BIOZONE

CLASSROOM GUIDE

IB BIOLOGY

DIPLOMA PROGRAMME

Contents

Published by BIOZONE International Ltd

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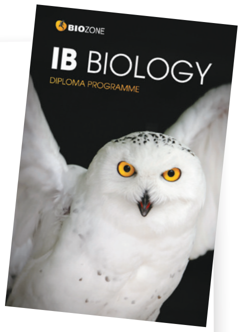
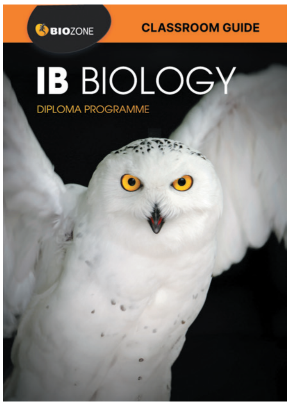
FAQs ABOUT IB BIOLOGY

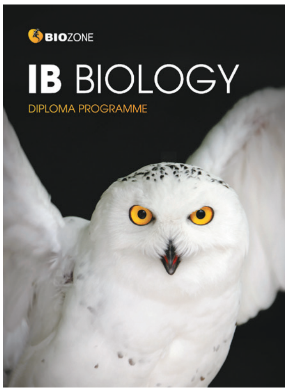


Using this Classroom Guide



This Classroom Guide has been designed to help teachers fully understand the features of *IB Biology* and provides some suggestions for how the worktext and associated resources can be used within your classroom. To find out about all of our support resources for *IB Biology*, and to get the best out of this resource, we recommend reviewing this guide before you begin using *IB Biology* in your classroom.

An Introduction to IB Biology



IB Biology has been specifically written for the two year International Baccalaureate (IB) Biology Diploma Programme (first assessed in 2025). This resource integrates BOTH standard level (SL) and additional higher level (AHL) material, ensuring comprehensive delivery of the IB Biology syllabus.

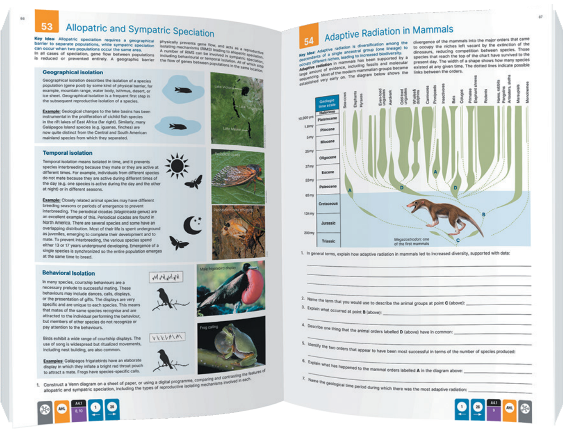
A simple structure allows for easy navigation and identification of the theme and organizational level being addressed at any time. Additional key components, including Nature of Science, Application of Skills, and tasks to support the experimental programme, have been built into the activities and are easily identifiable using our coding and tab systems. Inbuilt assessments conclude each chapter and also each theme (section) providing convenient ways to assess student understanding of the content. Use the contents and FAQs in this Classroom Guide to quickly find the answers to your questions about the syllabus roadmap (course structure), identifying key components, distinguishing between SL and AHL material, carrying out practical activities, and assessment tasks.

IB Biology is available as a print or digital resource, allowing teachers the flexibility of delivering the content across dual media if required. We provide a suite of resources, the Teacher Toolkit, to help teachers plan and deliver an engaging programme. More information about our delivery options and the Teacher Toolkit is provided in this Classroom Guide.

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 utilize. Whether they are using the print or digital version, students customize 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 *IB Biology*. 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 utilize this approach to set work for substitute teachers in their absence.

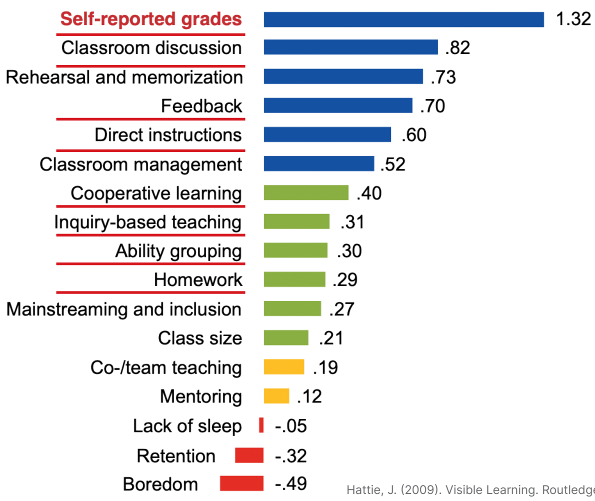
Not all answers need to be graded!

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 a the end of each chapter or at the conclusion of a unit. 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 utilize 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 utilizing *IB Biology*, these factors are organically incorporated into content delivery and enhance the teacher and learner experience.

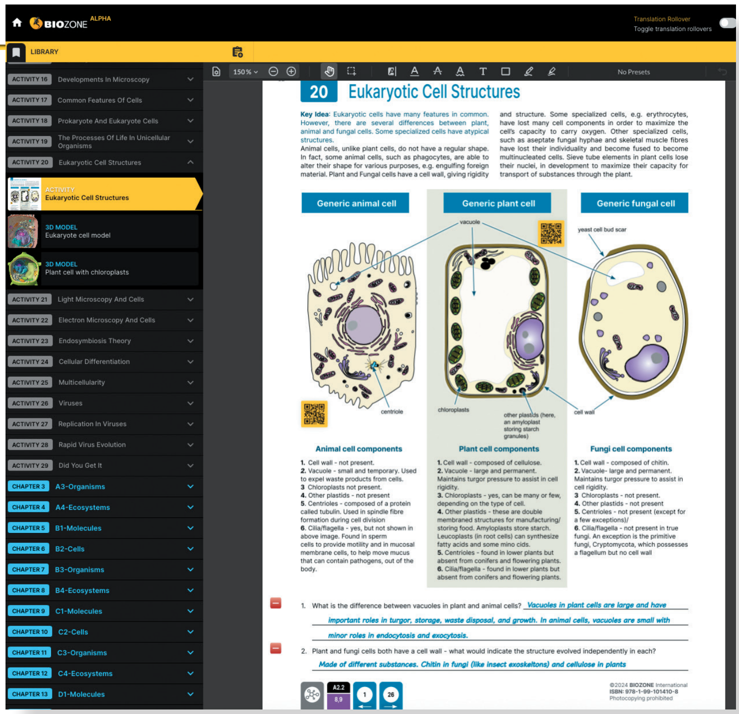


Hattie, J. (2009). Visible Learning. Routledge

The Teacher Toolkit

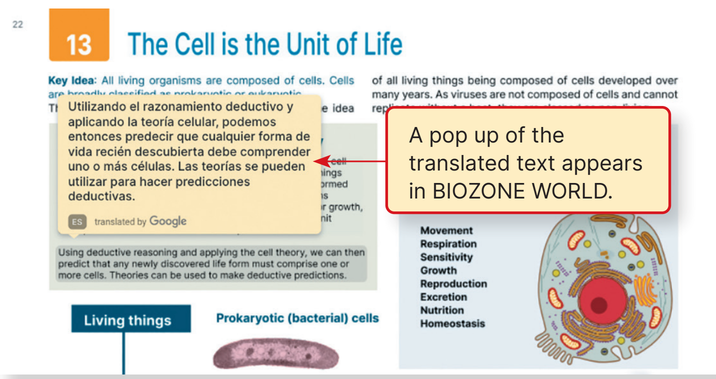
BIOZONE's *IB Biology* worktext is supported by the Teacher Toolkit, a suite of resources specifically developed to help plan and deliver an engaging programme. A brief description of the tools available are provided below and on the next page.

BIOZONE WORLD



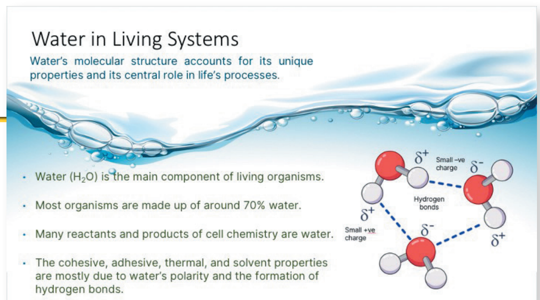
BIOZONE WORLD, our **digital science platform**, brings our digital worktexts and rich collection of digital resources together in a single location for easy use. Click on an activity to access the additional resources provided. These include: presentation slides, interactive 3D models, and curated videos 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:
  - Managing class student enrolments.
  - 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.
- The **translation tool** within BIOZONE WORLD translates the content into over 150 languages.



Find out more: biozone.com/us/biozone-world

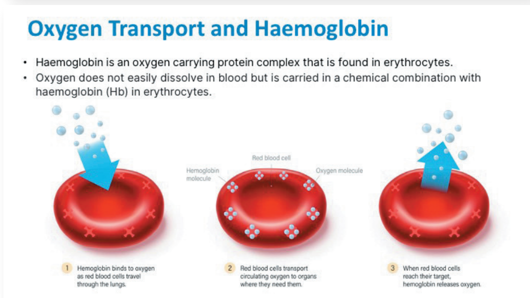
PRESENTATION SLIDES



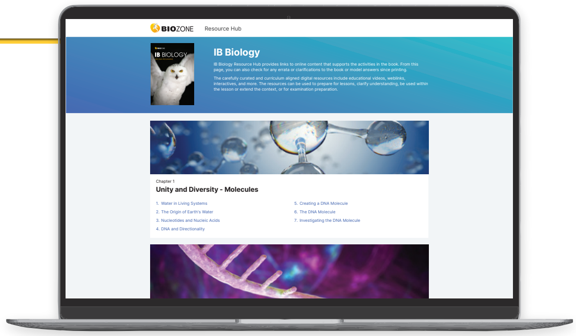
Presentation Slides are a very popular way for teachers to deliver a lesson in a presentation style format either in class or via remote delivery.

