  |
|-------------------------------------|--|
| <i>Key Skills</i> .....53           |  |
| <input type="checkbox"/>            | 53 Genomes .....53                               |
| <input type="checkbox"/>            | 54 Prokaryotic Genomes .....54                   |
| <input type="checkbox"/>            | 55 Plasmid DNA .....55                           |
| <input type="checkbox"/>            | 56 Eukaryotic Genomes .....56                    |
| <input type="checkbox"/>            | 57 What is a Gene? .....57                       |
| <input type="checkbox"/>            | 58 The Gene .....58                              |
| <input type="checkbox"/>            | 59 Transcription .....59                         |
| <input type="checkbox"/>            | 60 mRNA Processing .....60                       |
| <input type="checkbox"/>            | 61 Translation .....61                           |
| <input type="checkbox"/>            | 62 Application of Genetic Knowledge .....62      |
| <input type="checkbox"/>            | 63 Influences on Gene Expression .....63         |
| <input type="checkbox"/>            | 64 Genotype .....64                              |
| <input type="checkbox"/>            | 65 Gene Expression .....65                       |
| <input type="checkbox"/>            | 66 Epigenetics .....66                           |
| <input checked="" type="checkbox"/> | 67 Genes, Environment and Variation .....67      |
| <input type="checkbox"/>            | 68 Amino Acids .....68                           |
| <input type="checkbox"/>            | 69 Separating Chromosomes .....69                |
| <input checked="" type="checkbox"/> | 70 The Hierarchy of Genetic Organisation .....70 |
| <input type="checkbox"/>            | 71 Protein Synthesis .....71                     |
| <input type="checkbox"/>            | 72 Comparing Genomes .....72                     |
| <input type="checkbox"/>            | 73 Protein Folding .....73                       |
| <input type="checkbox"/>            | 74 How Are Proteins Made? .....74                |
| <input type="checkbox"/>            | 75 Chapter Review: Did You Get It? .....75       |

**Chapter 4: Genetic Inheritance**

|                           |   |
|---------------------------|---|
| <i>Key Skills</i> .....77 |   |
| <input type="checkbox"/>  | 77 Alleles .....77  |
| <input type="checkbox"/>  | 78 Probability in Genetics .....125   |
| <input type="checkbox"/>  | 79 Mendel's Laws of Inheritance.....126   |
| <input type="checkbox"/>  | 80 Dominant and Recessive Autosomal Inheritance .....127                            |
| <input type="checkbox"/>  | 81 Basic Genetic Crosses.....128  |
| <input type="checkbox"/>  | 82 Codominance .....129   |
| <input type="checkbox"/>  | 83 Incomplete Dominance .....132  |
| <input type="checkbox"/>  | 84 Lethal Alleles.....133   |
| <input type="checkbox"/>  | 85 Inheritance of Linked Genes .....134   |
| <input type="checkbox"/>  | 86 Recombination and Dihybrid Inheritance .....135                                  |
| <input type="checkbox"/>  | 87 Detecting Linkage in Dihybrid inheritance.....136                                |
| <input type="checkbox"/>  | 88 Testing the Outcome of Genetic Crosses: Chi Squared for Goodness of Fit .....137 |
| <input type="checkbox"/>  | 89 Sex Linkage .....139   |
| <input type="checkbox"/>  | 90 Predicting Genetic Outcomes .....141   |
| <input type="checkbox"/>  | 91 Inheritance Patterns.....143   |

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

© 2022 BIOZONE International

# Introducing the Chapter Content

Each chapter is prefaced with a one page introduction, providing students with an overview of the chapter content and organisation. Each of the numbered learning outcomes pertains to a point of key knowledge or a skill, and is matched to one or more activities. A list of key terms for the chapter is also included. The comprehensive, but accessible, list of learning outcomes encourages students to approach each topic confidently. Familiarity with the scientific terms used in each topic is implicit in this. Encourage your students to use the glossary (Appendix 1) to expand their scientific vocabulary.

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

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

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.

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.

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.

## CHAPTER 3

# DNA and Polypeptide Synthesis

Activity number

Inquiry question: Why is polypeptide synthesis important?

**Chromosomes, genes and genomes**

*Key skills*

- Distinguish and describe
- Describe, explain and investigate

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

Gene expression

*Key skills and knowledge*

- 4 Describe the relationship between the base sequence in mRNA and the order of the amino acids in a polypeptide chain. 57
- 5 Describe the features of the genetic code. Use the genetic code to identify the amino acid sequence produced by a specific DNA sequence. 58
- 6 Describe the steps involved in protein synthesis including transcription, RNA processing (eukaryotic cells), and translation. Identify where in the cell each step occurs. Assess the importance of mRNA and tRNA in transcription and translation. 59-61
- 7 Investigate how gene expression influences phenotype and how investigation of the genes being expressed can be used to treat disease, e.g. cancer. 62

Influence of environment on gene expression

*Key skills and knowledge*

- 8 Describe how genetic make-up (genotype), environmental factors, and epigenetic factors contribute to produce the phenotype of an organism. 63-64-67
- 9 Use examples in both plants and animals to explain how the environment of an organism during or after development can alter the expression of the genotype and produce variable phenotypes. Investigate how phenotypes, including height and weight, have continuous variation. 65-66
- 10 **PRAC** Measuring continuous variation 66

Protein structure and function

*Key skills and knowledge*

- 11 Explain how a polypeptide is synthesised from amino acid monomers. Explain how the properties of amino acids determine how they interact and how these interactions create the hierarchical levels of structure that produce a functional protein. 68-70
- 12 **PRAC** Separating amino acids. 69
- 13 **PRAC** Modelling protein structure 70
- 14 Explain how protein shape is related to function and compare the functional roles of globular and fibrous proteins. Identify and describe the diverse roles of proteins making up an organism's proteome. 71-73
- 15 Describe how proteins are modified after translation for different roles. Interpret diagrams to explain how various organelles are involved in the packaging and export of proteins from the cell. 74

Introduce the concept with a grounding activity

Follow with activities exploring the concept

### 57 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 protein.

**Key Idea:** Eukaryotic genes include non-protein coding regions called introns. These regions of intron DNA must be excised out before the mRNA is translated by the ribosomes.

**Key Idea:** Transcription of the genes and editing the primary transcript to form the mature mRNA occurs in the nucleus. Transcription of the DNA into mRNA and translation of the mRNA into protein by the ribosomes occurs in the cytoplasm.

**A summary of eukaryotic gene expression**

1. What is a gene?

2. What does gene expression mean?

3. What are the three stages in gene expression in eukaryotes and what happens in each stage?

4. The photograph (right) shows an SEM of a giant polytene chromosome. These chromosomes are common in the salivary glands of some insects, which must grow rapidly before changing to the adult form. They form as a result of repeated cycles of DNA replication without cell division. This creates many copies of genes. Within these chromosomes, visible 'puffs' indicate regions where there is active transcription of the genes.

(a) What is the consequence of active transcription in a polytene chromosome?

(b) Why might this be useful in a larval insect?

### 59 Transcription in Eukaryotes

**Key Idea:** Transcription is the first step of gene expression. It involves the enzyme RNA polymerase copying the information in a primary RNA transcript. In eukaryotes, transcription takes place in the nucleus. It takes place in the nucleus and is carried out by the enzyme RNA polymerase. This enzyme reads the DNA into a primary RNA transcript using a single template strand of DNA. The coding process also occurs in the nucleus.

**Transcription is carried out by RNA polymerase (RNAP)**

1. Name the enzyme responsible for transcribing the DNA.

2. What strand of DNA does this enzyme use?

3. The code on this strand is the same as / complementary to / the RNA being formed (circle correct answer).

4. Which nucleotide base replaces thymine in mRNA?

5. On the diagram, use a coloured pen to mark the beginning and end of the protein-coding region being transcribed.

6. In which direction is the RNA strand synthesised?

7. Explain why this is the case.

8. Why is AUG called the start codon?

9. What would the three letter code be on the DNA coding strand?

### 61 Translation

**Key Idea:** Translation is the final stage of gene expression in which ribosomes read the mRNA and convert (translate) it to synthesise a protein. This occurs in the cytoplasm. In eukaryotes, translation occurs in the cytoplasm rather than in ribosomes or ribosomes on the rough endoplasmic reticulum. Ribosomes translate the code carried in the mRNA, releasing the protein.

**Ribosome structure**

Ribosomes are made up of a complex of ribosomal RNA (rRNA) and fibrous proteins. These small cellular structures direct the catalytic steps required for protein synthesis and have specific regions that accommodate transfer RNA (tRNA) molecules loaded with amino acids.

Ribosomes exist as two separate sub-units (large and small) that are attracted to a binding site on the mRNA molecule, when they come together around the mRNA strand.

**tRNA structure**

tRNA molecules are RNA molecules, about 80 nucleotides long, which transfer amino acids to the ribosome to direct the synthesis of a protein. This occurs in the cytoplasm. In eukaryotes, translation occurs in the cytoplasm rather than in ribosomes or ribosomes on the rough endoplasmic reticulum. Ribosomes translate the code carried in the mRNA, releasing the protein.

