# DP Biology — Unit planner: INTRO — Course Introduction

IB Biology (First Assessment 2025) • SL & HL (combined class) • Year 1, Term 1 • Beijing, China • September 2026

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| **Teacher(s)** | | **Subject group and course** | Sciences: Biology |
| **Theme(s) and level(s) of organisation** | **All themes:** A Unity and diversity • B Form and function<br>C Interaction and interdependence • D Continuity and change<br>**All levels:** 1 Molecules • 2 Cells • 3 Organisms • 4 Ecosystems<br>Cross-curricular unit — all themes and levels are introduced. | **SL or HL / Year 1 or 2** | **SL/HL (combined classroom)**<br>**Year 1**<br>**Dates:** September 2026<br>Week 1, Term 1 |

## Unit description and content

**Guiding questions:**

"What does it mean to think and work scientifically?"

"How does the IB Biology programme develop scientific knowledge and practical skills?"

"What are our responsibilities as scientists in the laboratory and beyond?"

**Description:** This introductory unit establishes the shared foundations for the entire two-year IB Biology course. It orients students to programme structure, assessment requirements, laboratory protocols, and essential scientific skills. No prior biological content knowledge is assumed. All students begin on equal footing.

**Prior knowledge:** No specific IB Biology content knowledge required. Basic familiarity with scientific thinking and metric units from middle school science is helpful but not assumed.

**Content covered in this unit:**

- IB Biology programme structure: Themes A–D and Levels of Organisation (Molecules, Cells, Organisms, Ecosystems)
- Assessment components and weightings: Papers 1A, 1B, 2A, 2B (80%) and IA (20%)
- SL vs HL differences: HL-only units (A2.1, A2.3, A3.2, B3.3, C2.1, D2.2) identified
- Laboratory safety: PPE, risk assessment, CLEAPSS student safety sheets, ethical principles
- Scientific skills: SI units, significant figures, decimal places, measurement uncertainty (± notation), accuracy vs precision, random vs systematic error
- Data presentation: graph types, axes conventions, error bars (SD, range, SE), data tables
- IB Biology command terms (all 30+ terms — Objectives 1, 2 and 3)

## DP assessment(s) for unit

**External assessments (80% of final grade):**

- Paper 1A: Multiple-choice — 30 MCQ / 30 min (SL); 40 MCQ / 40 min (HL)
- Paper 1B: Data-based questions — 60 min (SL); 75 min (HL)
- Paper 2A: Data-based and short-answer questions — Part of Paper 2
- Paper 2B: Extended-response questions — Part of Paper 2

**Internal assessment (20% of final grade):**

- Scientific Investigation (IA): max 3,000 words (effective from May 2026 session)
- Four criteria: Exploring, Investigating, Concluding, Evaluating (each /6, total /24)
- Teacher-assessed; externally moderated by IB examiners
- Group 4 collaborative project (introduced here; not separately graded)

**Note:** This introductory unit does not directly assess specific biological content. It develops the scientific skills that are assessed across ALL four papers and the IA throughout the two-year course. Investing in these skills now has a direct, compounding return across every subsequent unit.

- Microscopy: compound light microscope technique, magnification formula, scale bar calculation, scientific drawing conventions, types of microscopy overview (LM, TEM, SEM)
- Academic integrity: IB policy, malpractice, IA authenticity, responsible use of AI tools

**Prior knowledge from previous units**

No prior IB Biology unit. This is Unit 1 in the teaching sequence.

**Recommended prior learning (from middle school / IGCSE):**

- Basic scientific method: observation, hypothesis, experiment, conclusion
- Familiarity with metric units: metres, grams, seconds, Celsius, litres
- Elementary experience with a compound light microscope
- Reading and constructing simple tables and line graphs

**Links to other units**

**Forward links (all 40 units):**

Scientific skills, lab safety and command term literacy developed here are applied in EVERY subsequent unit. This unit is the prerequisite for the entire course.

**Critical forward links:**

- IA-INTRO (Year 1, T2): RQ formulation, methodology design, variables
- IA-DATA (Year 2, T3): Data collection, statistical analysis, IA report writing
- All 35 content units: accurate measurement, graphing with error bars, command term use in practical write-ups
- All Paper 1B / 2A practice: data-based question skills established here

## Establishing the purpose of the unit

**Transfer goals** prompt students to “transfer” or apply their knowledge, skills and concepts from the unit to new/different circumstances, on their own without scaffolding from the teacher.

**List one to three transfer goals for this unit. The transfer goals list will depend on the sequence of units.**

**Transfer goals for this unit:**

**1.** Students will independently apply scientific skills — accurate measurement, SI units, significant figures, uncertainty notation, error bars and graph construction — to any biological investigation throughout the two-year course, without teacher prompting.

