

PEARSON
BIOLOGY
QUEENSLAND
STUDENT BOOK



UNITS 3 & 4

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How to use this book

PEARSON BIOLOGY 12 QUEENSLAND STUDENT BOOK

Pearson Biology 12 Queensland student book has been written to the new QCAA Biology 2019 General Senior Syllabus. The book is an easy-to-use resource that covers Units 3 & 4 and comprehensively addresses the skills and assessment requirements.

Explore how to use this book below.

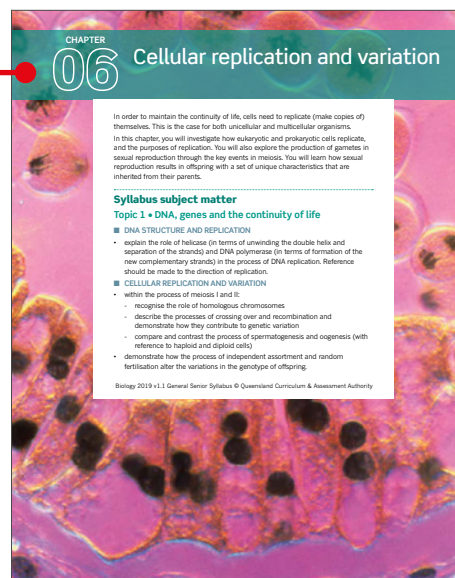
Design

The best-practice literacy and instructional design supports all learners.

A simple to navigate, predictable design enables ease of use. The high-quality, relevant photos and illustrations assist the student understanding of the concepts.

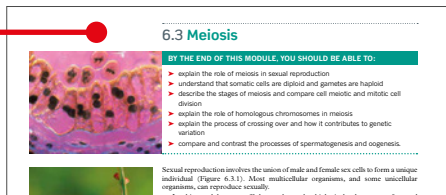
Chapter opener

The syllabus subject matter addressed in each chapter is clearly listed, along with any Science as a human endeavour features and mandatory practicals.



Module opener

Module openers outline the key concepts and skills to be developed and link to the syllabus subject matter listed in the chapter opener.



Science as a human endeavour

The SHE feature provides an opportunity for students to appreciate the development of science and its use and influence on society. The SHE features provide a segue into the development of claims and research questions for the research investigation.



Highlight box

Highlight features focus students' attention on important information such as key definitions, formulas and salient points.

Worked examples

Worked examples use sequential steps of thinking and working to enhance student understanding of subject matter. Each worked example is followed by a try yourself task where students apply their learning to a mirrored problem.

Fully worked solutions to all try yourself problems are available on *Pearson Biology 12 Queensland Teacher Support*.

Case studies

Case studies provide opportunities to engage with current applications and research in biology and address essential syllabus objectives beyond typical learning and understanding conventions. Case studies develop skills in analysing, interpreting, evaluating, decision-making and predicting. Skills are modelled for students in the case studies and then learning is applied in the case study review.

Mandatory practicals

The student book includes all mandatory practicals. Each practical has been trialled and tested to ensure it can be safely performed and yields effective results.

SKILLBUILDER

Converting between units

Often in science you need to know how to convert from one unit to another to complete a calculation. It is important to know the size of different units in relation to each other to avoid errors in calculations. It is important to give a symbol the correct case (upper or lower case)—there is a substantial difference between 1 mm and 1 Mm.

For example, blood concentrations of insulin can be measured in picomoles (pmol). Some studies have measured the amount of insulin in blood after a meal of pasta to be approximately 40 pmol L⁻¹. To 40 pmol L⁻¹ info context, you can convert this value into a unit you can easily visualise, such as grams per litre (g L⁻¹).

First convert 40 pmol L⁻¹ to mol L⁻¹ by moving the decimal 14 places to the left and becomes 0.000 000 000 000 000 mol L⁻¹. This can then be written as 4.0 × 10⁻¹⁴ mol L⁻¹. One mole of insulin weighs 5800 g; therefore, 0.000 000 000 000 000 mol L⁻¹ is equal to 0.000 000 232 g L⁻¹ (or 2.32 × 10⁻⁶ g L⁻¹), which is a very small indeed!