Protein synthesis begins at the start codon, and, as the ribosome slides along the mRNA strand, the polypeptide chain elongates. On reaching a stop codon, the ribosome subunits dissociate from the mRNA, releasing the protein.

Amino acid attachment site. Enzymes attach the tRNA to their specific amino acids.

Anticodon is a 3-base sequence complementary to the codon on mRNA.

1. Describe the structure of a ribosome.

2. What is the role of each of the following components in translation?

(a) Ribosome

(b) mRNA

(c) Amino acid

(d) Start codon

(e) Stop codon

3. There are many different types of tRNA molecules, each with a different anticodon (3NT: see the mRNA table).

(a) How many different tRNA types are there, each with a unique anticodon?

(b) Explain your answer.

(c) Determine the mRNA codons and the amino acid sequence for the following tRNA anticodons:

tRNA anticodons: U A C U A G C C G C G A U U U

Codons on the mRNA:

Amino acid encoded:

# Structure of an Activity Page

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

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

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

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

194

Mechanisms of Thermoregulation

339

**Key Idea:** The hypothalamus acts as the thermoregulation negative feedback loop. In humans, the temperature regulation centre in the brain called the **hypothalamus**. It contains neurons that monitor core body temperature and maintain it at a set point of 36.7°C. The hypothalamus acts as the body's thermostat. It registers changes in the core body temperature and initiates responses to restore the set point.

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

**Regulating body temperature**

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

**Increased body temperature, e.g. when exercising or in a hot climate.**

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

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

A-1
127 HSC1
📖
🏭
⚙️
🧬

1. In the diagram above showing the regulation of body temperature:
  - (a) Identify the stimulus: \_\_\_\_\_
  - (b) Identify the effectors: \_\_\_\_\_
  - (c) What structure(s) would you expect to be involved in the response? \_\_\_\_\_
2. Label the diagram above with the following terms: \_\_\_\_\_ effectors.
3. How do the effectors restore body temperature when it increases above the set point? \_\_\_\_\_

## 2 Binary Fission in Prokaryotes

**Key Idea:** Binary fission involves division of the parent body into two, fairly equal parts to produce two identical cells. New prokaryotic cells arise through the division of existing cells in a process called **binary fission**. Binary fission is a form of asexual reproduction. It is carried out by most prokaryotes; some eukaryotic organelles, such as chloroplasts; and some unicellular eukaryotes, although the process is different in eukaryotic cells. The time required for a bacterial cell to divide, or for a population of bacterial cells to double, is called the **generation time**. Generation times may be as short as 20 minutes in some species, and as long as several days in others.

**Cell wall forming**  
The cell becomes longer and the chromosome is duplicated.

**Two new cells**  
The growing cell walls meet and two identical cells are formed.

**Most bacteria reproduce asexually by binary fission (left). The cell's DNA is replicated and each copy attaches to a different part of the plasma membrane. When the cell begins to pull apart, the replicated and original chromosomes are separated. Binary fission in bacteria does not involve mitosis or cytokinesis.**

**This bacterium (right) is in the process of binary fission. The arrow shows where a cross wall has formed.**

**This bacterium (left) has completed cell division. The separation between the two cells can be clearly seen (arrow).**

| Generation time (minutes) | Population size |
|---------------------------|-----------------|
| 0                         | 1               |
| 20                        | 2               |
| 40                        | 4               |
| 60                        | 8               |
| 80                        |                 |
| 100                       |                 |
| 120                       |                 |
| 140                       |                 |
| 160                       |                 |
| 180                       |                 |
| 200                       |                 |
| 220                       |                 |
| 240                       |                 |
| 260                       |                 |
| 280                       |                 |
| 300                       |                 |
| 320                       |                 |
| 340                       |                 |
| 360                       |                 |

- What is binary fission?  
\_\_\_\_\_
- Explain why the formation of the cross wall is important in binary fission.  
\_\_\_\_\_
- Explain the term, generation time:  
\_\_\_\_\_
- A species of bacteria reproduces every 20 minutes. Complete the table (left) by calculating the number of bacteria present at 20 minute intervals:
- State how many bacteria were present after:
  - 1 hour: \_\_\_\_\_
  - 3 hours: \_\_\_\_\_
  - 6 hours: \_\_\_\_\_

© 2022 BIOZONE International  
ISBN: 978-1-98-856653-9  
Photocopying Prohibited

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



## Using the Tab System

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

**Green tabs link to related content.**

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








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

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




**Purple tabs identify cross-curriculum priorities.**

**Blue tabs indicate the general capabilities covered within the activity.**




## General capabilities

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





## Cross-curriculum priorities

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

## Other learning across curriculum areas

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

## Other tabs

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

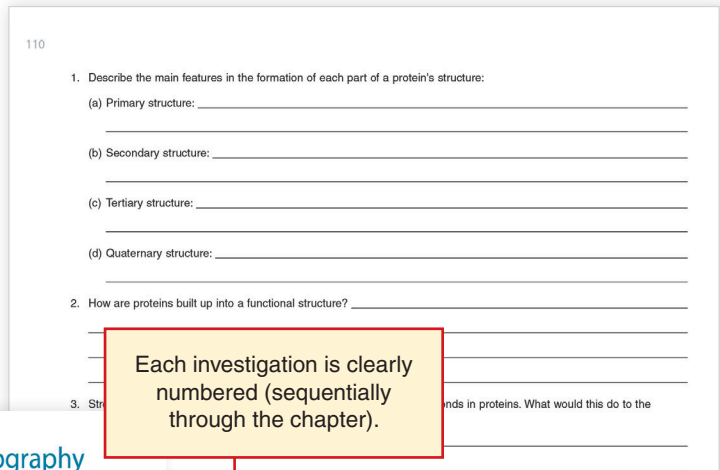
# Support for Science Skills and Practical Investigations

The *Working Scientifically Skills* (right) are well supported throughout the worktext. Throughout the HSC Biology course, students practise these skills by applying them in practical situations. Regular practise helps students become proficient in using these skills when they encounter them in assessments.

Practical investigations and hands-on activities appear in context throughout the worktext. The practical investigations provide opportunities for students to develop many 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 (see next page).

| WORKING SCIENTIFICALLY SKILLS   |
|---------------------------------|
| Questioning and predicting      |
| Planning Investigations         |
| Conducting Investigations       |
| Processing Data and Information |
| Analysing Data and Information  |
| Problem Solving                 |
| Communicating                   |

- ▶ 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.
- ▶ A list of the equipment and chemicals required for each investigation is provided in the appendix.
- ▶ Only standard equipment commonly found in high school laboratories or classrooms is used. No special kits are required.



This icon indicates group work.

## Separating Amino Acids by Chromatography

**Key Idea:** Amino acids can be separated and identified using chromatography. There are twenty essential amino acids used by the body to make proteins. Because each amino acid has a different chemical size and shape, they can be separated using thin layer chromatography. In thin layer chromatography, the mobile phase is the solvent which will separate the molecules. 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 3.2 Separating amino acids**

See appendix for equipment list.

**Hazard:** Do not handle the chromatography to avoid contaminating it. Solvents and ninhydrine solution should be used in a fume hood. You should wear protective eyewear and gloves.

- Wear safety gloves and goggles during this investigation.
- Cut a piece of filter paper or chromatography paper into a strip 5-6 cm wide. It should be long enough to reach from the top of the beaker to the bottom and 1 cm wide.

**Chromatography set up:** A diagram showing a beaker containing a solvent solution. A strip of chromatography paper is suspended from a pencil or bamboo stick across the top of the beaker. The bottom of the paper is in the solvent. A small amount of amino acid solution is placed on the paper near the bottom. Labels include: Beaker, Amino acid, Pencil line, Chromatography solution, Clingwrap (prevents chromatography solution evaporating), and Pencil or bamboo stick.

- Place the unknown solution on the fourth dot. Record the position, starting from the bottom.
- Place the unknown solution on the fourth dot. Record which amino acid was placed on which dot.
- Measure the distance from the start position to each amino acid spot and record.
- Measure the distance from the start position to the solvent front and record.
- In a fume hood, pour the solvent solution into a beaker to a depth of just over 1 cm. Set up the chromatography paper as in the diagram on the right.
- Cover the solution with parafilm or clingwrap and leave for up to an hour or until the solvent front is about 1 cm from the top of the chromatography paper.
- In a fume hood, remove the paper and mark the solvent front with a pencil. Dry with a hair dryer. Pour the solvent into the waste container provided by your teacher.
- In a fume hood, spray the chromatography paper with ninhydrin solution and dry with a hair dryer on heat for about 5 minutes. The spots of amino acid should become visible. Alternatively, the positions of the amino acids can be viewed with a black light.
- Identify the unknown amino acid. Measure the distance from the start position to each amino acid and record. Measure the distance from the start position to the solvent front and record.

Hazards, where applicable, are clearly identified on the investigation.