The Presentation Slides are a sizeable collection of slides specifically designed to support and enhance the content of the worktext. A set of slides is available for each chapter of *IB Biology*.

The Presentation Slides automatically appear in the resource list when an activity is selected.



RESOURCE HUB



The BIOZONE **Resource Hub** is a free resource, available to 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.

Print users access BIOZONE's **Resource Hub** content through QR codes and links provided on page x of the worktext. The codes have also been provided in this guide for easy reference (right). For digital users, the resources are embedded in BIOZONE WORLD and appear in the resource list when an activity is selected..

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 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 Resource Hub 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.

The BIOZONE **Resource Hub** content is easily shared with your students through your LMS. You can provide notes and guidance about what you want students to do with the resource.
The BIOZONE **Resource Hub** can be accessed directly via the QR code below:

Or bookmark the following link:

www.BIOZONEhub.com

Then enter this code: **IB3-4108**

SUMMARY OF RESOURCE HUB MATERIALS FOR IB BIOLOGY

Resource type	Number of resources*
PDFs	16
3D models	233
Videos	489
Weblinks	216
Interactives	90
Spreadsheets	5

* approximate number of resources

MODEL ANSWERS

Model answers are provided for each activity. Teachers can choose to provide model answers to students at their discretion.
Model answers can be accessed in two different ways:

1. Via the digital platform (BIOZONE WORLD). Using the teacher view, answers can be projected onto a shared screen (e.g. interactive whiteboard) and be revealed by toggling the show/hide buttons.
2. A physical printed booklet.

QUESTION LIBRARY

All embedded questions in *IB Biology* are extracted into Question Library files. Provided in QTI and RTF files, the questions can be ingested into a range of learning management systems or other digital delivery tools.

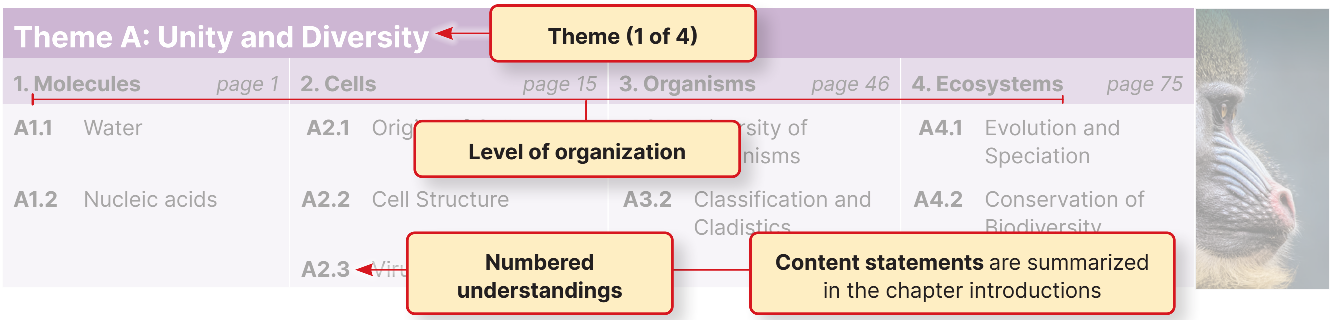
The Question Library content is fully editable, providing teachers with flexibility and control in assigning questions within a differentiated classroom. The questions can be customized to match a student's learning ability or reading level.

Access to the question library is complementary with multi-year purchases.

Syllabus Roadmap

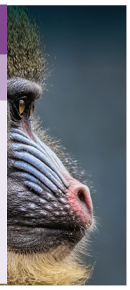
The IB syllabus comprises four themes and four organizational levels. BIOZONE's approach to delivering the syllabus has been to structure the worktext using the roadmap presented within the IB syllabus document. In this approach, the themes create four distinct sections and each organizational level is addressed within each theme. This spiralling approach allows exploration of the organizational levels (and the related understandings) within four different thematic contexts. The general hierarchical structure and sectioning of content using themes is outlined below.

Theme	Organizational Level	Understandings	Content statement



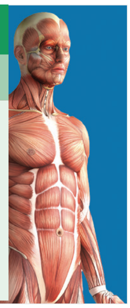
Theme A: Unity and Diversity

1. Molecules *page 1*	2. Cells *page 15*	3. Organisms *page 46*	4. Ecosystems *page 75*
A1.1 Water	**A2.1** Origins of Cells	**A3.1** Diversity of Organisms	**A4.1** Evolution and Speciation
A1.2 Nucleic acids	**A2.2** Cell Structure	**A3.2** Classification and Cladistics	**A4.2** Conservation of Biodiversity
	A2.3 Viruses		



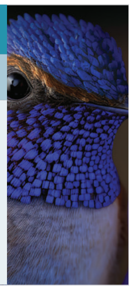
Theme B: Form and Function

5. Molecules *page 104*	6. Cells *page 122*	7. Organisms *page 156*	8. Ecosystems *page 208*
B1.1 Carbohydrates and Lipids	**B2.1** Membranes and Membrane Transport	**B3.1** Gas Exchange	**B4.1** Adaptation to Environment
B1.2 Proteins	**B2.2** Organelles and Compartmentalization	**B3.2** Transport	**B4.2** Ecological Niches
	B2.3 Cell Specialization	**B3.3** Muscle and Motility	



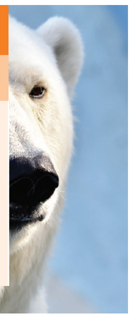
Theme C: Interaction and Interdependence

9. Molecules *page 239*	10. Cells *page 283*	11. Organisms *page 306*	12. Ecosystems *page 356*
C1.1 Enzymes and Metabolism	**C2.1** Chemical Signalling	**C3.1** Integration of Body Systems	**C4.1** Populations and Communities
C1.2 Cell Respiration	**C2.2** Neural Signalling	**C3.2** Defence Against Disease	**C4.2** Transfers of Energy and Matter
C1.3 Photosynthesis			



Theme D: Continuity and Change

13. Molecules *page 411*	14. Cells *page 441*	15. Organisms *page 470*	16. Ecosystems *page 535*
D1.1 DNA Replication	**D2.1** Cell and Nuclear Division	**D3.1** Reproduction	**D4.1** Natural Selection
D1.2 Protein Synthesis	**D2.2** Gene Expression	**D3.2** Inheritance	**D4.2** Stability and Change
D1.3 Mutations and Gene Editing	**D2.3** Water Potential	**D3.3** Homeostasis	**D4.3** Climate Change



Our tab system (CG14) allows teachers to readily identify the syllabus components covered in each activity. The coding can be used as a roadmap for teachers wishing to deliver the course from an organizational based framework, i.e. using the four organizational levels to divide the course into sections. In this approach, the themes form the spiralling context of study. A road map is provided below.

Organizational Level	Theme	Understandings	Content statement

Organizational Level: Molecules

Theme A: Unity and Diversity *Chapter 1: Page 1*	Theme B: Form and Function *Chapter 5: Page 104*	Theme C: Interaction and Interdependence *Chapter 9: Page 239*	Theme D: Continuity and Change *Chapter 13: Page 411*
A1.1 Water	**B1.1** Carbohydrates and Lipids	**C1.1** Enzymes and Metabolism	**D1.1** DNA Replication
A1.2 Nucleic Acids	**B1.2** Proteins	**C1.2** Cell Respiration	**D1.2** Protein Synthesis
		C1.3 Photosynthesis	**D1.3** Mutations and Gene Editing

Organizational Level: Cells

Theme A: Unity and Diversity *Chapter 2: Page 15*	Theme B: Form and Function *Chapter 6: Page 122*	Theme C: Interaction and Interdependence *Chapter 10: Page 283*	Theme D: Continuity and Change *Chapter 14: Page 441*
A2.1 Origin of Cells	**B2.1** Membranes and Membrane Transport	**C2.1** Chemical Signalling	**D2.1** Cell and Nuclear Division
A2.2 Cell Structure	**B2.2** Organelles and Compartmentalization	**C2.2** Neural Signalling	**D2.2** Gene Expression
A2.3 Viruses	**B2.3** Cell Specialization		**D2.3** Water Potential

Organizational Level: Organisms

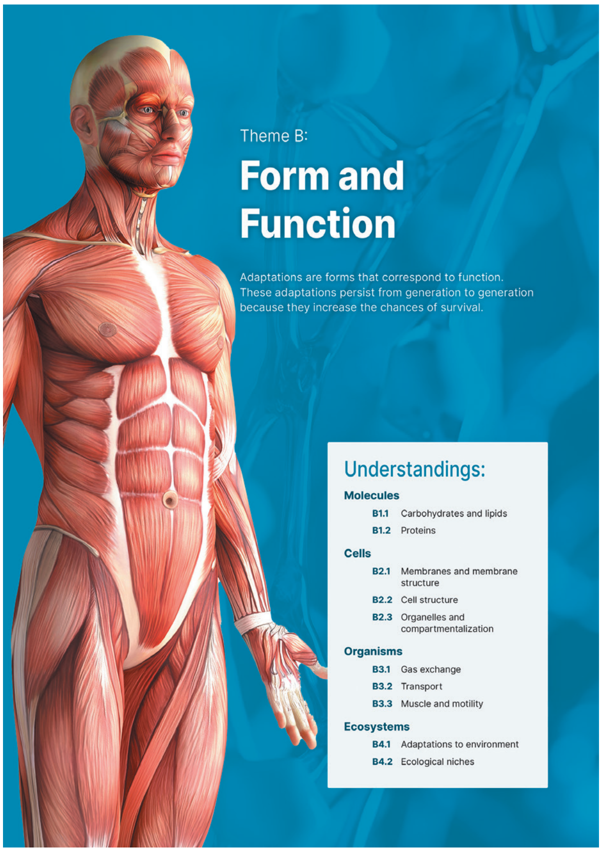
Theme A: Unity and Diversity *Chapter 3: Page 46*	Theme B: Form and Function *Chapter 7: Page 156*	Theme C: Interaction and Interdependence *Chapter 11: Page 306*	Theme D: Continuity and Change *Chapter 15: Page 470*
A3.1 Diversity of Organisms	**B3.1** Gas Exchange	**C3.1** Integration of Body Systems	**D3.1** Reproduction
A3.2 Classification and Cladistics	**B3.2** Transport	**C3.2** Defence Against Disease	**D3.2** Inheritance
	B3.3 Muscle and Motility		**D3.3** Homeostasis