**2.** Students will correctly identify any IB command term in an examination question and structure their response to match the appropriate depth, detail and format required to achieve full marks.

**3.** Students will follow all laboratory safety protocols and complete risk assessments independently before any practical activity, without teacher reminders, throughout the two-year course.

**Concepts, themes and linking questions to be explored:**

**All Themes (A–D) — cross-curricular:** Scientific knowledge in biology is generated through the same empirical process regardless of the theme. This unit introduces the tools and inquiry skills that underpin all biological investigation.

**Nature of Science:** The scientific method, role of models, importance of measurement uncertainty, falsifiability and collaborative peer review are introduced here and revisited throughout the course.

**Linking question A:** How do scientists collect, present and analyse data in a way that allows others to evaluate their findings?
**Linking question B:** What is the difference between accuracy and precision, and why does this distinction matter in biological investigation?
**Linking question C:** To what extent can science be objective, given that what we observe depends on the instruments and methods we use?

**Guiding questions for this unit:**

- What does it mean to think and work scientifically?
- How does the IB Biology programme develop scientific knowledge and skills over two years?
- What are our responsibilities as scientists in the laboratory and beyond?
- How do we present and interpret biological data in a way that is honest and reproducible?

## Teaching and learning through inquiry

| Concepts, skills and nature of science — essential understandings | Learning process (in order of teaching sequence) |
|---|---|
| Students will have the following understandings in relation to concepts, application of skills and nature of science. Refer to the IB Biology Guide (FA2025) Tools and Inquiry section for full detail. | Check the boxes for any pedagogical approaches used during the unit. Aim for a variety of approaches to help facilitate learning. |
| **1. IB Biology Programme Structure and Assessment Overview** | |
| **Programme structure:**<br>• Theme A: Unity and diversity — common ancestry, evolution, biodiversity<br>• Theme B: Form and function — adaptations, structure–function relationships<br>• Theme C: Interaction and interdependence — systems, homeostasis, ecology<br>• Theme D: Continuity and change — genetics, inheritance, natural selection<br><br>**Levels of organisation:**<br>• Level 1: Molecules — chemical basis of life (Themes A–D)<br>• Level 2: Cells — structure and function of cells (Themes A–D)<br>• Level 3: Organisms — whole-organism physiology and ecology (Themes B–D)<br>• Level 4: Ecosystems — ecology and environmental biology (Themes A, C, D)<br><br>**Assessment components and weightings:**<br>• Paper 1A: Multiple-choice — 30 MCQ (SL, 30 min) / 40 MCQ (HL, 40 min)<br>• Paper 1B: Data-based questions — 60 min (SL) / 75 min (HL)<br>• Paper 2A: Data-based and short-answer questions (within Paper 2)<br>• Paper 2B: Extended-response questions (within Paper 2); SL 90 min / HL 120 min total for Paper 2<br>• Internal Assessment: Scientific Investigation, 3,000 words max, 20% of final grade | ☒ **Activity 1: Programme overview and course orientation**<br>Teacher presents the two-year course roadmap using the IB Biology syllabus roadmap (available on IB PRC). Students are guided through the four themes, their organising ideas, and the levels of organisation. The distinction between SL and HL content is explained clearly, with HL-only units colour-coded on a printed course map. Students receive their personalised two-year course planner template.<br><br>☒ **Activity 2: Assessment demystification session**<br>Teacher displays and explains each assessment component with a sample question from each paper type. Students calculate the approximate marks available per paper and understand the weighting. Students note key facts: IA word limit, marking criteria, Group 4 Project purpose.<br><br>☒ **Small group/pair work 1: Assessment “who gets what marks” activity**<br>In pairs, students receive a past Paper 2B question (4–6 marks) with two student answers and the mark scheme. They attempt to award marks to each answer and explain their reasoning. Class discusses: What did Answer B do that Answer A did not? This demystifies mark scheme language and introduces command terms in context. |

- Group 4 Project: ~10 hours; collaborative; not separately graded

**SL vs HL differences (for combined class):**

- HL has 6 additional units taught separately during shared lessons: A2.1, A2.3, A3.2, B3.3, C2.1, D2.2
- HL has extended content in several shared units (indicated in each unit planner)
- During HL-only teaching, SL students self-study using a provided menu of activities

## 2. Laboratory Safety and Ethical Principles

**Personal protective equipment (PPE):**

- Lab coat: mandatory; protects clothing and skin from chemicals and biohazards
- Safety goggles: mandatory when working with chemicals, heat or glassware
- Nitrile gloves: when handling hazardous chemicals or biological material Closed-
- toe shoes: required in all laboratory sessions; sandals prohibited