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

**Investigation 3.3 Modelling protein structure**

equipment list:  
10 pipe cleaners with four colours. We have used 2 white, 2 purple, and 4 blue but you can use the colours you have. Each colour represents a different amino acid.

1. Twist the pipe cleaners in the centre of each pipe cleaner (Figure 1). The twist represents the amino acid's functional group.

2. Join the amino acids together (Figure 2) by twisting their arms together in the following sequence: white 3) blue 4) purple 5) blue 6) pink 7) blue 8) white 9) blue 10) purple.

3. What type of protein organisation does the structure in Figure 2 represent?

4. Label the primary, secondary, tertiary and quaternary structure of the protein. Label the places where hydrogen bonding can occur.

**Figure 1:** A diagram showing a single pipe cleaner twisted at its center.

**Figure 2:** A diagram showing multiple pipe cleaners twisted together to form a complex protein structure.

The investigations have been designed using everyday materials and equipment easily found in most high school laboratories. **No special kits are required.**

$$R_f = \frac{\text{Distance travelled by spot (from start position)}}{\text{Distance travelled by solvent (from start position)}}$$

©2022 BIOZONE International  
ISBN: 978-1-98-856655-9  
Photocopying Prohibited

122 **158 Testing Food for Microbes**

**Key Idea:** Testing food for the presence of dangerous microbes ensures the food we consume is safe. Food poisoning (foodborne poisoning) occurs when a person consumes food or water contaminated with a pathogen and becomes sick. Food poisoning is quite common, affecting 4.1 million Australians each year. Sometimes the illness is so severe a person needs to be hospitalised, and every year 80 people die from food poisoning. In Australia, food and beverages must meet strict testing guidelines to make sure the food is safe from microbial contamination. However, contamination can still occur. Sometimes this is the result of poor manufacturing, transport, or storage processes from the manufacturer or supplier, but most often it occurs due to poor food handling techniques at home. In this activity you will design and carry out a practical investigation to test for microbial contamination in food.



Sometimes it is easy to tell when food has been contaminated and shouldn't be eaten, like the spoiled jam, above left. However, most food contaminated with microbes is not so obvious, and people eat contaminated food and become sick. High risk foods include chicken, seafood, rice, egg, deli meats, and dairy products.

**Investigation 9.1 Investigating microbial contamination in food samples**

See appendix for equipment list.

**⚠️ ⚠️ ⚠️** Treat all samples and equipment as though they contain pathogenic microorganisms. Wear protective eyewear and gloves. Wash surfaces and your hands thoroughly.

Design and carry out a practical investigation to determine the level of microbial contamination present in food samples. You may work in pairs or groups.

- Decide what food you want to test (e.g. milk, meat, yoghurt, etc).
- Decide if you want to test the food simply for microbial contamination or do you want to do a comparative study. Comparative studies include comparing microbial content of:
  - Refrigerated food or food left at room temperature
  - Cooked versus uncooked food
  - Food handled with unwashed hands vs washed hands
- Design your own investigation using the following equipment list: food sample, agar plates, inoculation loops, Bunsen burner, sterilising autoclave, test tubes, glass rods, distilled water, tape, marker pens, incubator (if available). You may want to carry out some research to help you design your investigation. At the end of the investigation you should be able to count the number of fungal and bacterial colonies to determine the level of contamination. NOTE: It is important to exclude any environmental microbial contamination (e.g. from the air or your hands) when you carry out your investigation. Some information on aseptic technique is provided at the top of the next page.
- Use the space below to plan your investigation. Use extra paper and staple it to this page if you need it.



© 2022 BIOZONE International  
ISBN 978-1-927309-4-4  
Photocopying Prohibited

69 **46 What Does DNA Look Like?**


**Key Idea:** Strands of DNA can be extracted from any cells, but those with large amounts of DNA and large chromosomes produce the best results. In a lab, scientists usually use extraction kits to separate DNA from cells. These kits contain all the parts needed to accurately separate the DNA, but in general they are all based on the same technique. This includes breaking open the cells, precipitating the DNA, and removing contaminants. In a classroom, DNA is usually extracted by precipitating it out of solution using the cold ethanol. It is good to use strawberries for this method because they are plentiful (have 8 sets of chromosomes) and their colour makes it easy to see the precipitating DNA. However, other fruits and vegetables such as kiwifruit, bananas, and broccoli can also be used.

**Investigation 2.3 Extracting DNA**

See appendix for equipment list.

Work in pairs for this activity.

- Take 5-6 strawberries and place them in a large zip-lock bag. Squash the strawberries into a smooth paste. This mechanically breaks up the cells, but does not release the DNA.
- To release the DNA add 100 mL of water, 5 mL of detergent, and a pinch of salt to the paste. Reseal the bag and mix the contents by squeezing and crushing the bag. The detergent breaks down the cellular membranes and disintegrates tissues, which releases the DNA. The salt helps to remove the proteins bound to the DNA and keeps them in solution. Their role in the salt also neutralises the negative charge of the DNA.
- Place a piece of filter paper in a funnel and position the funnel in the excess fluid can drain into a beaker. Pour the contents of the bag into the filter funnel and allow it to drain. It should produce a clear reddish solution (fruit).
- Gently add the ethanol on top of the strawberry solution by placing a clean glass rod into the beaker and carefully pouring the ethanol down the rod. Add ethanol until there are equal volumes of strawberry solution and ethanol.
- ethanol removes the water from around the DNA so it precipitates where the ethanol and the solution meet, forming whitish glue-like strands. Low temperatures speed up the precipitation and limit these activities.
- The DNA strands can be centrifuged with ethanol to isolate the DNA as a pellet.



- In the extraction and isolation of DNA:
  - Why is it necessary to disrupt the cellular membranes?
  - Why does the DNA precipitate out in ethanol?
  - For a DNA extraction, why is it helpful that strawberries are octoploid?
  - Why is salt added?
- In a DNA extraction, student A obtained DNA in long threads, whereas student B obtained DNA that appeared fluffy. Account for the differences in these two results and suggest what student B might have done incorrectly.

© 2022 BIOZONE International  
ISBN 978-1-927309-4-4  
Photocopying Prohibited

70 **47 Creating a DNA Model**

**Key Idea:** Nucleotides pair according to the base pairing rules. 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 pair together in a predictable way, referred to as the **base pairing rules**. The strands of the DNA are antiparallel (they run in opposite directions) and there are 10 base pairs per 3.4 nm turn of the helix. The activity below will guide you through constructing a three dimensional model of DNA.

**DO YOU KNOW?**

**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 ratios between species were equal when he looked at the percentage of A and T bases and equal and the percentage of G and C bases were equal. Watson and Crick's base pairing rules were the basis of Watson and Crick's base pairing in the DNA double helix model.

| DNA base pairing rules |                   |          |        |
|------------------------|-------------------|----------|--------|
| 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 |

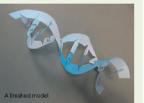
**Investigation 2.4 Creating a model of a DNA molecule**

See appendix for equipment list.

Work in pairs for this activity.

- Cut out the opposite page. Cut out the template strand. Don't break lines should be cut. Make a slight fold on the red dashed lines so that the grey surfaces are facing (or rather 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 (left) 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 bases are 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)     | Cytosine (C)         |
| Thymine (T)     | Adenine (A)          |
| Adenine (A)     | Thymine (T)          |
| Adenine (A)     | Thymine (T)          |
| Thymine (T)     | Adenine (A)          |
| Adenine (A)     | Thymine (T)          |
| Cytosine (C)    | Guanine (G)          |
| Guanine (G)     | Cytosine (C)         |



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

© 2022 BIOZONE International  
ISBN 978-1-927309-4-4  
Photocopying Prohibited

Some 'practical' activities give students a place to develop their skills in planning and designing an experiment. They then carry out the investigation they have designed.

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

Practical investigations may involve setting up and carrying out an experiment, or could involve a paper practical (above) or modelling activity.

**Equipment lists**

- ▶ Equipment lists for each investigation are provided in Appendix 2 at the back of the book.
- ▶ Use these lists to plan and prepare the required equipment for each practical investigation.
- ▶ The investigations use materials commonly found in most high school laboratories and classrooms.