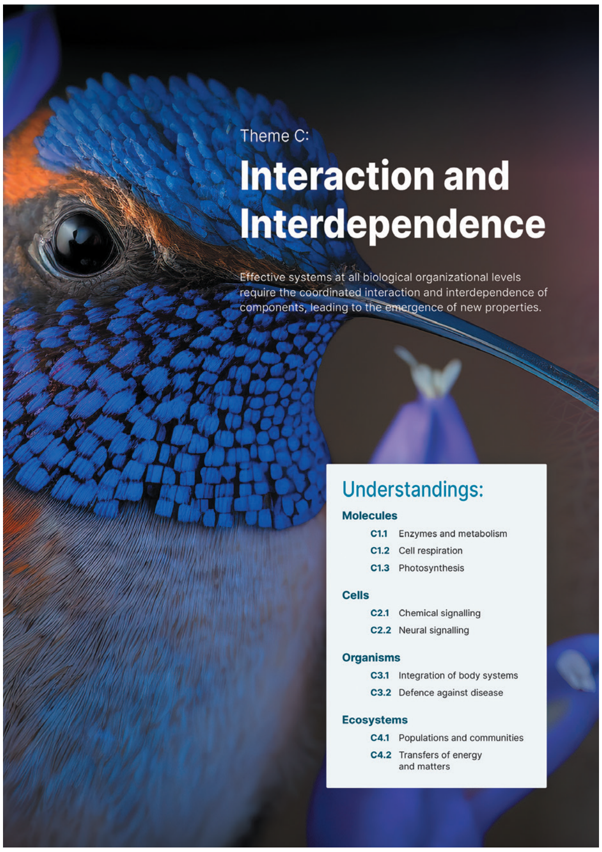
Organizational Level: Ecosystems

Theme A: Unity and Diversity *Chapter 4: Page 75*	Theme B: Form and Function *Chapter 8: Page 208*	Theme C: Interaction and Interdependence *Chapter 12: Page 356*	Theme D: Continuity and Change *Chapter 16: Page 535*
A4.1 Evolution and Speciation	**B4.1** Adaptation to Environment	**C4.1** Populations and Communities	**D4.1** Natural Selection
A4.2 Conservation of Biodiversity	**B4.2** Ecological Niches	**C4.2** Transfers of Energy and Matter	**D4.2** Stability and Change
			D4.3 Climate Change

Theme Sections

IB Biology is divided into four sections based on the four themes identified in the IB Biology syllabus. Each theme consists of four levels of organization: Molecules, Cells, Organisms, and Ecosystems. Each section is introduced with a title page clearly identifying the theme, its summary statement, and the understandings for each level of biological organization. Use these for easy navigation for the course and to quickly identify the understandings which will be covered in each chapter.





Theme and Chapter Structure

Each theme (section) contains four chapters. Each chapter follows the four levels of biological organization:

1. Molecules
2. Cells
3. Organisms
4. Ecosystems

The levels of biological organization act as conceptual lenses for exploring each theme. This approach allows for scaffolding of biological knowledge from the microscopic to the ecosystem level within each theme. This spiralling delivery provides opportunities for revisiting each of the of the levels of biological organization within a different conceptual lens, encouraging learners to see the interconnectedness of the themes and ideas as they progress through the syllabus.

Organizational structure

Theme introduction

Provides a section break. Identifies the theme and the understandings within the theme.

Summary Assessment

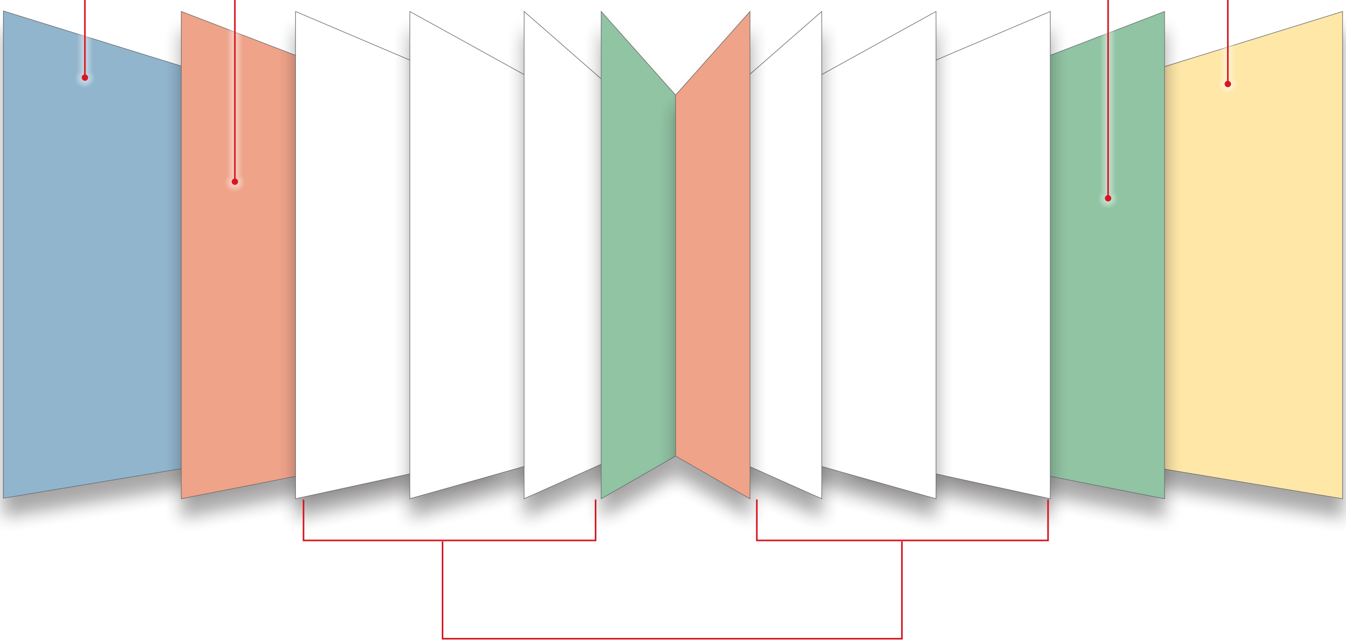
A summative assessment task testing understanding over the entire theme.

Chapter introduction

Short statements summarize the **learning outcomes** for the chapter.

Did You Get It?

A formative or summative assessment task covering the content in the chapter.



Activity Pages

The activity pages have been designed to address the **content statements** of the course. **Application of Skills** and **Nature of Science** are also embedded and identified where applicable.
Most activities have questions for students to answer. This forms a record of the student's work and allows them to demonstrate their understanding of the content.

The Contents: A Planning Tool

The contents pages are not merely a list of the activities. Encourage your students to use them as a planning tool for their programme of work. Students can identify the activities they are to complete and then tick them off when completed. Ticking off the activities as they are completed gives students a sense of progression and helps them to be more personally organized in their work and time management. Teachers can see at a glance how a student is progressing through the set work. Any concerns with progress can be addressed early.

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Contents

CODING Activity is marked: to be done; when completed; AHL content; AOS; NOS

A legend at the bottom of the page provides an explanation of the colour coding.

Chapter Introductions

The chapter introductions are a quick reference guide to help navigate the content. They provide access to the BIOZONE **Resource Hub** via a QR code and can be used by students to plan their workflow. Concise learning outcomes list the knowledge and skills students will need to master as they work through the IB Biology syllabus. Colour coding allows for quick identification of AHL, NOS, and AOS material. Key features of the chapter introductions are explained below.

Encourage your students to use the chapter introductions as a planning tool to set their workflow. Students can identify the activities they are to complete and then tick them off when completed. The teacher can also see at a glance how quickly the student is progressing through the assigned material.

Chapter Title
Identifies the chapter number, theme, and level of organization.

Numbered Understandings

Learning outcome statements indicate what is required to effectively cover each content statement in the chapter.

Use the check boxes to identify activities to be done (•) and tick them off (✓) when you have completed the learning outcome.

Application of Science (**AOS**) content is identified with **green text**.

Nature of Science (**NOS**) content is identified with a **red text** tag.

Chapter 1 Unity and Diversity

Molecules

Resource Hub
bit.ly/3Nafv77

A1.1 Water — Activity Number

Guiding Questions:
- What properties of water make it essential for life?
- What are the advantages and disadvantages of water as a habitat?

Learning Outcomes:

			Activity Number
☐	1	Explain the significance of water as a medium for cellular processes, and as a requirement for the origin of cells.	1
☐	2	Draw and correctly annotate a model water molecule, showing hydrogen bonding.	1
☐	3	Link water's cohesive properties to important biological processes including transport in the xylem, and surface tension that allows movement of organisms on its surface.	1
☐	4	Link water's adhesive properties to its significance for organisms, including soil and plant cell wall capillary action.	1
☐	5	Explain how the solvent properties of water allow it to function as a medium for plant and animal metabolism and transport in plants and animals, for both hydrophilic and hydrophobic molecules.	1
☐	6	Compare and contrast the physical properties of water and air and how they impact animals in aquatic habitats.	1
☐	7	AHL: Evaluate the extraplanetary asteroid hypothesis for the origin and retention of water on Earth.	2
☐	8	AHL: Explain the relationship between water on 'Goldilocks zone' planets and the possibility of finding extraterrestrial life.	2

A1.2 Nucleic acids — Activity Number

Guiding Questions:
- How does nucleic acid structure enable hereditary information to be stored?
- How does the structure of DNA enable accurate replication?