**General laboratory rules (CLEAPSS-informed):**

- No food or drink in the laboratory at any time
- Long hair tied back; loose clothing secured before entering the lab
- Know the locations of: fire extinguisher, fire blanket, eye wash station, first aid kit, emergency exit, spill kit
- Never leave an experiment unattended when heat or hazardous materials are in use
- All waste disposed of as directed: sharps in sharps bins; chemicals via appropriate route
- Report all accidents, spills and near-misses to the teacher immediately

**Risk assessment framework:**

- Hazard identification: biological (pathogens, allergens), chemical (corrosive, flammable), physical (glassware, heat), ethical
- Risk level: severity × likelihood matrix (low / medium / high)
- Control measures: elimination, substitution, engineering controls, administrative controls, PPE
- CLEAPSS Student Safety Sheets: mandatory reference for all chemicals and procedures

**Ethical principles in biological investigation:**

- Minimise harm to living organisms: do not collect more material than needed
- No human tissue samples (blood, saliva) without explicit approved protocol
- Environmental responsibility: dispose of biological material safely; return field organisms
- Respect for human subjects in any survey or observational research

☒ **Activity 3: Laboratory safety contract, tour and quiz**

Students receive the school's laboratory safety contract. Teacher leads a guided tour of the laboratory, requiring students to locate and correctly identify all safety equipment. Students sign the safety contract. A 10-question safety quiz (paper or Kahoot) must be passed (100%) before any practical work begins. Students who do not pass retake immediately.

☒ **Small group/pair work 2: Risk assessment workshop**

Groups of 3 students receive 5 biology practical scenario cards (e.g. heating a test tube of acidified starch, using a scalpel on plant material, preparing agar plates with bacteria, using electric hotplate with oil, extracting DNA from fruit in ethanol). For each scenario, groups complete a risk assessment matrix: (a) hazard, (b) risk level, (c) control measures. Groups share results; teacher displays model answers and discusses borderline decisions.

☒ **Other: CLEAPSS Student Safety Sheets exploration**

Students are directed to the CLEAPSS Student Safety Sheets website (science.cleapss.org.uk/resources/student-safety-sheets/) and practise finding hazard information on two chemicals they will use in upcoming units (e.g. iodine solution, methylene blue). This establishes the habit of checking safety information before any practical.

## 3. Scientific Skills: Measurement, Uncertainty and Data Presentation

**SI units and common biological measurements:**

- Base units: metre (m), kilogram (kg), second (s), kelvin (K), mole (mol), ampere (A)
- Common derived units in biology: $cm^3$, $dm^3$, mol $dm^{-3}$, g $cm^{-3}$, nm (wavelength/size)
- Key conversions: 1 $dm^3$ = 1 L; 1 $cm^3$ = 1 mL; 1 μm = $10^{-6}$ m; 1 nm = $10^{-9}$ m

**Significant figures (sig figs):**

- Non-zero digits: always significant
- Zeros between non-zero digits: significant (e.g. 405 has 3 sig figs)
- Leading zeros: NOT significant (0.0042 has 2 sig figs)
- Trailing zeros after decimal point: significant (3.40 has 3 sig figs)
- In multiplication/division: answer has fewest sig figs of input values
- In addition/subtraction: answer has fewest decimal places of input values

**Measurement uncertainty:**

- Instrument uncertainty: typically ± half of the smallest scale division
- Record as: measurement ± uncertainty, with units (e.g. 25.4 ± 0.1 cm)
- Accuracy: closeness to the true value; Precision: reproducibility of measurements
- Random errors: reduce by increasing repeats and sample size
- Systematic errors: reduce by calibrating instruments; checking zero errors

**Data presentation conventions:**

- Tables: clear headings with units in column header (not in data cells); consistent sig figs/decimal places; title
- Line graphs: continuous IV; x-axis = IV, y-axis = DV; labelled axes with units; data points; line or curve of best fit
- Bar charts: discrete IV; bars do not touch; correct scale; error bars
- Scatter plots: for correlation; line of best fit; do not force through origin
- Error bars: must represent SD, SE or range; must be labelled in figure legend

☒ **Activity 4: Units and significant figures — worked examples and worksheet**

Teacher models how to: (a) record a measurement with correct units, sig figs and uncertainty; (b) calculate sig figs in a product and a sum. Students complete a 20-problem sig figs and units worksheet independently. Marked in class with immediate feedback. Common errors discussed (e.g. trailing zeros, unit conversion mistakes).