400 **A-2 Appendix 2: Equipment List**

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

|   |   |   |
|---|---|---|
| <p><b>1: Reproduction</b></p> <p><b>INVESTIGATION 1.1 Plant propagation</b></p> <p>Per student/pair</p> <ul style="list-style-type: none"> <li>9 x plant/seed containers or trays <li>3 x potting mediums (e.g. sand, bark, potting mix) <li>Rooting hormone <li>9 x ice block sticks <li>Secateurs or scissors</li> <li>Measuring flask or container for water</li> </li></li></li></li></ul> <p><b>INVESTIGATION 1.2 Germination investigation</b></p> <p>4 x plant/seed trays</p> <ul style="list-style-type: none"> <li>4 x sets of 100 tomato seeds or similar (e.g. mustard seeds)</li> <li>Sterilised growing medium</li> <li>Measuring flask or container for water</li> </ul> <p><b>2: Cell Replication</b></p> <p><b>INVESTIGATION 2.1 Modelling mitosis</b></p> <p>String</p> <ul style="list-style-type: none"> <li>4 x pipe-cleaners (2 colors) cut in half</li> <li>A3 sheet of paper</li> <li>Marker</li> </ul> <p><b>INVESTIGATION 2.2 Modelling meiosis using ice block sticks</b></p> <p>Per student/pair</p> <ul style="list-style-type: none"> <li>6 x 500 mL beakers</li> <li>Balance and equipment to weigh sugar</li> <li>Table sugar or lab sucrose</li> <li>Potato</li> <li>Cork borer or scalpel</li> <li>Paper towels</li> <li>Marker pen</li> </ul> <p><b>INVESTIGATION 2.3 Extracting DNA</b></p> <p>Per pair</p> <ul style="list-style-type: none"> <li>5 - 6 strawberries</li> <li>1 large zip-lock bag</li> <li>100 mL water</li> <li>5 mL detergent</li> <li>pinch of salt</li> <li>1 x filter paper</li> <li>1 x glass filter funnel</li> <li>1 x 250 mL glass beaker</li> <li>1 x glass rod</li> <li>100 mL ethanol (for rinsing)</li> <li>2 x centrifuge tubes</li> <li>Centrifuge</li> </ul> | <p><b>INVESTIGATION 2.4 Creating a model of a DNA molecule</b></p> <p>Per pair</p> <ul style="list-style-type: none"> <li>Scissors</li> <li>Tape or paste</li> </ul> <p><b>3: DNA and Polypeptide Synthesis</b></p> <p><b>INVESTIGATION 3.1 Measuring continuous variation</b></p> <p>Per pair</p> <ul style="list-style-type: none"> <li>Measuring tape or scales</li> <li>Graph paper</li> </ul> <p><b>INVESTIGATION 3.2 Separating amino acids</b></p> <p>Per student/pair</p> <ul style="list-style-type: none"> <li>Pencil</li> <li>Clingwrap or parafilm</li> <li>Scissors</li> <li>1% amino acid solutions (leucine, lysine, glycine).</li> <li>Chromatography solution (butan-2-ol, glacial ethanoic acid, water in ratio 6:1.5:2)</li> <li>Ninhydrin spray or black light</li> <li>Nitrile gloves</li> </ul> <p><b>INVESTIGATION 3.3 Modelling protein structure</b></p> <p>Per student/pair/group</p> <ul style="list-style-type: none"> <li>Pipe cleaners (2 white, 2 pink, 2 purple, 4 blue)</li> <li>Sticky tape</li> <li>2 x binder clips or paper clips</li> </ul> <p><b>4: Genetic Variation</b></p> <p><b>INVESTIGATION 4.1 Measuring continuous variation</b></p> <p>Computer with spreadsheeting programme e.g. Excel.</p> | <p><b>6: Mutation</b></p> <p><b>INVESTIGATION 6.1 Investigating natural selection</b></p> <p>Per student</p> <ul style="list-style-type: none"> <li>Computer</li> <li>Spreadsheet application (e.g. Excel)</li> </ul> <p><b>INVESTIGATION 6.2 Modelling genetic drift</b></p> <p>Per student</p> <ul style="list-style-type: none"> <li>Computer</li> <li>Spreadsheet application (e.g. Excel)</li> </ul> <p><b>9: Causes of Infectious Disease</b></p> <p><b>INVESTIGATION 9.1 Investigating microbial contamination in food samples</b></p> <p>Per student or group</p> <ul style="list-style-type: none"> <li>Food sample</li> <li>Agar plates</li> <li>Inoculation loops</li> <li>Bunsen burner</li> <li>Sterilising alcohol</li> <li>Test tubes</li> <li>Glass rods</li> <li>Distilled water</li> <li>Tape</li> <li>Marker pens</li> <li>Incubator</li> </ul> <p><b>12: Prevention, Treatment and Control</b></p> <p><b>INVESTIGATION 12.1 Investigating the effectiveness of handwashing</b></p> <p>Per class</p> <ul style="list-style-type: none"> <li>Warm water</li> <li>Soup</li> <li>Hand sanitiser</li> </ul> <p>Per individual</p> <ul style="list-style-type: none"> <li>1 x nutrient agar plates</li> <li>Marker pen</li> <li>Paper towels</li> <li>Incubator (if using)</li> </ul> <p><b>INVESTIGATION 12.2 Modelling disease outbreak and spread</b></p> <p>Per pair</p> <ul style="list-style-type: none"> <li>Computer</li> <li>Spreadsheet application (e.g. Excel)</li> </ul> |
|---|---|---|

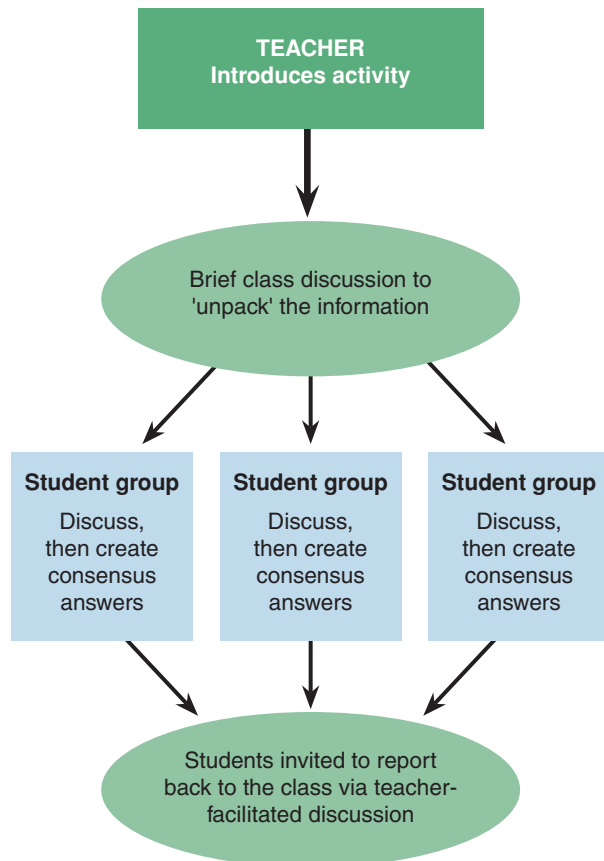
© 2022 BIOZONE International  
Photocopying Prohibited

# 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 5-8* 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.
- Collaborating, listening to others, and voicing their own ideas is valuable for supporting English language learners and developing their English and scientific vocabularies.
- Use a short, informal collaborative learning session to get students to exchange ideas about the answer to a question. Alternatively, collaboration may take a more formal role that lasts for a longer period of time, e.g. assign groups to work together for a practical activity, to research an extension question, or design a solution to a problem.



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



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



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





## Peer to peer support

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

70 **47** **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 |                   |          |       |
|-----------------------|-------------------|----------|-------|
| 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 2.4** Creating a model of a DNA molecule

See appendix for equipment list.  
 Work in pairs for this activity.

1. Cut out the opposite page. Cut out the template strand. Dark
- 2.
- 3.
- 4.
- 5.
6. Continue sticking base pairs together, working your way around the helix, to complete the DNA molecule.
7. 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.

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

**In this activity, students can work together to build a DNA model. This helps students visualise its helical structure.**

A finished model

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

©2022 BIOZONE International  
 ISBN: 978-1-98-856655-9  
 Photocopying Prohibited

310 **180** **The Effectiveness of Hand Washing**

**Key Idea:** Hand washing is one of the most effective ways of preventing the spread of disease. 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 12.1** Investigating the effectiveness of handwashing

See appendix for equipment list.

1. The class will be divided into thirds. 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!**
2. 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.
3. Then use the marker pen to divide the plate lid into quarters and label them as shown below:

4. 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.

5. (a)

| Your 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:

©2022 BIOZONE International  
 ISBN: 978-1-98-856655-9  
 Photocopying Prohibited

## Collaboration and discovery

- BIOZONE's *HSC Biology Modules 5-8* 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 5-8* builds student understanding by providing a range of activities. These include getting students to think about and share what they already know and then build on this knowledge by exploring and explaining phenomena.



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

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

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

## Interactive revision of tasks in class

Review answers in class via BIOZONE WORLD

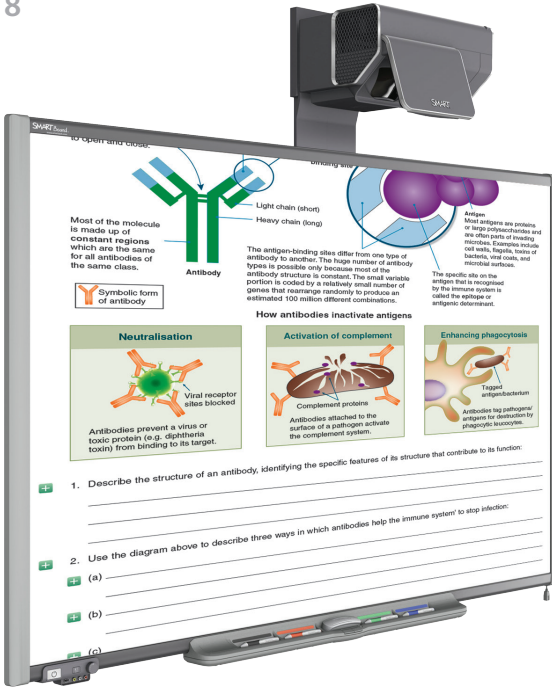
The teacher view in BIOZONE WORLD has model answers which can be toggled on and off using the show/hide buttons on an activity page.