Learning Outcomes:

			Activity Number
☐	1	Identify DNA as the universal genetic material found in all living organisms.	3
☐	2	Draw a diagram of a nucleotide, identifying and annotating the components.	3, 8
☐	3	Link the properties of the sugar-phosphate bond to its role as the backbone of DNA and RNA.	3, 5
☐	4	Recall nitrogenous base names in both DNA and RNA.	3
☐	5	Draw diagrams of single nucleotide monomers and RNA polymers, representing the condensation reaction in the polymer formation.	3
☐	6	Name the shape of DNA as a double helix. Draw a diagram of DNA antiparallel 3' and 5' strands, demonstrating base pairing.	3, 8
☐	7	Construct models to compare and contrast the components of DNA and RNA.	3, 5
☐	8	Explain how complementary base pairing enables DNA to function as genetic material. Explain the role of hydrogen bonds connecting base pairs, and therefore strands, together.	3
☐	9	Link the structure of DNA to its ability to economically store huge quantities of information with almost limitless sequence combinations.	3
☐	10	Explain how the universality of genetic code in DNA of all living organisms is evidence of common ancestry.	3
☐	11	AHL: Connect DNA and RNA 5' to 3' linkage directionality to the processes of replication, transcription, and translation.	4
☐	12	AHL: Explain the purpose of purine-to-pyrimidine bonding in enabling DNA helix stability.	4
☐	13	AHL: Identify histone proteins as the molecule forming the core of a nucleosome. AOS: Use digital molecular visualization to investigate the structure of a nucleosome.	6
☐	14	AHL: Provide evidence from the Hershey Chase experiment to support the conclusion that DNA is the genetic material. NOS: Explain how technological developments, such as use of radioisotopes, enabled Hershey and Chase to carry out their innovative investigation into DNA.	7
☐	15	AHL: NOS: Investigate Chargaff's pyrimidine and purine data and explain how their ratios addressed the 'problem of induction' and falsified the tetranucleotide hypothesis.	7

BIOZONE Resource Hub
A quick link to the BIOZONE Resource Hub using QR code or bit.ly URL

Guiding Questions
These help to identify important areas of study within this chapter.

The activity in the book related to this learning outcome.

Learning statements on a white background denote standard level content and it should be assigned to both SL and HL students.

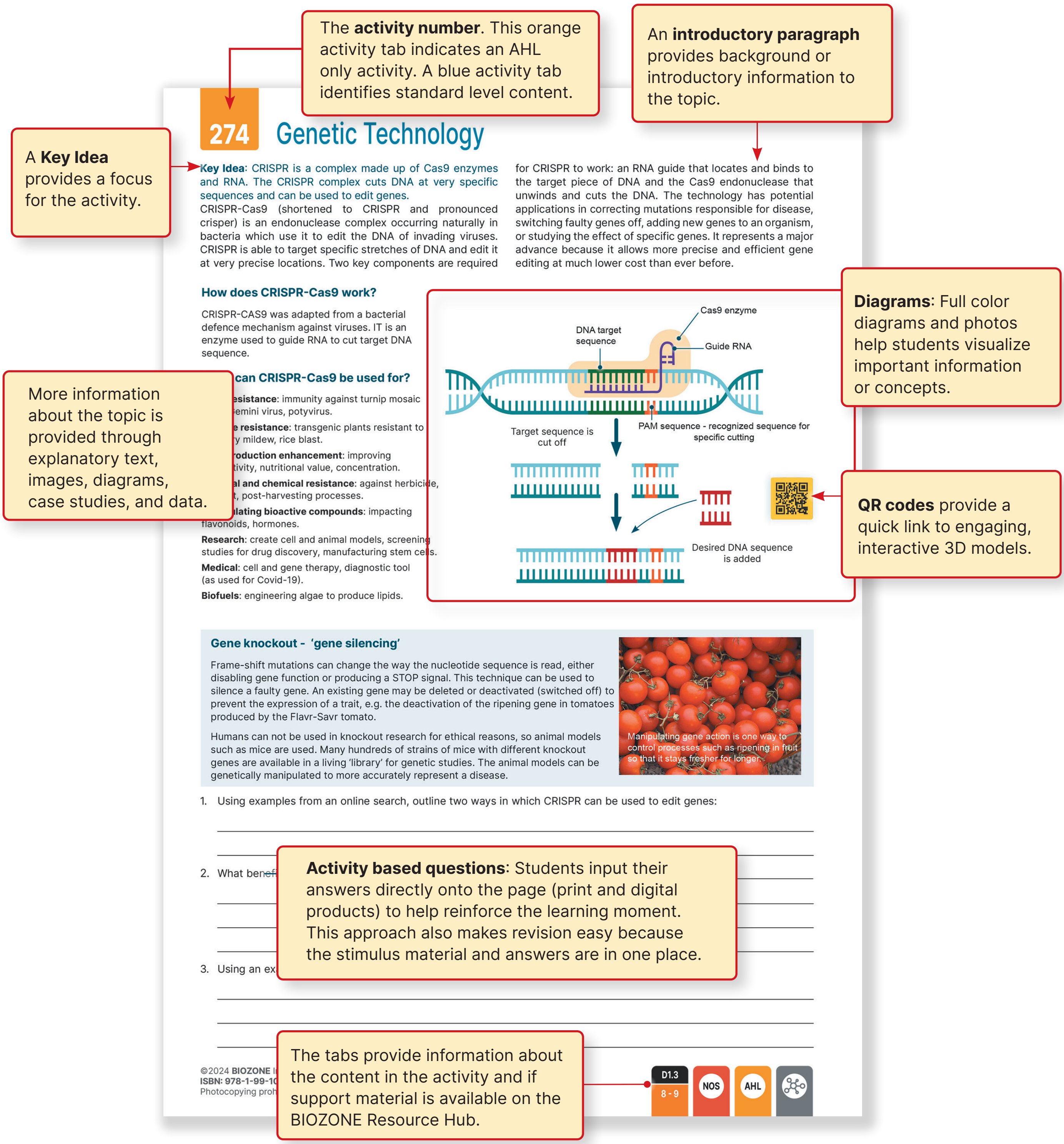
An orange **AHL tag** and a yellow shaded box identify **Advanced Higher Learning** content statements. This material should only be assigned to students doing the higher level course.

Features of the Activity Pages

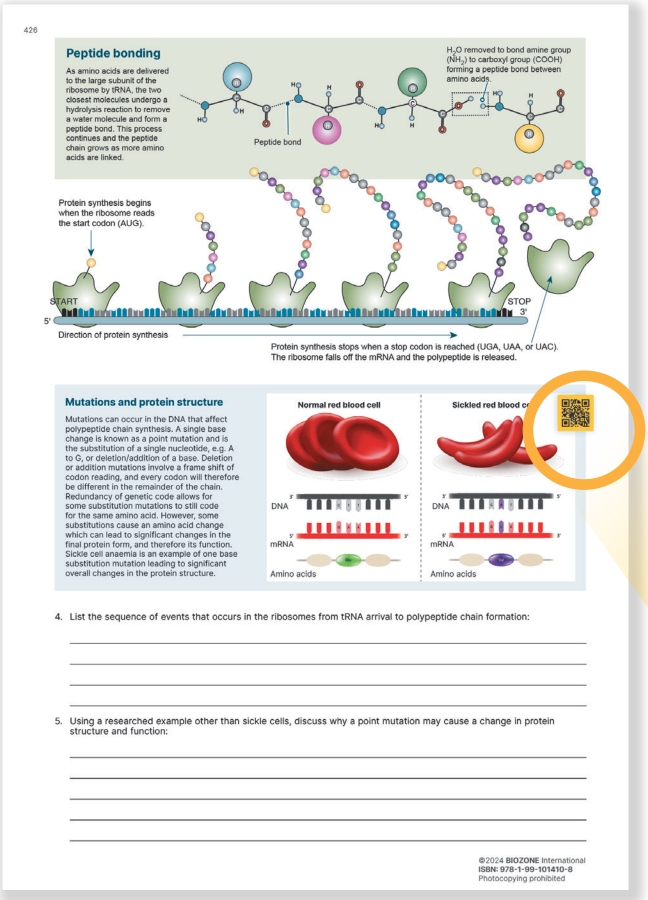
The activity pages have been carefully designed to provide high quality information to students in an easily accessible format. They include a number of features designed to engage students and help them unpack and understand the information. Guide students through the features of the activity pages to ensure that they make the most of each activity.

Features include:

- Short blocks of text so that students do not feel overwhelmed with too much reading.
- High quality, informative graphics.
- QR codes link directly to 3D models (following page). These provide fun engagement and learning moments.
- 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.
- The tab system identifies when there is support material on the **Resource Hub**. Tabs also identify the applicable syllabus components (see following page).



The QR codes link directly to 3D models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Peptide bonding

As amino acids are delivered to the large subunit of the ribosome by tRNA, the two closest molecules undergo a hydrolysis reaction to remove a water molecule and form a peptide bond. This process continues and the peptide chain grows as more amino acids are linked.

Mutations and protein structure

Mutations can occur in the DNA that affect polypeptide chain synthesis. A single base change is known as a point mutation and is the substitution of a single nucleotide, e.g. A to G, or deletion/addition of a base. Deletion or addition mutations involve a frame shift of codon reading, and every codon will therefore be different in the remainder of the chain. Redundancy of genetic code allows for some substitution mutations to still code for the same amino acid. However, some substitutions cause an amino acid change which can lead to significant changes in the final protein form, and therefore its function. Sickle cell anaemia is an example of one base substitution mutation leading to significant overall changes in the protein structure.