Worked example 1.2.2

CONVERTING BETWEEN UNITS

The rate of photosynthesis is measured in some plants by measuring the change in atmospheric CO₂ in moles per m² of leaf area per second (mol m⁻² s⁻¹ or mol m⁻² s⁻¹). If a plant was measured to photosynthesise CO₂ at a rate of 0.000 025 mol m⁻² s⁻¹, calculate how many bacterial cells you would need to photosynthesise per second, and then per hour.

Thinking	Working
To calculate moles per second, multiply 25 by 10 ⁻⁶ by the multiplying factor for μ (micro).	25 × 0.000 001 = 0.000 025 mol m ⁻² s ⁻¹
To calculate moles per hour, multiply 0.000 025 mol m ⁻² s ⁻¹ by 3600 (because there are 3600 s in an hour).	0.000 025 × 3600 = 0.09 mol m ⁻² h ⁻¹

Try yourself 1.2.2

CONVERTING BETWEEN UNITS

The photosynthetic rate of CO₂ by a plant was measured to be 6.2 μmol m⁻² s⁻¹. Calculate the number of moles of CO₂ that are photosynthesised per square metre per second.

Worked example 1.2.3

CONVERTING BETWEEN UNITS WITH MAGNITUDE

A bacterial culture contains 2 × 10⁷ cells L⁻¹. If you transferred 2 mL of the bacterial culture to an agar plate, calculate how many bacterial cells you transferred. Provide the answer in scientific notation.

Thinking	Working
To convert cells L ⁻¹ to cells mL ⁻¹ , multiply 2 × 10 ⁷ by the multiplying factor for mL (mL).	2 × 10 ⁷ × 0.001 = 2 × 10 ⁴
Multiply 2 × 10 ⁴ cells mL ⁻¹ by 2.	2 × 10 ⁴ × 2 = 4 × 10 ⁴ cells mL ⁻¹

Try yourself 1.2.3

CONVERTING BETWEEN UNITS WITH MAGNITUDE

CASE STUDY 3.1.1

Species interactions in Shark Bay

Shark Bay in Western Australia is the site of the famous Monkey Mia beach. Public interest in this area has stimulated considerable study of the ecology of this area. Studies have been undertaken by the Shark Bay Ecological Research Project of the populations of dolphins, sea turtles, sharks and dugongs, along with the availability of the fish, invertebrates and sea grasses that provide the major food sources of the large vertebrates. Dolphins, sea turtles and dugongs in Shark Bay are also preyed upon by the larger shark species, especially tiger sharks.

At least 24 species of shark inhabit Shark Bay, but by far the most abundant species is the tiger shark. Tiger sharks have a significant effect on the abundance and distribution of species in Shark Bay. Tiger shark numbers in the bay are strongly influenced by seasonal effects. Tiger shark numbers are significantly lower in colder months than in warmer months. For research purposes, tiger sharks are caught and tissue samples are taken before they are released. Far fewer sharks are caught during cold periods of the year (Figure 3.1.19).

Number of tiger sharks (estimated count) caught in Shark Bay WA in different seasons

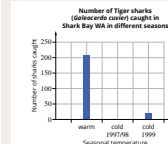


FIGURE 3.1.19 The variation in tiger sharks caught seasonally in Shark Bay, Western Australia.

The activities of a number of species are influenced by the sharks. Dugongs and green turtles both feed on the seagrasses of Shark Bay. The turtles also feed on comb jellies and other invertebrates but the dugongs' diet is almost exclusively seagrass.

Snipping the leaves of the seagrasses causes very little harm to the seagrass population, but when the dugongs dig out the roots for food the population is reduced in size. The impact of the dugongs on both the richness and abundance of the seagrass species can be significant due to their large appetites. Shark Bay contains 12 species of seagrass, belonging to at least three different genera. During the warm summer months, the dugongs feed on seagrasses in the shallow seagrass beds of the bay. Studies have shown that in some areas the dugongs remove up to 50% of the seagrass, resulting in a significant reduction in abundance of these species.