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

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

Students benefit from the feedback in class, where questions can be addressed, and teachers benefit by having students self-mark their work and receive helpful feedback on their responses.

This approach is particularly suited to activities with questions requiring a discussion, as students will be able to clarify some aspects of their responses. Stronger students can benefit by contributing to the explanatory feedback and class discussion.



## Support for the Depth Study

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

Chapter 18 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?

### Critical evaluation of source material

- What types of source material are available?
- Why are some sources of information more trustworthy than others?
- What is the difference between anecdotal evidence and scientific evidence?

### Presenting the findings

- What is the best way to communicate and share the findings of a depth study?
- What structure should be used and when, to deliver the findings?
- How should online resources be referenced?



# Differentiated Learning

Tools for differentiated instruction within *HSC Biology Modules 5-8* help teachers to support students at 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 5-8* in a differentiated classroom:

**56 Eukaryotic Chromosomes**

**Key Idea:** In eukaryotes DNA is stored as linear chromosomes. The DNA in eukaryotes is packaged as discrete linear chromosomes. The number of chromosomes varies from species to species. The extent of DNA packaging changes during the life cycle of the cell, but classic chromosome structures (below) appear during mitosis of somatic cells.

1. Explain why eukaryotic DNA needs to be packaged in this way.

2. How do histone proteins help in the coiling of DNA?

3. Suggest why a cell coils up its chromosomes into chromosomes.

4. Explain how the packaging of DNA in an organized way enables regular regulation of gene expression.

**69 Separating Amino Acids by Chromatography**

**Key Idea:** Amino acids can be separated and identified using chromatography. There are twenty essential amino acids used by the body to make proteins. Because each amino acid has a different chemical side and shape, they can be separated using thin layer chromatography. In this layer chromatography, the mobile phase is the solvent which will separate the molecules. 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 3.2 Separating amino acids**

**Group symbol:** Do not handle the chromatography to avoid contamination. It. Solvents and nitroprusside solution should be used in a fume hood. You should wear protective eyewear and gloves.

1. Wear safety goggles and a lab coat.

2. Cut a piece of paper (e.g. Whatman No. 1) into a strip 5-6 cm wide and 10 cm long. Fold the top edge of the paper to form a 'U' shape. Use a pencil to draw a horizontal line across the paper 1 cm from the bottom edge. This is the start line. Use a water-soluble ink to draw a vertical line across the paper 1 cm from the left edge. This is the solvent front line.

3. In a fume hood, pour the solvent to a depth of 1 cm from the bottom edge of the chromatography paper.

4. Cover the solution with parafilm to prevent evaporation and leave for up to an hour or until the solvent front is about 1 cm from the top of the chromatography paper.

5. In a fume hood, remove the paper and mark the solvent front with a pencil. Dry with a hair dryer or the solvent in the mobile chamber provided by your teacher.

6. In a fume hood, spray the chromatography paper with ninhydrin solution and dry with a hair dryer or heat for about 5 minutes. The spots of amino acid should become visible. Alternatively, the positions of the amino acids can be viewed with a black light.

7. Identify the unknown amino acid. Measure the distance from the start position to each amino acid and record. Measure the distance from the start position to the solvent front and record.

1. What was the unknown amino acid?

2. Use the formula below to calculate the  $R_f$  values for the amino acids you used. Each amino acid has its own  $R_f$  value.  $R_f$  values can be used to identify unknowns in reaction solutions.

$$R_f = \frac{\text{Distance travelled by spot (from start position)}}{\text{Distance travelled by solvent (from start position)}}$$

**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, including 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.

**4 Processing and Analysing Data**

**Key Idea:** Raw data can be processed and analysed to help show any patterns or trends in the data. Data collected in the laboratory or field (raw data) usually needs to be processed. This may include tally charts, tables, graphs and calculating percentages. Processed data can be analysed for trends or for any significant differences between groups. Presenting the data graphically (e.g. scatter graphs) can also help identify trends.

**Tally charts and tables**

- Tally charts process measurements into classes and record the number in each class. This is a useful way to organize data and get an early idea of any trends or patterns.
- Tables provide a way to systematically record and condense a large amount of information. They provide an accurate record of numerical data and allow you to organize and summarize your data.
- Table titles and row and column headings must be clear and accurate. In a table, where only one variable is manipulated, the independent variable is recorded in the left column, with control values at the top and one for each treatment. Calculations such as area and summary statistics (such as mean or standard deviation) may be included on a table.
- Summary statistics make it easier to identify trends and compare different treatments. Tables can be used in making multiple data sets comparable. A 2 x 2 recordings were made over different time periods.

**Table 1: Tally chart of size classes of pods from straws A**

| Size class (mm) | Tally | # |
|-----------------|-------|---|
| 0-4.9           |       | 3 |
| 5.0-9.9         |       | 5 |
| 10.0-14.9       |       | 5 |
| 15.0-19.9       |       | 5 |
| 20.0-24.9       |       | 4 |

**Table 2: Mass (g) of radish plant roots under six different concentrations of data given to 10g**

| Fertiliser concn (g/L) | Sample 1 | Sample 2 | Sample 3 | Sample 4 | Sample 5 | Total | Mean  |
|------------------------|----------|----------|----------|----------|----------|-------|-------|
| 0                      | 80.1     | 83.2     | 82.0     | 79.1     | 84.1     | 398.5 | 79.7  |
| 0.06                   | 108.2    | 110.3    | 108.2    | 107.8    | 112.1    | 546.6 | 109.3 |
| 0.12                   | 117.9    | 118.9    | 118.3    | 118.1    | 117.2    | 590.4 | 118.1 |
| 0.18                   | 128.3    | 127.8    | 127.7    | 128.8    | 126.0    | 638.7 | 127.7 |
| 0.24                   | 23.6     | 140.3    | 138.6    | 137.8    | 141.1    | 581.4 | 116.3 |
| 0.30                   | 122.3    | 121.1    | 125.6    | 121.9    | 123.1    | 614.0 | 122.8 |

1. Using evidence from Table 2 above, explain the value in having a sample size (n) of more than 10.

2. A page from a student book is presented (right). Using the data presented, create a tally chart of size classes of 10 mm.

**Size class (mm)** | **Tally** | **Total**

|         |  |   |
|---------|--|---|
| 0-10    |  | 4 |
| 10-20   |  | 5 |
| 20-30   |  | 5 |
| 30-40   |  | 5 |
| 40-50   |  | 5 |
| 50-60   |  | 5 |
| 60-70   |  | 5 |
| 70-80   |  | 5 |
| 80-90   |  | 5 |
| 90-100  |  | 5 |
| 100-110 |  | 5 |
| 110-120 |  | 5 |
| 120-130 |  | 5 |
| 130-140 |  | 5 |
| 140-150 |  | 5 |
| 150-160 |  | 5 |
| 160-170 |  | 5 |
| 170-180 |  | 5 |
| 180-190 |  | 5 |
| 190-200 |  | 5 |

3. What sort of plot is suggested by the tally chart as appropriate for this data?

**140 Engineering for Improvement**

**Key Idea:** The use of recombinant DNA to build a new metabolic pathway can greatly increase the nutritional value of a variety of rice.

**Beta-carotene (β-carotene)** is a precursor to vitamin A which is involved in many functions including vision, immunity, fetal development, and skin health. Vitamin A deficiency is common in developing countries, where up to 10% of children are blind.

**Concept 1**  
Rice plants contain beta-carotene but not in the edible rice endosperm. Engineering a new biosynthetic pathway into the endosperm of rice plants to produce β-carotene is a major goal for rice breeding.

**Concept 2**  
Rice plants contain beta-carotene but not in the edible rice endosperm. Engineering a new biosynthetic pathway into the endosperm of rice plants to produce β-carotene is a major goal for rice breeding.

**The development of golden rice**

Genes for the enzyme **phytyl transferase (PT)** were isolated from the soil bacterium *Erwinia uryzoe*.

PT is needed for the synthesis of the endosperm of rice. This allows rice to produce β-carotene. This allows rice to produce β-carotene.

The transgene (PT) plant is inserted into the rice genome. This allows rice to produce β-carotene. This allows rice to produce β-carotene.

Recombinant DNA is inserted into the rice genome. This allows rice to produce β-carotene. This allows rice to produce β-carotene.

Modified plants are identified by resistance to herbicides.