4. List the sequence of events that occurs in the ribosomes from tRNA arrival to polypeptide chain formation:

5. Using a researched example other than sickle cells, discuss why a point mutation may cause a change in protein structure and function:

ISBN: 978-1-99-101410-8

Some activities have QR codes on the pages (circled, left). These link directly to informative and engaging 3D models. All models can be rotated and zoomed, and some contain informative annotations.

If your school does not allow students to access phones in class time, students can still access the 3D models through the Resource Hub and via BIOZONE WORLD.

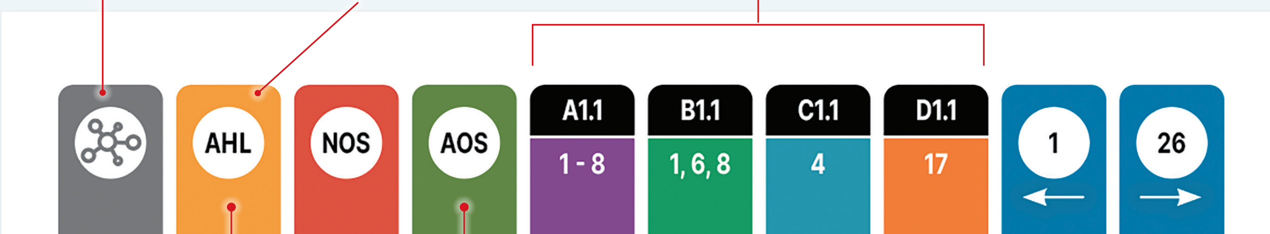
Understanding the Tab System

A tab system is found at the bottom of the first page of each activity, providing information about the content. Use the tabs to identify the theme and content statement components of the activity, whether it is an AHL activity, and if Nature of Science (NOS) and Application of Skills (AOS) content is embedded. Blue connection tabs identify if there are connections to other activities, and the grey tabs indicate whether support material is provided on BIOZONE's **Resource Hub**.
The tab system is explained below.

The **grey hub tab** indicates that the activity has online support via BIOZONE's **Resource Hub**. This may include videos, animations, articles, 3D models, and interactives.

The **orange AHL** tab indicates that the activity addresses Additional Higher Learning content. This activity will also have an orange activity tab at the top of the first page.

The **black top** of the tab indicates the theme and understanding that the activity addresses. The lower, **coloured section** reflects the theme and the numerical identification of one or more content statements covered in the activity.



The **red NOS** tab indicates that a Nature of Science theme is covered in the activity.

The **green AOS** tab indicates that Application of Skills content is covered in the activity.

Concept connection tabs point you forward or back to activities with related concepts.

Supporting the Experimental Programme

The IB syllabus includes an experimental programme comprising three components: practical work, a collaborative science project, and an independent scientific investigation. This comprehensive experimental programme encourages the development of skills and attributes essential to a successful IB learner. Through the varied experimental programme, learners develop scientific skills, demonstrate safe and competent practices, demonstrate analysis and problem solving skills, work collaboratively, and communicate ideas and outcomes effectively. Support for the experimental programme is embedded within *IB Biology* and is explained below and on the following pages.

Collaborative sciences project

The collaborative sciences project is an interdisciplinary project requiring students to work collaboratively to develop a solution-focussed result in response to a complex issue. The ability to work on a real world problem brings relevance to the project, and provides opportunities to address problems at a local, national, or global level. The interdisciplinary nature of the project allows students to apply their skills and ideas from a range of disciplines to find a solution. Exposure to other ways of thinking and working enriches all students and encourages open mindedness and communication to achieve the desired outcome.

Throughout *IB Biology*, students are presented with a range of tasks, questions, and activities that support the development of the skills required for success in the collaborative sciences project. These include:

- Real world case studies and data sets requiring students to analyse problems and find solutions provide excellent practise for the analysis and problem solving goals required in the collaborative sciences project. For example, carbon sequestration techniques to lower atmospheric CO_2 levels.
- Providing case studies and examples from around the world encourages students to have a global perspective and allows them to see that issues can traverse local, regional, and global boundaries. For example, international conservation strategies, or the international response to the Covid-19 pandemic.
- All learners have opportunities to apply existing knowledge to new or more complex situations. This skill is well utilized in the collaborative project where learners must extend their knowledge base and skills to novel situations.
- Encouraging students to become involved in citizen science projects, e.g. local biodiversity projects, promotes awareness that science is all around and that individual contributions contribute to larger data sets and wider projects.
- Inclusion of research questions hones research skills, e.g. research the effect of the increasing human population on biodiversity. Students can practise analysing the credibility of information sources, evaluating information for bias and accuracy, and summarizing their findings.
- Collaborative work (investigations and research tasks) encourages the development and refinement of communication skills, highlights the need to appreciate the insight and needs of others, and provides opportunities to resolve conflict (should any arise).
- Information and case studies requiring students to evaluate and defend social and ethical implications of science and technology, or debate an issue, require students to consider and reflect on the perspectives of others while broadening their own understanding. For example, debating the pros and cons of using CRISPR technology to genetically engineer genes in humans.

Practical Investigations

Throughout *IB Biology*, students are given opportunities to explore through investigations. These are opportunities for students to develop competency in laboratory procedures, practice and refine skills in observation and analysis, manipulate data, and analyse findings. Investigations can take several forms including paper practicals, modelling activities, and wet lab experiments. The practical investigations provide students with experience and skills needed to carry out the experimental investigation required for Assessment Objective AO4.

The investigations provide an excellent opportunity for collaborative work and will stimulate discussion and the sharing of ideas. You may wish to pair students of different abilities for these tasks. Confident students can guide and encourage less able students and by working together students can share their own observations and ideas. Collaboration through paired practical work provides an excellent opportunity for students to consolidate their scientific vocabulary, communication, and social skills. English language learners can interact in meaningful ways to practise and extend their English language skills.

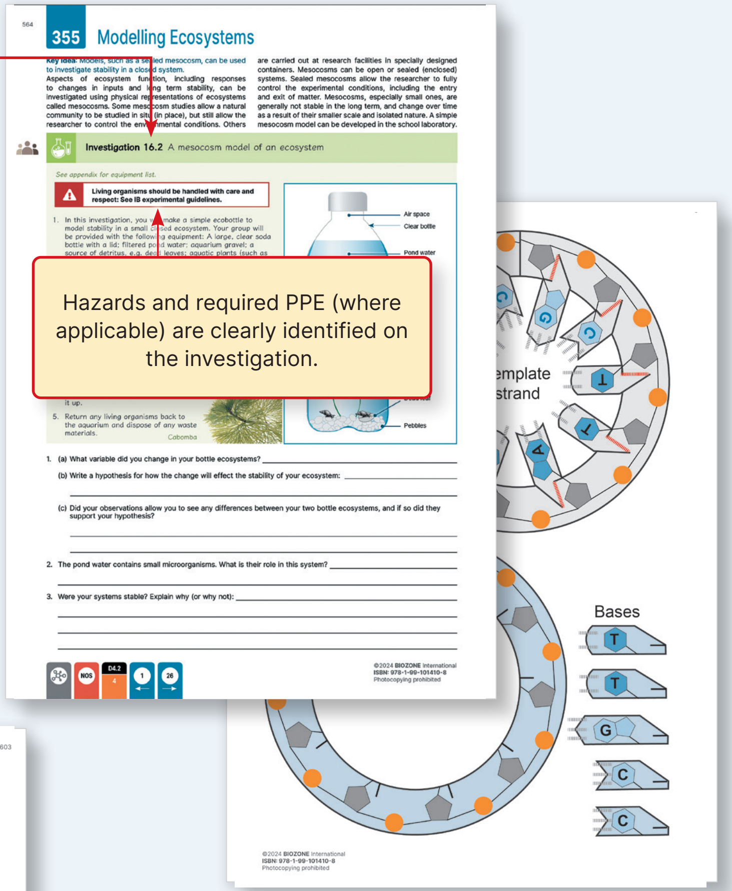
Each investigation is clearly numbered sequentially through the chapter.

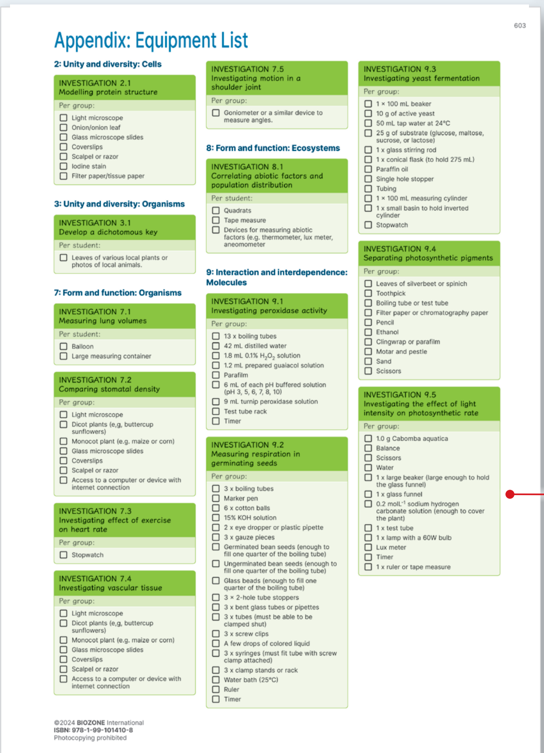
Where applicable, the investigations provide students with health and safety information at the start of the investigation.

Ensure the students read through the procedure fully *before beginning* the investigation.

Highlight any hazardous steps or important steps where extra care may be required.

Ensure students have all the equipment assembled and know if there are pinch points in the process. If necessary, have the groups allocate specific people to steps, e.g. timing, collecting samples, recording data or observations etc.





No kits are required for the investigations.

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

A list of the equipment and reagents required for each investigation is provided in the back of the worktext.