As the seagrasses also shelter other species, providing camouflage and protecting them from predation, this loss is likely to impact on other species present in the bay. The dugongs prefer the rhizomes that form the root system of the seagrass, but will crop the leaves when sharks are around. Rhizomes are a better-quality food source, but digging for them puts the dugongs at greater risk from shark predation as it makes observing sharks more difficult. When sharks are common, the dugongs feed on leaves because it is safer. The studies in Shark Bay also showed that the dugongs tend to feed along the edges of the seagrass fields, close to deep water. In the warmer months, if the dugongs gained deep water, they were likely to escape from an attacking shark.

At the water temperature drops in the winter, the dugongs move to the outer areas of the bay. In these areas the dominant species of seagrass is *Amphibolis antarctica*. This is a less nutritious food source, but the water is warmer than in the shallows. The dugongs are a major food source for tiger sharks and the sharks are most likely to catch dugongs when they are feeding in the shallow seagrass beds during the summer. It has been hypothesised that the dugongs attract the tiger sharks to Shark Bay.

Review

- 1 Explain the dugongs' effect on species abundance and distribution in Shark Bay.
- 2 Identify one biotic and one abiotic difference between the seagrass in Shark Bay in winter and summer.
- 3 Identify two species within Shark Bay that are in competition.
- 4 State one resource that they compete for.
- 5 Name the relationship that exists between comb jellies and turtles.

Skillbuilder

A Skillbuilder outlines a method or technique. Each is instructive and self-contained. Skillbuilders step students through the skill to support science application required when analysing or utilising knowledge.

Module summary

Each module concludes with a summary to help students consolidate the key points and concepts.

3.1 Review

SUMMARY

- Biodiversity can be characterised in three ways: genetic, species, and ecosystem or biome.
- Each biome has its own unique set of physical and climatic characteristics and these determine the species that live there.
- Biodiversity can be measured using various measures, including percentage cover, percentage frequency, species richness, species abundance and evenness.
- Species evenness can be calculated using the Shannon-Wiener index.
- Species diversity can be calculated using Simpson's diversity index.
- Species interactions are a major determinant of the species present in an area. They may be positive, negative or neutral.
- Species interactions can be scored on an interaction matrix and displayed as an interaction network.
- Relationships between species are sometimes difficult to establish and many methods are used, including direct observation in person, by air or boat or by attaching monitoring equipment such as cameras to individual members of a species. Biochemical studies of tissue samples or waste products can also be used.

KEY QUESTIONS

- Retrieval**
- 1 Describe the difference between species richness and relative species abundance.
 - 2 Describe two percentage abundance can exceed 100%.
- Comprehension**
- 3 Calculate the percentage cover of the plant shown in this 1 m × 1 m quadrat.
- Analysis**
- 5 During a 2003 study in the Caribbean, the mass of fish in acropools near both mangrove-rich and mangrove-poor coastal regions was determined. The results of that study are shown in the table below. The scientists performing the study were using fish mass as a measure of abundance, with higher mass indicating a higher abundance.
- Mass of fish in acropools near mangrove-rich and mangrove-poor coastal regions
- | Species surveyed | Mangrove-poor area (kg fish m ⁻²) | Mangrove-rich area (kg fish m ⁻²) | Mean mass of individual fish (kg) |
|---------------------|---|---|-----------------------------------|
| Striped parrotfish | 1530 | 2170 | 6.9 |
| Brown snapper | 280 | 447 | 0.65 |
| Schoolmaster wrasse | 1747 | 1898 | 0.8 |
| French grunt | 1508 | 1643 | 0.7 |
| White grunt | 523 | 862 | 0.65 |
| Yellowtail | 958 | 1715 | 0.2 |
- Calculate the mean number of individuals of each species per 1 m² for each species in each area.
- Calculate the species evenness of the two areas.
- Comment on species richness and evenness in the two areas.

continued over page

MANDATORY PRACTICAL 2

Comparing species diversity of communities

Research and planning

Aim

- To determine species diversity of a community of organisms using species richness and Simpson's diversity index.
- To compare species diversity calculated using species richness and Simpson's diversity index.

Optional

- To practise using formulas in spreadsheets, such as Microsoft Excel, to calculate species diversity indexes.