**A-1 Appendix 1: Glossary**

**active defence**  
Defence mechanism that is activated only when a pathogen has been detected.

**active immunity**  
Immunity resulting from the production of antibodies in response to an antigen.

**adaptive immune response**  
The antigen-specific immune response, responsible for immunological memory.

**agent (of disease)**  
The non-hereditary disease causation, such as bacteria, or alcohol.

**agglutination**  
Agglutination is the clumping of particles.

**antibiotics**  
Species of bacteria commonly used to kill or inhibit the growth of other bacteria. They are used to produce antibiotics.

**antigen**  
A substance that is recognized by the immune system.

**antigen-specific immune response**  
The immune response to a specific antigen.

**antigenic determinant**  
A part of an antigen that is recognized by the immune system.

**antigenic variation**  
The ability of a pathogen to change its surface proteins to avoid the immune system.

**antigenic drift**  
A small change in the surface proteins of a virus, allowing it to evade the immune system.

**antigenic shift**  
A major change in the surface proteins of a virus, allowing it to evade the immune system.

**antigenic variation**  
The ability of a pathogen to change its surface proteins to avoid the immune system.

**antigenic drift**  
A small change in the surface proteins of a virus, allowing it to evade the immune system.

**antigenic shift**  
A major change in the surface proteins of a virus, allowing it to evade the immune system.

**antigenic variation**  
The ability of a pathogen to change its surface proteins to avoid the immune system.

**antigenic drift**  
A small change in the surface proteins of a virus, allowing it to evade the immune system.

**antigenic shift**  
A major change in the surface proteins of a virus, allowing it to evade the immune system.

**antigenic variation**  
The ability of a pathogen to change its surface proteins to avoid the immune system.

**antigenic drift**  
A small change in the surface proteins of a virus, allowing it to evade the immune system.

**antigenic shift**  
A major change in the surface proteins of a virus, allowing it to evade the immune system.

**antigenic variation**  
The ability of a pathogen to change its surface proteins to avoid the immune system.

**antigenic drift**  
A small change in the surface proteins of a virus, allowing it to evade the immune system.

**antigenic shift**  
A major change in the surface proteins of a virus, allowing it to evade the immune system.

**antigenic variation**  
The ability of a pathogen to change its surface proteins to avoid the immune system.

**antigenic drift**  
A small change in the surface proteins of a virus, allowing it to evade the immune system.

**antigenic shift**  
A major change in the surface proteins of a virus, allowing it to evade the immune system.

**antigenic variation**  
The ability of a pathogen to change its surface proteins to avoid the immune system.

**antigenic drift**  
A small change in the surface proteins of a virus, allowing it to evade the immune system.

**antigenic shift**  
A major change in the surface proteins of a virus, allowing it to evade the immune system.

**antigenic variation**  
The ability of a pathogen to change its surface proteins to avoid the immune system.

**antigenic drift**  
A small change in the surface proteins of a virus, allowing it to evade the immune system.

**antigenic shift**  
A major change in the surface proteins of a virus, allowing it to evade the immune system.

**antigenic variation**  
The ability of a pathogen to change its surface proteins to avoid the immune system.

**antigenic drift**  
A small change in the surface proteins of a virus, allowing it to evade the immune system.

**antigenic shift**  
A major change in the surface proteins of a virus, allowing it to evade the immune system.

**antigenic variation**  
The ability of a pathogen to change its surface proteins to avoid the immune system.

**antigenic drift**  
A small change in the surface proteins of a virus, allowing it to evade the immune system.

**antigenic shift**  
A major change in the surface proteins of a virus, allowing it to evade the immune system.

**antigenic variation**  
The ability of a pathogen to change its surface proteins to avoid the immune system.

**antigenic drift**  
A small change in the surface proteins of a virus, allowing it to evade the immune system.

**antigenic shift**  
A major change in the surface proteins of a virus, allowing it to evade the immune system.

**antigenic variation**  
The ability of a pathogen to change its surface proteins to avoid the immune system.

**antigenic drift**  
A small change in the surface proteins of a virus, allowing it to evade the immune system.

**antigenic shift**  
A major change in the surface proteins of a virus, allowing it to evade the immune system.

**antigenic variation**  
The ability of a pathogen to change its surface proteins to avoid the immune system.

**antigenic drift**  
A small change in the surface proteins of a virus, allowing it to evade the immune system.

**antigenic shift**  
A major change in the surface proteins of a virus, allowing it to evade the immune system.

**antigenic variation**  
The ability of a pathogen to change its surface proteins to avoid the immune system.

**antigenic drift**  
A small change in the surface proteins of a virus, allowing it to evade the immune system.

**antigenic shift**  
A major change in the surface proteins of a virus, allowing it to evade the immune system.

**antigenic variation**  
The ability of a pathogen to change its surface proteins to avoid the immune system.

**antigenic drift**  
A small change in the surface proteins of a virus, allowing it to evade the immune system.

**antigenic shift**  
A major change in the surface proteins of a virus, allowing it to evade the immune system.

**antigenic variation**  
The ability of a pathogen to change its surface proteins to avoid the immune system.

**antigenic drift**  
A small change in the surface proteins of a virus, allowing it to evade the immune system.

**antigenic shift**  
A major change in the surface proteins of a virus, allowing it to evade the immune system.

**antigenic variation**  
The ability of a pathogen to change its surface proteins to avoid the immune system.

**antigenic drift**  
A small change in the surface proteins of a virus, allowing it to evade the immune system.

**antigenic shift**  
A major change in the surface proteins of a virus, allowing it to evade the immune system.

**antigenic variation**  
The ability of a pathogen to change its surface proteins to avoid the immune system.

**antigenic drift**  
A small change in the surface proteins of a virus, allowing it to evade the immune system.

**antigenic shift**  
A major change in the surface proteins of a virus, allowing it to evade the immune system.

**antigenic variation**  
The ability of a pathogen to change its surface proteins to avoid the immune system.

**antigenic drift**  
A small change in the surface proteins of a virus, allowing it to evade the immune system.

**antigenic shift**  
A major change in the surface proteins of a virus, allowing it to evade the immune system.

**antigenic variation**  
The ability of a pathogen to change its surface proteins to avoid the immune system.

**antigenic drift**  
A small change in the surface proteins of a virus, allowing it to evade the immune system.

**antigenic shift**  
A major change in the surface proteins of a virus, allowing it to evade the immune system.

**antigenic variation**  
The ability of a pathogen to change its surface proteins to avoid the immune system.

**antigenic drift**  
A small change in the surface proteins of a virus, allowing it to evade the immune system.

**antigenic shift**  
A major change in the surface proteins of a virus, allowing it to evade the immune system.

**antigenic variation**  
The ability of a pathogen to change its surface proteins to avoid the immune system.

**antigenic drift**  
A small change in the surface proteins of a virus, allowing it to evade the immune system.

**antigenic shift**  
A major change in the surface proteins of a virus, allowing it to evade the immune system.

**antigenic variation**  
The ability of a pathogen to change its surface proteins to avoid the immune system.

**antigenic drift**  
A small change in the surface proteins of a virus, allowing it to evade the immune system.

**antigenic shift**  
A major change in the surface proteins of a virus, allowing it to evade the immune system.

**antigenic variation**  
The ability of a pathogen to change its surface proteins to avoid the immune system.

**antigenic drift**  
A small change in the surface proteins of a virus, allowing it to evade the immune system.

**antigenic shift**  
A major change in the surface proteins of a virus, allowing it to evade the immune system.

**antigenic variation**  
The ability of a pathogen to change its surface proteins to avoid the immune system.

**antigenic drift**  
A small change in the surface proteins of a virus, allowing it to evade the immune system.

**antigenic shift**  
A major change in the surface proteins of a virus, allowing it to evade the immune system.

**antigenic variation**  
The ability of a pathogen to change its surface proteins to avoid the immune system.

**antigenic drift**  
A small change in the surface proteins of a virus, allowing it to evade the immune system.

**antigenic shift**  
A major change in the surface proteins of a virus, allowing it to evade the immune system.

**antigenic variation**  
The ability of a pathogen to change its surface proteins to avoid the immune system.

**antigenic drift**  
A small change in the surface proteins of a virus, allowing it to evade the immune system.

**antigenic shift**  
A major change in the surface proteins of a virus, allowing it to evade the immune system.

**antigenic variation**  
The ability of a pathogen to change its surface proteins to avoid the immune system.

**antigenic drift**  
A small change in the surface proteins of a virus, allowing it to evade the immune system.

**antigenic shift**  
A major change in the surface proteins of a virus, allowing it to evade the immune system.

**antigenic variation**  
The ability of a pathogen to change its surface proteins to avoid the immune system.

**antigenic drift**  
A small change in the surface proteins of a virus, allowing it to evade the immune system.

**antigenic shift**  
A major change in the surface proteins of a virus, allowing it to evade the immune system.

**antigenic variation**  
The ability of a pathogen to change its surface proteins to avoid the immune system.

**antigenic drift**  
A small change in the surface proteins of a virus, allowing it to evade the immune system.