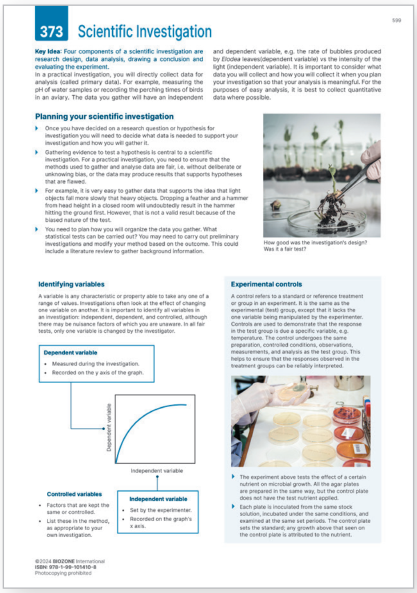
Support for the Scientific Investigation

The IB syllabus requires students to demonstrate the application of skills necessary to carry out insightful and ethical investigations (Assessment Objective AO4). In this assessment, students carry out a scientific investigation to answer a research question of their own. To help students prepare for this assessment, we have included a dedicated chapter (Scientific Investigation) to provide guidance on how to plan, carry out, and report on the scientific investigation. Use this information, along with your own resources, to help students succeed in this assessment task.

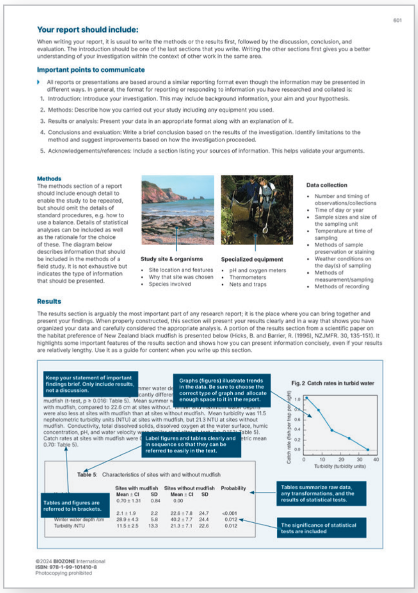
In addition, the practical investigations provided in the *IB Biology* worktext give students experience in planning, setting up, and running a scientific investigation. There are also opportunities to collate, present, and analyse data before communicating the findings. While carrying out the investigations, students develop many of the skills required to be successful in their own investigation. These include:

- Observation.
- Critical analysis and problem solving.
- Mathematics and numeracy practise.
- Data collection and analysis.
- Maintaining accurate records.
- Opportunities to work independently or collaboratively.
- Communication and reporting.

Planning

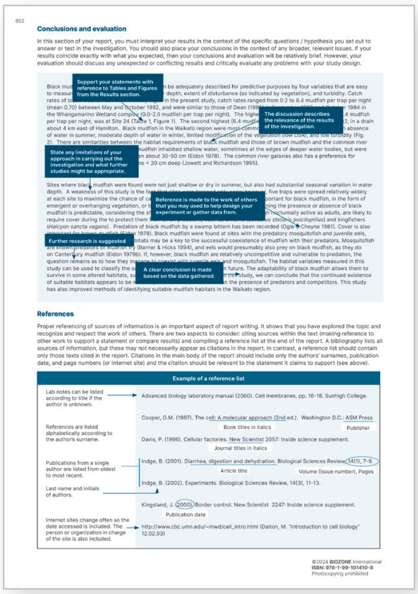


Method, data collection, and results



Reviewing and presenting data

Summarizing findings and references



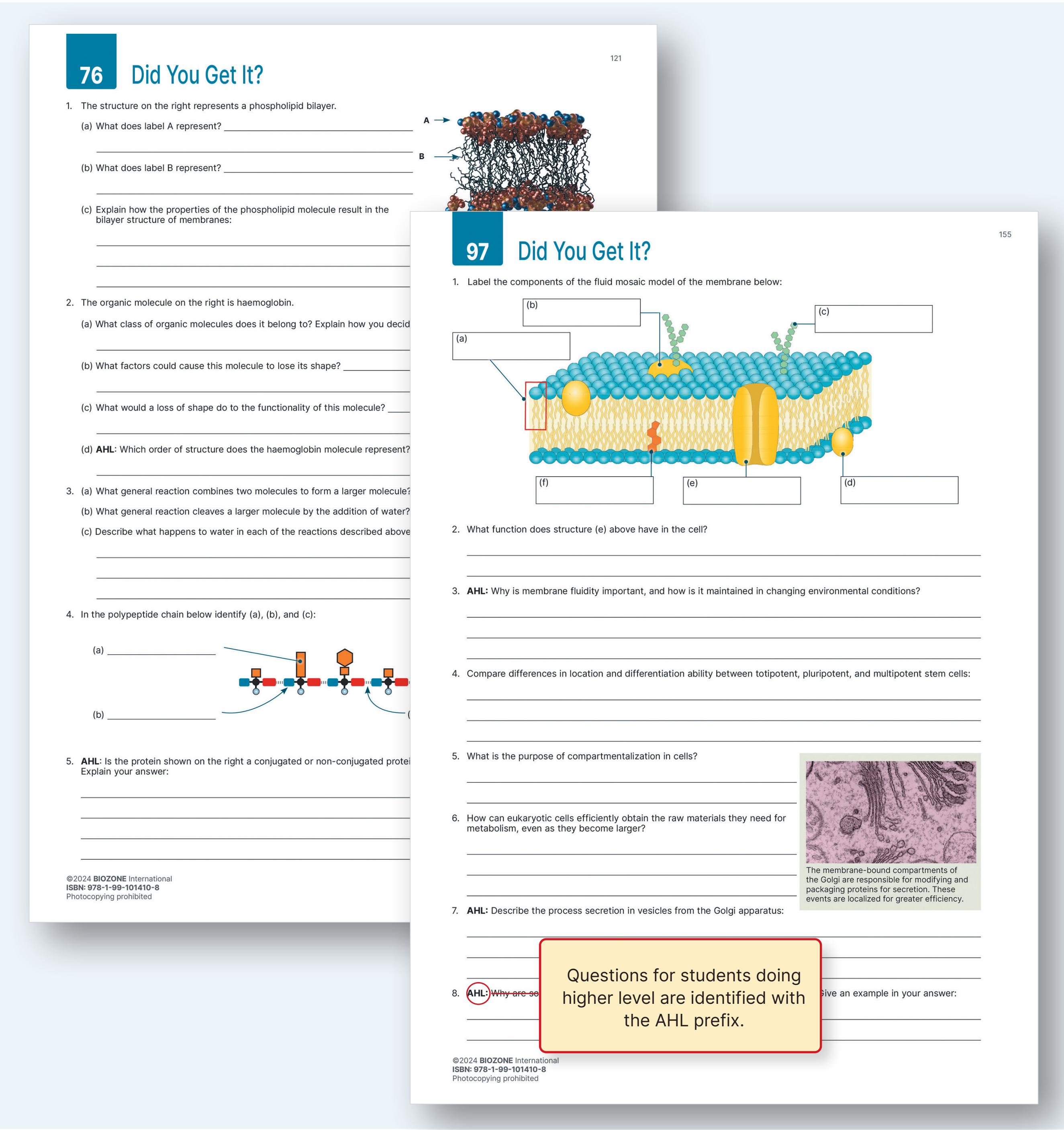
Evaluating Student Performance

IB Biology provides assessment tasks which you can use to test student understanding of the IB syllabus. Opportunities for formative and summative assessment are provided in the form of chapter assessments and theme assessments (see below and next page).

While most activities require students to record a response, we do not recommend that every question is graded. In most instances, student answers form an individual record of work, allowing students to review their answer within the context of the activity at any time. We recommend teachers are selective about activities, or questions they choose to review or grade to avoid assessment fatigue. We highly recommend that chapter and theme assessments are graded.

Chapter assessments

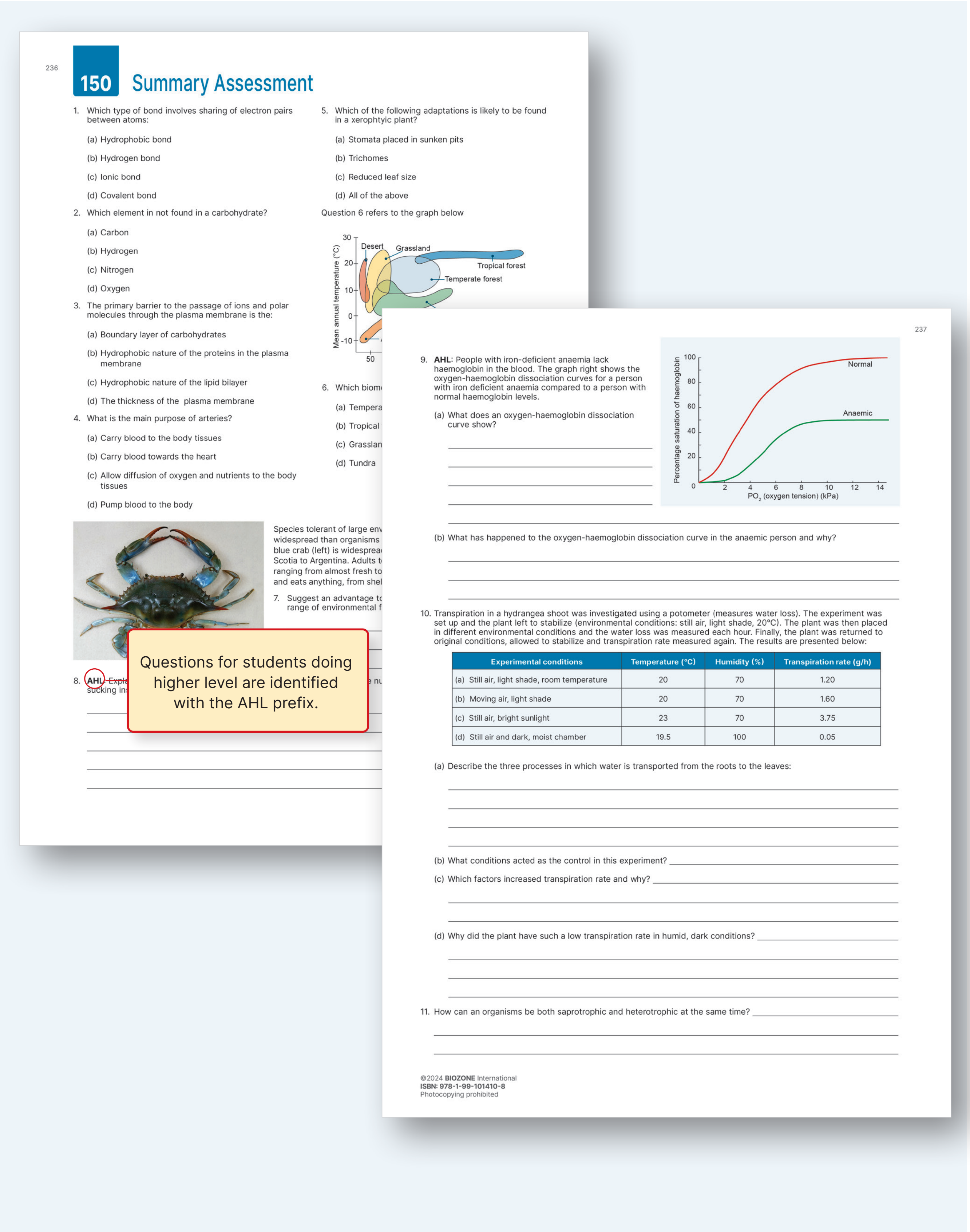
Chapters 1-16 each conclude with a *Did you Get It?* assessment task. These have been designed to test student understanding of the chapter content, and can be used to help identify any gaps or misconceptions which still need to be addressed before moving on. AHL questions are clearly identified for easy differentiation of question setting. Students undertaking the standard level course should complete the questions *without the AHL tag*. Students undertaking the higher level course should answer all questions.