Rationale (scientific background to the experiment)

Biodiversity, or biological diversity, refers to the variety of organisms living within a particular area. Biodiversity can be measured by the number and diversity of species, the extent to which a particular habitat or ecosystem varies, or the amount of genetic diversity within a species. The more diverse an area is, the more likely it is to withstand environmental pressures or diseases. Biodiversity is often used as an indication of the health of a habitat.

There are several ways to measure biodiversity. Two common methods are calculating species richness and Simpson's diversity index. Species richness is a simple measure of biodiversity and is the number of different species in a given habitat. The more species present in a community, the more 'rich' or 'biodiverse' it is. Simpson's diversity index takes into account the number of different species in a community and their relative abundance of each species.

Simpson's diversity index is calculated using the formula:

$$SDI = 1 - \frac{2n(n-1)}{N(N-1)}$$

where:

- n = number of organisms of one species
 - N = total number of organisms of all species
- Using this formula, the Simpson's diversity index ranges from 0 to 1. A Simpson's diversity index of 0 means that there is no diversity, that is, all of the organisms in a particular area are from the one species. The closer the Simpson's diversity index is to 1, the more diverse the community is.

Timing

60 minutes

Materials

- images showing organisms in a four different communities

Optional

- Microsoft Excel or another spreadsheet program
- sampling equipment (e.g. quadrats)

Method

Risk assessment

Assessment of risks include chemical hazards and physical hazards. Before you commence this practical activity, you must conduct a risk assessment. Complete the template in your SBK and Assessment book or download it from your eBook.

- 1 Count the number of organisms and species in each community and record in the table.
- 2 Alternatively you could use sampling techniques, such as quadrats, to count the number of organisms and species in habitats in or around the school.
- 3 Calculate the species richness for each community.
- 4 Calculate the Simpson's diversity index for each community. This can be done using the tables below. Alternatively, you can practise using a spreadsheet, such as Excel, to calculate Simpson's diversity index. Tutorials are available on YouTube.

Analysis

Raw data

- 1 Complete the table below.

Species	Number of individuals	Community 1	Community 2	Community 3	Community 4
A					
B					
C					
D					
E					
Total					

How to use this book

Chapter review

Each chapter finishes with a list of key terms covered in the chapter and a set of tasks to test students' abilities to apply the knowledge gained from the chapter.

Chapter review

KEY TERMS

abundant
aquifer
basal cover
benthic region
bioclogging event
biodegradation
canopy cover
consumer
ecosystem diversity
ectothermic
genetic diversity

ground cover
horizon
humus
hypoxic
intertidal zone
leaching
leaf cover
littoral zone
network
pelagic zone
percentage cover
percentage frequency

producer
relative species abundance
Sachs etc.
Simpson's diversity index
species abundance
species diversity
species evenness
species richness
tolerance range
turbidity
undirected network
unweighted network

KEY QUESTIONS

Retrieval

- The conditions in the deeper areas of the Great Barrier Reef are such that most corals are unable to survive there. Identify the term which describes the conditions over which a species of coral could survive.
 - its tidal range
 - its optimal range
 - its survival range
 - its tolerance range
- A student performed a study of the local park and listed all of the plant species present. The student named 60 different species. Identify the measure of biodiversity that the student has calculated.
 - species diversity
 - species richness
 - species evenness
 - species abundance
- Explain how a quadrat can have a percentage cover greater than 100%.
 - genetic diversity
 - biodiversity

Comprehension

- Identify the community showing the greatest species evenness. Each community has 1000 members in total, spread between four species.

	Numbers of individuals of each species in each area surveyed			
	Species 1	Species 2	Species 3	Species 4
A Area 1	100	400	300	300
B Area 2	240	240	253	253
C Area 3	115	333	498	54
D Area 4	333	333	333	1

- Explain why the intertidal zone is a challenging habitat for the organisms that live there.
- Explain how habitat fragmentation affects biodiversity.
- Many of the techniques used to assess biodiversity involve sampling. Discuss the advantages and limitations of sampling as a means of assessing ecosystems.

CHAPTER 3 | RECOVERY 55

Icons

Go To icons make important links to relevant content within the student books in the course. The Go To icons indicate where to engage with Chapter 1 in your eBook.



Every mandatory practical is supported by a complementary **SPARKlab** alternative practical.