**antigenic shift**  
A major change in the surface proteins of a virus, allowing it to evade the immune system.

**antigenic variation**  
The ability of a pathogen to change its surface proteins to avoid the immune system.

**antigenic drift**  
A small change in the surface proteins of a virus, allowing it to evade the immune system.

**antigenic shift**  
A major change in the surface proteins of a virus, allowing it to evade the immune system.

**antigenic variation**  
The ability of a pathogen to change its surface proteins to avoid the immune system.

**antigenic drift**  
A small change in the surface proteins of a virus, allowing it to evade the immune system.

**antigenic shift**  
A major change in the surface proteins of a virus, allowing it to evade the immune system.

**antigenic variation**  
The ability of a pathogen to change its surface proteins to avoid the immune system.

**antigenic drift**  
A small change in the surface proteins of a virus, allowing it to evade the immune system.

**antigenic shift**  
A major change in the surface proteins of a virus, allowing it to evade the immune system.

**antigenic variation**  
The ability of a pathogen to change its surface proteins to avoid the immune system.

**antigenic drift**  
A small change in the surface proteins of a virus, allowing it to evade the immune system.

**antigenic shift**  
A major change in the surface proteins of a virus, allowing it to evade the immune system.

**antigenic variation**  
The ability of a pathogen to change its surface proteins to avoid the immune system.

**antigenic drift**  
A small change in the surface proteins of a virus, allowing it to evade the immune system.

**antigenic shift**  
A major change in the surface proteins of a virus, allowing it to evade the immune system.

**antigenic variation**  
The ability of a pathogen to change its surface proteins to avoid the immune system.

**antigenic drift**  
A small change in the surface proteins of a virus, allowing it to evade the immune system.

**antigenic shift**  
A major change in the surface proteins of a virus, allowing it to evade the immune system.

**antigenic variation**  
The ability of a pathogen to change its surface proteins to avoid the immune system.

**antigenic drift**  
A small change in the surface proteins of a virus, allowing it to evade the immune system.

**antigenic shift**  
A major change in the surface proteins of a virus, allowing it to evade the immune system.

**antigenic variation**  
The ability of a pathogen to change its surface proteins to avoid the immune system.

**antigenic drift**  
A small change in the surface proteins of a virus, allowing it to evade the immune system.

**antigenic shift**  
A major change in the surface proteins of a virus, allowing it to evade the immune system.

**antigenic variation**  
The ability of a pathogen to change its surface proteins to avoid the immune system.

**antigenic drift**  
A small change in the surface proteins of a virus, allowing it to evade the immune system.

**antigenic shift**  
A major change in the surface proteins of a virus, allowing it to evade the immune system.

**antigenic variation**  
The ability of a pathogen to change its surface proteins to avoid the immune system.

**antigenic drift**  
A small change in the surface proteins of a virus, allowing it to evade the immune system.

**antigenic shift**  
A major change in the surface proteins of a virus, allowing it to evade the immune system.

**antigenic variation**  
The ability of a pathogen to change its surface proteins to avoid the immune system.

**antigenic drift**  
A small change in the surface proteins of a virus, allowing it to evade the immune system.

**antigenic shift**  
A major change in the surface proteins of a virus, allowing it to evade the immune system.

**antigenic variation**  
The ability of a pathogen to change its surface proteins to avoid the immune system.

**antigenic drift**  
A small change in the surface proteins of a virus, allowing it to evade the immune system.

**antigenic shift**  
A major change in the surface proteins of a virus, allowing it to evade the immune system.

**antigenic variation**  
The ability of a pathogen to change its surface proteins to avoid the immune system.

**antigenic drift**  
A small change in the surface proteins of a virus, allowing it to evade the immune system.

**antigenic shift**  
A major change in the surface proteins of a virus, allowing it to evade the immune system.

**antigenic variation**  
The ability of a pathogen to change its surface proteins to avoid the immune system.

**antigenic drift**  
A small change in the surface proteins of a virus, allowing it to evade the immune system.

**antigenic shift**  
A major change in the surface proteins of a virus, allowing it to evade the immune system.

**antigenic variation**  
The ability of a pathogen to change its surface proteins to avoid the immune system.

**antigenic drift**  
A small change in the surface proteins of a virus, allowing it to evade the immune system.

**antigenic shift**  
A major change in the surface proteins of a virus, allowing it to evade the immune system.

**antigenic variation**  
The ability of a pathogen to change its surface proteins to avoid the immune system.

**antigenic drift**  
A small change in the surface proteins of a virus, allowing it to evade the immune system.

**antigenic shift**  
A major change in the surface proteins of a virus, allowing it to evade the immune system.

**antigenic variation**  
The ability of a pathogen to change its surface proteins to avoid the immune system.

**antigenic drift**  
A small change in the surface proteins of a virus, allowing it to evade the immune system.

**antigenic shift**  
A major change in the surface proteins of a virus, allowing it to evade the immune system.

**antigenic variation**  
The ability of a pathogen to change its surface proteins to avoid the immune system.

**antigenic drift**  
A small change in the surface proteins of a virus, allowing it to evade the immune system.

**antigenic shift**  
A major change in the surface proteins of a virus, allowing it to evade the immune system.

**antigenic variation**  
The ability of a pathogen to change its surface proteins to avoid the immune system.

**antigenic drift**  
A small change in the surface proteins of a virus, allowing it to evade the immune system.

**antigenic shift**  
A major change in the surface proteins of a virus, allowing it to evade the immune system.

**antigenic variation**  
The ability of a pathogen to change its surface proteins to avoid the immune system.

**antigenic drift**  
A small change in the surface proteins of a virus, allowing it to evade the immune system.

**antigenic shift**  
A major change in the surface proteins of a virus, allowing it to evade the immune system.

**antigenic variation**  
The ability of a pathogen to change its surface proteins to avoid the immune system.

**antigenic drift**  
A small change in the surface proteins of a virus, allowing it to evade the immune system.

**antigenic shift**  
A major change in the surface proteins of a virus, allowing it to evade the immune system.

**antigenic variation**  
The ability of a pathogen to change its surface proteins to avoid the immune system.

**antigenic drift**  
A small change in the surface proteins of a virus, allowing it to evade the immune system.

**antigenic shift**  
A major change in the surface proteins of a virus, allowing it to evade the immune system.

**antigenic variation**  
The ability of a pathogen to change its surface proteins to avoid the immune system.

**antigenic drift**  
A small change in the surface proteins of a virus, allowing it to evade the immune system.

**antigenic shift**  
A major change in the surface proteins of a virus, allowing it to evade the immune system.

**antigenic variation**  
The ability of a pathogen to change its surface proteins to avoid the immune system.

**antigenic drift**  
A small change in the surface proteins of a virus, allowing it to evade the immune system.

**antigenic shift**  
A major change in the surface proteins of a virus, allowing it to evade the immune system.

**antigenic variation**  
The ability of a pathogen to change its surface proteins to avoid the immune system.

**antigenic drift**  
A small change in the surface proteins of a virus, allowing it to evade the immune system.

**antigenic shift**  
A major change in the surface proteins of a virus, allowing it to evade the immune system.

**antigenic variation**  
The ability of a pathogen to change its surface proteins to avoid the immune system.

**antigenic drift**  
A small change in the surface proteins of a virus, allowing it to evade the immune system.

**antigenic shift**  
A major change in the surface proteins of a virus, allowing it to evade the immune system.

**antigenic variation**  
The ability of a pathogen to change its surface proteins to avoid the immune system.

**antigenic drift**  
A small change in the surface proteins of a virus, allowing it to evade the immune system.

**antigenic shift**  
A major change in the surface proteins of a virus, allowing it to evade the immune system.

**antigenic variation**  
The ability of a pathogen to change its surface proteins to avoid the immune system.

**antigenic drift**  
A small change in the surface proteins of a virus, allowing it to evade the immune system.

**antigenic shift**  
A major change in the surface proteins of a virus, allowing it to evade the immune system.

**antigenic variation**  
The ability of a pathogen to change its surface proteins to avoid the immune system.

**antigenic drift**  
A small change in the surface proteins of a virus, allowing it to evade the immune system.

**antigenic shift**  
A major change in the surface proteins of a virus, allowing it to evade the immune system.

**antigenic variation**  
The ability of a pathogen to change its surface proteins to avoid the immune system.

**antigenic drift**  
A small change in the surface proteins of a virus, allowing it to evade the immune system.

**antigenic shift**  
A major change in the surface proteins of a virus, allowing it to evade the immune system.

**antigenic variation**  
The ability of a pathogen to change its surface proteins to avoid the immune system.

**antigenic drift**  
A small change in the surface proteins of a virus, allowing it to evade the immune system.

**antigenic shift**  
A major change in the surface proteins of a virus, allowing it to evade the immune system.

**antigenic variation**  
The ability of a pathogen to change its surface proteins to avoid the immune system.

**antigenic drift**  
A small change in the surface proteins of a virus, allowing it to evade the immune system.

**antigenic shift**  
A major change in the surface proteins of a virus, allowing it to evade the immune system.