Theme assessments

Longer, summative assessment tasks conclude each theme section. There are four in total. The questions allow students to demonstrate their understanding through a variety of question types including multiple choice, short answer, and longer answer responses. The questions allow students to demonstrate understanding and application of their acquired knowledge, and to analyse, evaluate, and synthesize information. These assessments can be used to help prepare students for the formal assessment requirements of the syllabus (Assessment Objectives AO1-AO3).

AHL questions are clearly identified for easy differentiation of question setting. Students undertaking the standard level course should complete the questions *without the AHL tag*. Students undertaking the higher level course should answer all questions.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150 Summary Assessment

1. Which type of bond involves sharing of electron pairs between atoms:
   (a) Hydrophobic bond
   (b) Hydrogen bond
   (c) Ionic bond
   (d) Covalent bond
2. Which element in not found in a carbohydrate?
   (a) Carbon
   (b) Hydrogen
   (c) Nitrogen
   (d) Oxygen
3. The primary barrier to the passage of ions and polar molecules through the plasma membrane is the:
   (a) Boundary layer of carbohydrates
   (b) Hydrophobic nature of the proteins in the plasma membrane
   (c) Hydrophobic nature of the lipid bilayer
   (d) The thickness of the plasma membrane
4. What is the main purpose of arteries?
   (a) Carry blood to the body tissues
   (b) Carry blood towards the heart
   (c) Allow diffusion of oxygen and nutrients to the body tissues
   (d) Pump blood to the body
5. Which of the following adaptations is likely to be found in a xerophytic plant?
   (a) Stomata placed in sunken pits
   (b) Trichomes
   (c) Reduced leaf size
   (d) All of the above

Question 6 refers to the graph below

6. Which biom
   (a) Tempera
   (b) Tropical
   (c) Grasslan
   (d) Tundra

Species tolerant of large env widespread than organisms blue crab (left) is widesprea Scotia to Argentina. Adults t ranging from almost fresh to and eats anything, from shel

7. Suggest an advantage to range of environmental f

8. AHL Expl sucking in

237

9. **AHL**: People with iron-deficient anaemia lack haemoglobin in the blood. The graph right shows the oxygen-haemoglobin dissociation curves for a person with iron deficient anaemia compared to a person with normal haemoglobin levels.
   (a) What does an oxygen-haemoglobin dissociation curve show?
   (b) What has happened to the oxygen-haemoglobin dissociation curve in the anaemic person and why?

10. Transpiration in a hydrangea shoot was investigated using a potometer (measures water loss). The experiment was set up and the plant left to stabilize (environmental conditions: still air, light shade, 20°C). The plant was then placed in different environmental conditions and the water loss was measured each hour. Finally, the plant was returned to original conditions, allowed to stabilize and transpiration rate measured again. The results are presented below:

Experimental conditions	Temperature (°C)	Humidity (%)	Transpiration rate (g/h)
(a) Still air, light shade, room temperature	20	70	1.20
(b) Moving air, light shade	20	70	1.60
(c) Still air, bright sunlight	23	70	3.75
(d) Still air and dark, moist chamber	19.5	100	0.05

   (a) Describe the three processes in which water is transported from the roots to the leaves:
   (b) What conditions acted as the control in this experiment?
   (c) Which factors increased transpiration rate and why?
   (d) Why did the plant have such a low transpiration rate in humid, dark conditions?
11. How can an organisms be both saprotrophic and heterotrophic at the same time?

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Identifying SL and HL Content

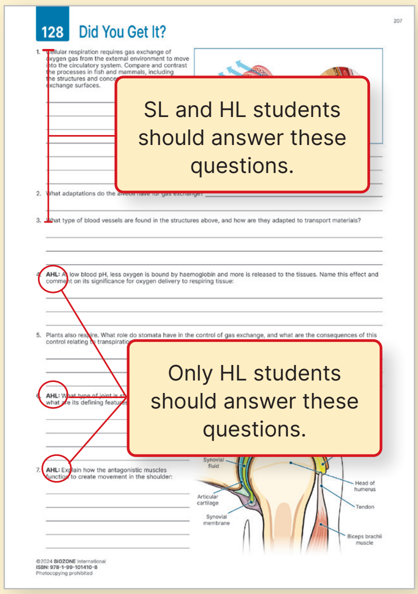
The IB Biology syllabus is taught at two levels, standard level (SL) and higher level (HL). While there is content common to both levels, students undertaking the HL course are required to complete additional material. This allows HL students to study selected topics in greater detail and expands on the breadth and depth of the material covered in the SL course, preparing students for study at university level.

The IB Biology syllabus divides content into SL and HL (to be covered by students doing both the SL and HL courses) and additional higher level (AHL). *Material marked as AHL content should only be taught to HL students*. We have tagged AHL material so teachers can easily identify the differentiated content. The identification strategies are described below.

Content pages: Activities written in orange text indicate AHL only material. This allows you to easily identify AHL material and assign it to students taking the HL course. The legend underneath the contents tells students orange text denotes AHL content.

Chapter introductions: An orange AHL tag and a yellow shaded box identify AHL statements. This material should only be assigned to students doing the HL course.

Activity tabs: Activity numbers are contained in either a blue or orange box. Blue boxes indicate the activity should be assigned to SL and HL students. An orange activity box indicates the material should only be assigned to HL students. An AHL tab is also present on the bottom of the page (inset, above).



Assessment tags: Chapter and theme assessments contain both SL and HL content. HL content is identified with an **AHL prefix** at the start of the question.

Identifying AOS and NOS Components

Application of Skills

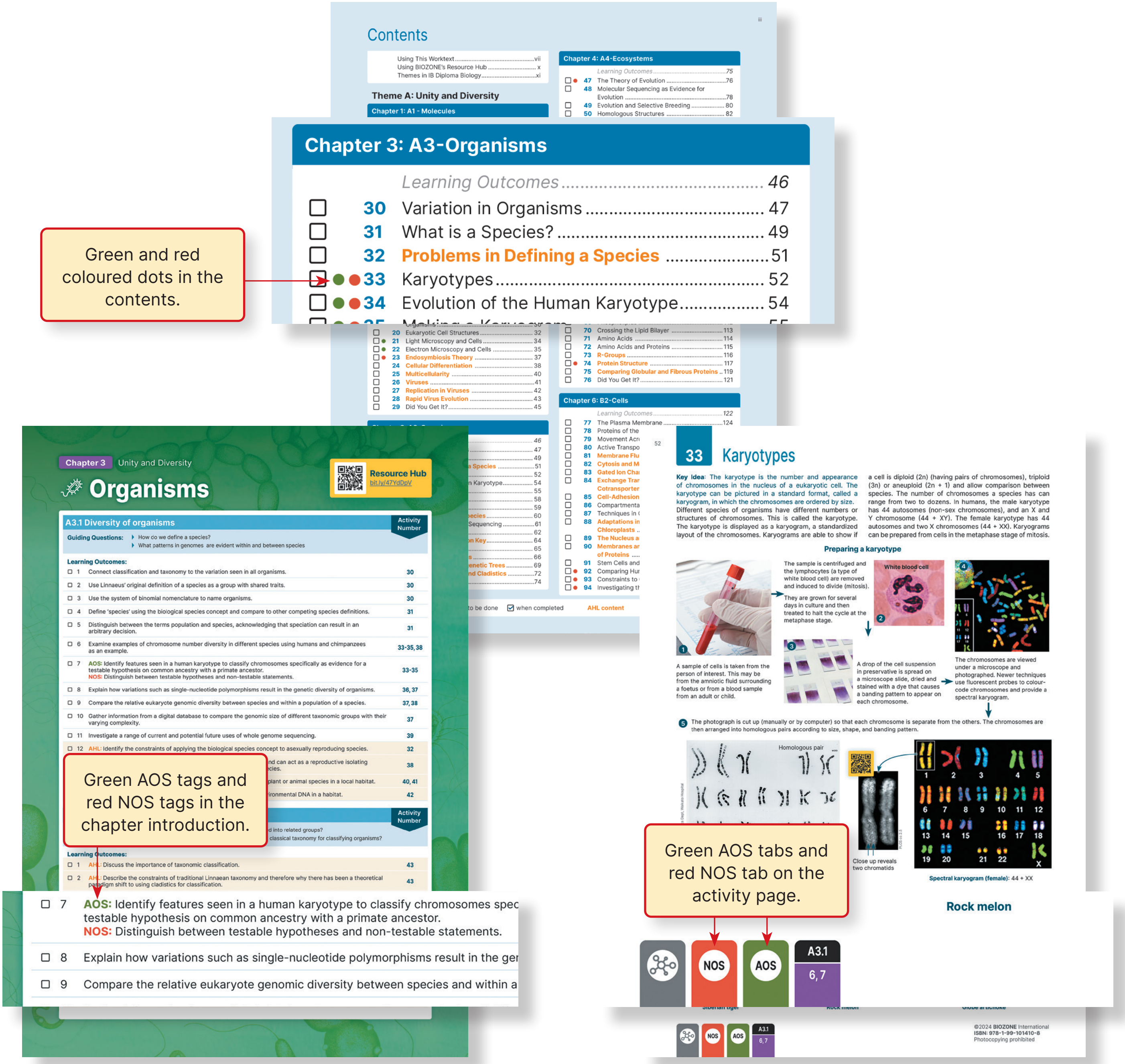
Application of skills (AOS) are directed tasks requiring students to connect a specific understanding with a skill. This is usually achieved through an action. For example, use banding patterns, length, and position of the centromere to classify chromosomes. These skills are often, but not always, associated with a practical activity. In order to help with planning and checking off required skills, activities with an AOS component have been identified in the contents, chapter introduction, and through the tab system on an activity page.