The **Pearson Biology Skills and Assessment** book icons indicate the best time to engage with an activity for practice, application and revision.

The type of activity is indicated as follows:

Worksheet (WS)

Mandatory practical (MP)

Practical activity (PA)

Sample assessment task (SAT)

Topic review (TR)

The **Reader+** icon indicates when to engage with an asset via your Reader+ eBook. Assets may include videos and interactive activities.



Unit review

Each unit finishes with a comprehensive set of exam-style instructions, including multiple choice and short answer. These review tasks assist students to draw together their knowledge and understanding of the whole unit.

UNIT 4 • REVIEW

REVIEW QUESTIONS

Topic 1 DNA, genes and the continuity of life

Multiple choice

- Complete this statement: A DNA molecule consists of two strands in which:
 - the percentage of adenine is the same in each strand
 - the percentage of adenine is the same as that of thymine in each strand
 - the percentage of adenine is the same as that of uracil in the whole molecule
 - the percentage of adenine is the same as that of thymine in the whole molecule
- Identify the laboratory technique that is used to separate fragments of DNA.
 - karyotyping
 - genetic screening
 - gel electrophoresis
 - polymerase chain reaction
- Consider the structures shown below.

Structure A

Structure B

Structure C

Structure D

Identify the alternative that correctly names the type of nucleic acid forming each structure.

Structure	Structure A	Structure B	Structure C	Structure D
A	messenger RNA	messenger RNA	ribosomal RNA	transfer RNA
B	transfer RNA	ribosomal RNA	messenger RNA	ribosomal RNA
C	ribosomal RNA	messenger RNA	ribosomal RNA	messenger RNA
D	messenger RNA	ribosomal RNA	messenger RNA	ribosomal RNA

Examine the following diagram of a cell.

Identify the organelles which contain DNA.

- organelles D, E and F
- organelles B, C and D
- organelles D, G, I and F
- organelles D, G and H

DNA replication is a semi-conservative process. In order to demonstrate this, a piece of radioactively labelled DNA was allowed to replicate through two cycles. The radioactively labelled piece of DNA is shown below.

The new strands of DNA are not radioactive and are shown as solid lines. Indicate which diagram shows the DNA after two replication cycles.

A	B	C	D
-----	-----	-----	-----
-----	-----	-----	-----
-----	-----	-----	-----
-----	-----	-----	-----

510 UNIT 4 | HEREDITY AND CONTINUITY OF LIFE

Glossary

Key terms are shown in **bold** throughout the student book and are listed at the end of each chapter. A comprehensive glossary at the end of the book defines all the key terms. The glossary aligns with the syllabus context and includes the QCAA defined terminology.

Answers

Comprehensive answers and fully worked solutions for all module review tasks, try yourself, Science as a human endeavour, case studies, chapter reviews and unit reviews are provided via the teacher *Pearson Biology 12 Queensland Reader+ eBook*.

Pearson Biology 12 Queensland



Student book

Pearson Biology 12 Queensland Student Book has been developed by experienced Queensland teachers to address all the requirements of the new QCAA Biology 2019 General Senior Syllabus. The series features the very latest developments and applications of biology, literacy and instructional design to ensure the content and concepts are fully accessible to all students.

Skills and assessment book

The *Pearson Biology 12 Skills and Assessment* book gives students the edge in preparing for all forms of assessment. Specifically prepared to provide opportunities to consolidate, develop and apply subject matter and science inquiry skills, this resource features a toolkit, key knowledge summaries, worksheets, practical activities and guidance, assessment practice and topic review sets.



Reader+ the next generation eBook

Reader+ is our next generation eBook. Students can read, take notes, save bookmarks and more in the one seamless experience. Integrated multimedia (audio/video) and interactive activities enhance and extend the learning experience. In addition, Reader+ provides the digital-only Chapter 1 Biology skills and assessment toolkit.

Teacher support

Pearson Biology 12 Queensland Teacher Support provides:

- complete answers, fully worked solutions or suggested answers to all tasks in the student book, and the skills and assessment book
- expected results, common mistakes, suggested answers and full safety notes and risk assessments for all practical activities
- teaching, learning and assessment programs.



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