**antigenic variation**  
The ability of a pathogen to change its surface proteins to avoid the immune system.

**antigenic drift**  
A small change in the surface proteins of a virus, allowing it to evade the immune system.

**antigenic shift**  
A major change in the surface proteins of a virus, allowing it to evade the immune system.

**antigenic variation**  
The ability of a pathogen to change its surface proteins to avoid the immune system.

**antigenic drift**  
A small change in the surface proteins of a virus, allowing it to evade the immune system.

**antigenic shift**  
A major change in the surface proteins of a virus, allowing it to evade the immune system.

**antigenic variation**  
The ability of a pathogen to change its surface proteins to avoid the immune system.

**antigenic drift**  
A small change in the surface proteins of a virus, allowing it to evade the immune system.

**antigenic shift**  
A major change in the surface proteins of a virus, allowing it to evade the immune system.

**antigenic variation**  
The ability of a pathogen to change its surface proteins to avoid the immune system.

**antigenic drift**  
A small change in the surface proteins of a virus, allowing it to evade the immune system.

**antigenic shift**  
A major change in the surface proteins of a virus, allowing it to evade the immune system.

**antigenic variation**  
The ability of a pathogen to change its surface proteins to avoid the immune system.

**antigenic drift**  
A small change in the surface proteins of a virus, allowing it to evade the immune system.

**antigenic shift**  
A major change in the surface proteins of a virus, allowing it to evade the immune system.

**antigenic variation**  
The ability of a pathogen to change its surface proteins to avoid the immune system.

**antigenic drift**  
A small change in the surface proteins of a virus, allowing it to evade the immune system.

**antigenic shift**  
A major change in the surface proteins of a virus, allowing it to evade the immune system.

**antigenic variation**  
The ability of a pathogen to change its surface proteins to avoid the immune system.

**antigenic drift**  
A small change in the surface proteins of a virus, allowing it to evade the immune system.

**antigenic shift**  
A major change in the surface proteins of a virus, allowing it to evade the immune system.

**antigenic variation**  
The ability of a pathogen to change its surface proteins to avoid the immune system.

**antigenic drift**  
A small change in the surface proteins of a virus, allowing it to evade the immune system.

**antigenic shift**  
A major change in the surface proteins of a virus, allowing it to evade the immune system.

**antigenic variation**  
The ability of a pathogen to change its surface proteins to avoid the immune system.

**antigenic drift**  
A small change in the surface proteins of a virus, allowing it to evade the immune system.

**antigenic shift**  
A major change in the surface proteins of a virus, allowing it to evade the immune system.

**antigenic variation**  
The ability of a pathogen to change its surface proteins to avoid the immune system.

**antigenic drift**  
A small change in the surface proteins of a virus, allowing it to evade the immune system.

**antigenic shift**  
A major change in the surface proteins of a virus, allowing it to evade the immune system.

**antigenic variation**  
The ability of a pathogen to change its surface proteins to avoid the immune system.

**antigenic drift**  
A small change in the surface proteins of a virus, allowing it to evade the immune system.

**antigenic shift**  
A major change in the surface proteins of a virus, allowing it to evade the immune system.

**antigenic variation**  
The ability of a pathogen to change its surface proteins to avoid the immune system.

**antigenic drift**  
A small change in the surface proteins of a virus, allowing it to evade the immune system.

**antigenic shift**  
A major change in the surface proteins of a virus, allowing it to evade the immune system.

**antigenic variation**  
The ability of a pathogen to change its surface proteins to avoid the immune system.

**antigenic drift**  
A small change in the surface proteins of a virus, allowing it to evade the immune system.

**antigenic shift**  
A major change in the surface proteins of a virus, allowing it to evade the immune system.

**antigenic variation**  
The ability of a pathogen to change its surface proteins to avoid the immune system.

**antigenic drift**  
A small change in the surface proteins of a virus, allowing it to evade the immune system.

**antigenic shift**  
A major change in the surface proteins of a virus, allowing it to evade the immune system.

**antigenic variation**  
The ability of a pathogen to change its surface proteins to avoid the immune system.

**antigenic drift**  
A small change in the surface proteins of a virus, allowing it to evade the immune system.

**antigenic shift**  
A major change in the surface proteins of a virus, allowing it to evade the immune system.

**antigenic variation**  
The ability of a pathogen to change its surface proteins to avoid the immune system.

**antigenic drift**  
A small change in the surface proteins of a virus, allowing it to evade the immune system.

**antigenic shift**  
A major change in the surface



# 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.

179

## 109 Mutagens

**Key Idea:** Mutagens are chemical or physical agents that cause a change in the DNA sequence. The natural mutations occur spontaneously in all organisms. The rate at which a gene will undergo change is normally very low, but this rate can be increased by environmental factors such as ionising radiation and mutagenic chemicals.

**Mutagens and effects**

**Ionising radiation**  
High energy radiation in the form of ultraviolet radiation, x-rays, gamma rays and particle emission from radioactive isotopes can penetrate tissue and cause DNA damage. Rates of thyroid cancer increased in areas near Chernobyl after the explosion of the No. 4 reactor. Skin cancer from high exposure to ultraviolet is increasingly common and is most likely to occur in people with fair skinned people at low latitudes are at greatest risk. Safe equipment has reduced the risks to those working with ionising radiation, e.g. radiographers.

**Viruses and microorganisms**  
Some viruses integrate into the human chromosome, upserting genes and triggering cancers. Examples include hepatitis B virus (liver cancer), HIV (Kaposi's sarcoma, Hodgkin's disease), Burkitt's lymphoma, Epstein-Barr virus (B-cell lymphoma), and HPV (cervical cancer). *Aspergillus flavus* is a fungus that produces aflatoxin, a potent liver cancer inducer. Those at higher risk of viral infections include intravenous drug users and those with unsafe sex practices.

**Poisons and irritants**  
Many chemicals interact directly with DNA to trigger cancer (they are carcinogenic). Synthetic and natural examples include organic solvents, e.g. benzene, tobacco tar, formaldehyde, vinyl chlorides, coal tar, some dyes, and nitrates. Those most at risk include workers in the glue, paint, rubber, resin, and leather industries, petrol pump attendants, and those in the coal and other mining industries. Firefighters and those involved in environmental clean-up of toxic spills are at high risk of exposure to mutagens.

**Diet, alcohol and tobacco**  
Diets high in fat, especially fatty, highly preserved meat, slow the passage of food through the gut, giving time for mutagenic agents to form in the lower bowel. High alcohol intake increases the risk of some cancers and increases susceptibility to tobacco-smoking related cancers. Tobacco tars contain at least 17 known carcinogens (cancer inducing mutagenic agents) and cause chronic irritation of the gas exchange system and cause cancer in smokers.

188

## 114 Sickle Cell Mutation

**Key Idea:** The substitution of one nucleotide from T to A with a G results in sickle cell disease. The mutation is autosomal recessive.

Sickle cell disease, including inherited blood disorder caused by producing a faulty beta (β) chain. The disease causes the body...

**Normal red blood cells**  
Each red blood cell (RBC) contains a 270 million haemoglobin molecules. In their normal state, the red blood cells have a flattened disc shape which allows them to squeeze through capillaries to offload their oxygen to tissues.

**The HBB Gene**  
The gene coding for the β-chain of haemoglobin is on chromosome 11 and consists of 438 bases.

**HBB gene**  
First base  
DNA  
Code corresponding to the 1st

This sequence is the beginning β-chain of haemoglobin (excluded mutation involves the substituting gene, causing one amino acid to hydrophobic rather than hydrophilic when deprived of oxygen).

280

## 162 Chapter Review: Did You Get It?

- Describe the difference between a pandemic and an epidemic: \_\_\_\_\_
- The diagram (right) shows a simplified model of disease transmission.
  - Pathogen A spreads very easily between people and its most likely entry route is through a person's nose and mouth. What is pathogen A's most likely mode of transmission?
  - Researchers suspect that a new pathogen (pathogen B) infecting humans may be transferred from bats to humans. What is the name given to diseases which spread from other animals to humans?
  - What would the researchers need to prove in order to confirm their suspicion about the transmission of pathogen B? \_\_\_\_\_
- The diagrams below represent the four common bacterial shapes. Name each shape and provide an example of a bacterial pathogen and disease for each group:
  -  \_\_\_\_\_
  -  \_\_\_\_\_
  -  \_\_\_\_\_
  -  \_\_\_\_\_
- The table below lists some infectious diseases. Complete the table by naming the type of pathogen that causes the disease (bacteria, virus, protist), and the symptoms of the disease. You may need to do some extra research.

| Disease  | Type of pathogen | Symptoms of disease |
|----------|------------------|---------------------|
| Cholera  | (a)              |                     |
| Malaria  | (b)              |                     |
| TB       | (c)              |                     |
| HIV/AIDS | (d)              |                     |
| Smallpox | (e)              |                     |
| Measles  | (f)              |                     |

©2022 BIOZONE International  
ISBN: 978-1-94-85655-9  
Photocopying Prohibited

Introductory activities can be useful to set the scene for a chapter. In this activity, students are introduced to the main categories of mutagens. As they progress through the chapter, students explore how mutagens can cause mutations, and 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 sources of infectious disease to answer the questions. Such activities allow the teacher to address any misconceptions before formal assessment.