AOS material has a green tag for easy identification.

Nature of Science

The nature of science (NOS) is an overarching theme that enhances students' understandings of science concepts. It is broader than simply understanding science concepts. The NOS encompasses the purpose, features, and impact of scientific knowledge, enabling students to make informed decisions about scientifically-based personal and social issues. NOS is an important component in IB Biology, and is integral within the understandings. In order to help with planning and checking off required skills, activities with a NOS component have been identified in the contents, chapter introduction, and through the tab system on an activity page.

NOS material has a red tag for easy identification.



Teaching Strategies for Classroom Use

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

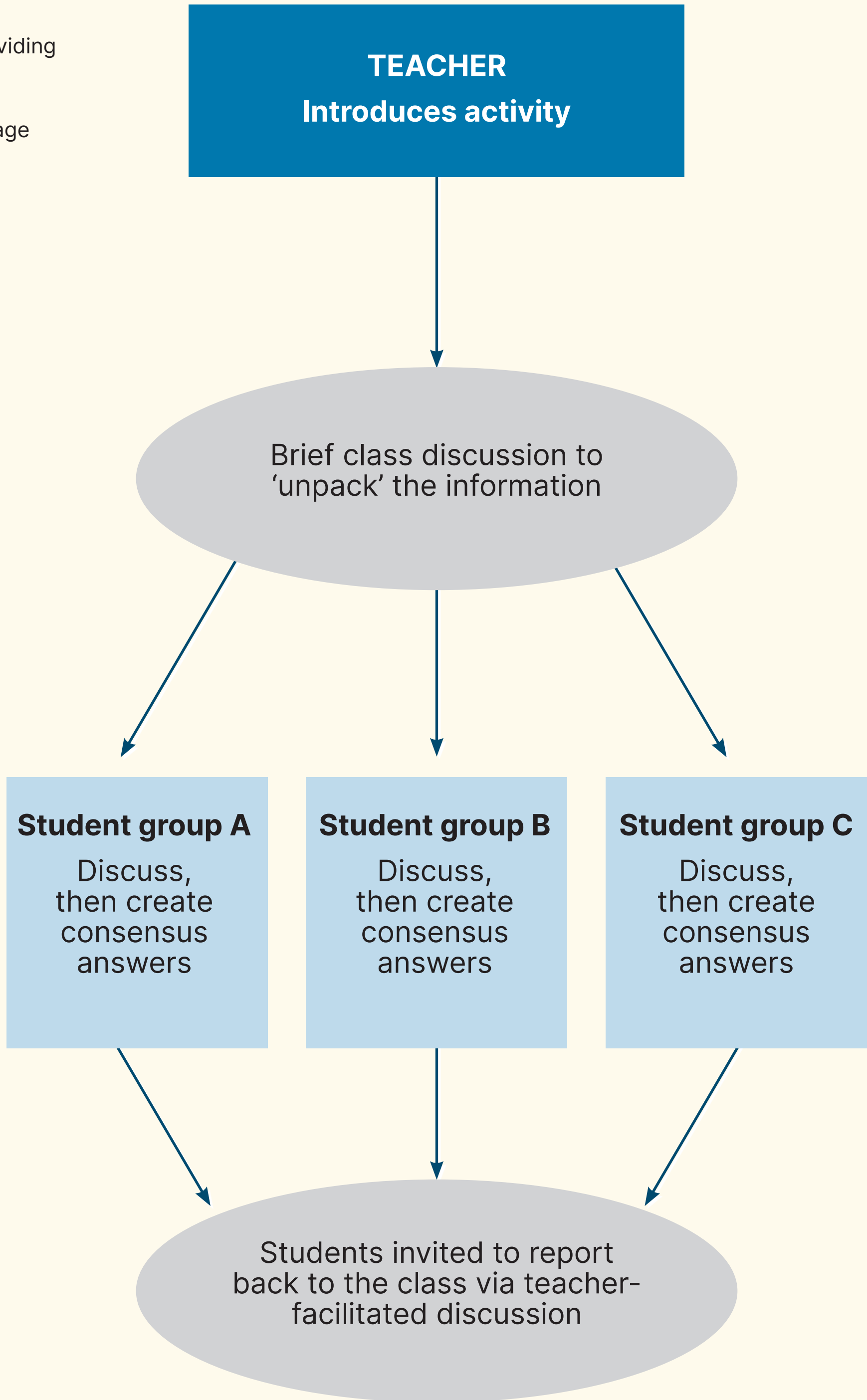
Making a start

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 or to present their findings.

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 emphasized 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 discussing questions and formulating a consensus answer (or not), not just sharing ideas.

At the end of the session, students report back on their findings. Each student should have enough knowledge to report back on the group's findings. Reporting consists primarily of providing answers to questions, but may involve presenting a report, model, or slide show, or contributing to a debate.



Using collaboration to maximize learning outcomes

- The structure of *IB Biology* 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 maximize their own and each other's learning opportunities. They are exposed to ideas and perspectives they may not have come up with on their own.
- Collaboration, listening to others, and voicing their own ideas is valuable for supporting English language learners and developing their English and scientific vocabularies.
- Use a short, informal, collaborative learning session to encourage students to exchange ideas about the answer to a question.
- A collaboration icon (right) indicates where there is an opportunity for students to work together.

Peer to peer collaboration and support

- Peer-to-peer learning is emphasized throughout the worktext, 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.
- Stronger students can assist their peers and both groups benefit from verbalizing their ideas. Students for whom English is an additional language can ask their classmates to explain unfamiliar terms and this benefits the understanding of both parties.
- *IB Biology* provides a range of activities. These include encouraging students to think about and share what they already know and then build on this knowledge by exploring and explaining content in 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 questions, or design a solution to a problem.

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.

Reviewing work and providing answers

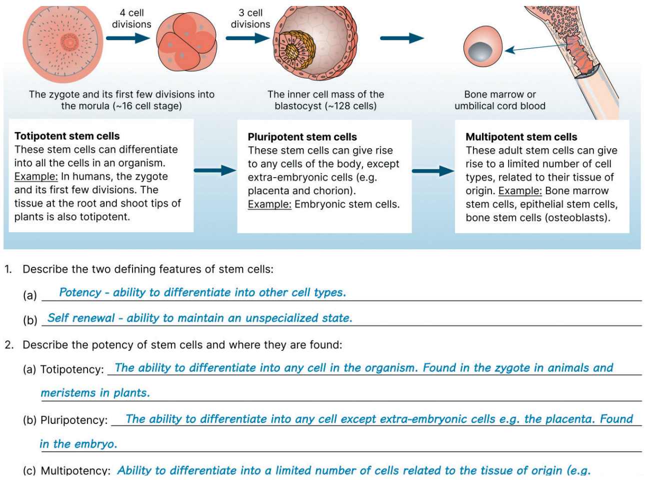
Our worktext approach encourages students to demonstrate their understanding of the content by inputting their answers on the activity page, either by writing it into the printed book or typing answers onto the digital version in BIOZONE WORLD. This approach makes it easy for students to record and share their answer and ideas with other students. They can also review their own work or peer-review the work of others. Teachers can easily review an individual's work and see how they are progressing through the content. Model answers are provided for each activity and these can be shared with students at the teacher's discretion. Self reported grading is a powerful tool for accelerating learning (CG4) and should be encouraged where possible. Students should also be encouraged to refine their answers (if needed) and deepen their level of understanding. This enhances the learning moment.

Peer feedback

Dividing students into small groups allows them to share their answers and ideas and receive immediate peer feedback. Sharing ideas and discussing alternative perspectives and solutions can broaden each student's understanding or perspective. Students may or may not come to a consensus answer through this process. Some students may wish to refine their original answer after the discussion.

Class discussion to review answers

Small groups can partake in collaborative summarizing when brought together as a larger group or class. Students can share ideas and answers through structured discussion, either as a class or within larger groups. The class benefits from hearing a range of ideas, and teachers can guide the discussion to ensure efficient use of time. At the end of the discussion, the teacher may wish to share the model answer with the 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.

Teacher review of student work

Students using the print version of *IB Biology* each have their own worktext and write their answers directly into the space provided. Teachers can revise student responses as required.

Students using the digital version of *IB Biology* input and submit their answers via the digital platform, BIOZONE WORLD. Teachers can revise each activity as required.