☒ **Small group/pair work 3: Measurement workshop**

Students use rulers (mm resolution), digital balances (0.01 g), 25 $cm^3$ graduated cylinders (±0.5 $cm^3$) and 0–100°C thermometers (±0.5°C) to make five different measurements of provided objects/liquids. They record each with correct units, sig figs and uncertainty notation. Group results are compared: class discusses sources of random error (reading parallax, inconsistent technique) vs systematic error (miscalibrated balance).

☒ **Activity 5: Graph construction task — paper and Excel**

Teacher demonstrates constructing a line graph in Excel with error bars (SD), following IB conventions. Students receive a data table (enzyme activity at five temperatures, with mean and SD for each). They construct: (a) a hand-drawn graph with error bars, (b) the same graph in Excel. Peer assessment using a 10-point marking checklist (title, axis labels, units, scale, data points, error bars, best-fit line, appropriate graph type). Teacher provides model graph for comparison.

☒ **Multimedia presentation: Graph critique and data interpretation**

Teacher projects 4 graphs with deliberately introduced formatting errors (missing units, no error bars, incorrect scale, disconnected data points instead of best-fit line). Students identify the errors and suggest corrections. Teacher then shows an actual IB Paper 1B question and models a full worked answer using correct command term language.

## Application of Skills (AoS) — Cross-unit reference

**Cross-cutting skills established in this unit:**

- Inquiry 2 (Investigating): safe and accurate data collection; recording with units and uncertainty; systematic data tables
- Inquiry 3 (Concluding/Evaluating): processing data (mean, SD, % change); constructing graphs; interpreting trends and anomalies
- General mathematics: sig figs; unit conversions; mean; SD; error bars; percentage change; magnification calculations

**Where these skills appear in IB assessments:**

- Paper 1B: data-based questions (describe trends, calculate from tables, interpret error bars)
- Paper 2A, Section A: short-answer data questions (describe, calculate, explain from graphs/tables)
- Paper 2B: extended-response evaluation of experimental design
- IA (all four criteria): skills from this unit are assessed in every section of the Scientific

- Technology: Microsoft Excel or Google Sheets for data tables, AVERAGE(), STDEV(), charts with error bars

Investigation

Reference: IB Biology Guide (FA2025) — Tools and Inquiry section (pp. 1–27)

## 4. IB Biology Command Terms

**Objective 1 terms (brief, factual responses):**

- State: give a specific fact without further detail
- List: give several points, no explanation required
- Define: give the precise meaning of a word, phrase or quantity
- Label: add names or brief annotations to a diagram
- Identify: recognise and name a feature or select a correct answer
- Outline: give a brief summary of the main points only
- Annotate: add short explanatory notes to a diagram or graph
- Measure: find a value using an instrument or from a graph; give units
- Draw: produce an accurate, labelled, to-scale diagram (pencil, no shading)

**Objective 2 terms (longer, structured responses):**

- Describe: give a detailed account of the main features; no explanation required
- Explain: give reasons for or mechanisms behind a feature or process (the “why” and “how”)
- Distinguish: state clearly the differences between two or more items
- Compare: give both similarities AND differences between two or more items
- Calculate: find a numerical answer using given data and a formula; show working
- Deduce: reach a conclusion from information provided in the question
- Predict: give an expected result based on reasoning or a pattern in data
- Suggest: propose a hypothesis or explanation (may have more than one correct answer)
- Construct: represent information as a graph, table or diagram

**Objective 3 terms (critical, evaluative responses):**

- Analyse: break down information to identify patterns, trends and draw conclusions
- Evaluate: assess merits and limitations; make a justified judgement
- Discuss: give a balanced account considering multiple perspectives; no single correct answer
- Justify: give reasons and evidence to support a conclusion or decision
- Design: plan an experiment, including IV, DV, controls, materials, method
- Derive: reach a result by reasoning and calculation from first principles

☒ **Activity 6: Command terms card sort and matching activity**

Students receive 28 command term cards and 28 definition cards. In pairs, they match each term to its definition, then sort cards into three piles (Objective 1, 2, 3). Teacher projects correct answers. Students self-correct and note any terms they found difficult.

☒ **Small group/pair work 4: Exam question command term analysis**

Students receive 6 past Paper 2A/2B questions. For each question, they: (a) underline the command term, (b) identify its objective level (1, 2 or 3), (c) write a 3-bullet plan of what a full-mark answer would include. Teacher reviews plans against mark scheme, emphasising the difference between “describe” and “explain” (the most frequently confused pair).

☒ **Student explanation activity: Command term “spot the difference”**

Each pair receives one command term and must explain to the class: (a) what it means, (b) what a full answer looks like, (c) how it differs from one similar term. The teacher pre-selects common confusions to address: describe vs explain; compare vs distinguish; evaluate vs discuss; state vs outline. Most confident students explain to the whole class; others work in pairs.

☒ **Homework: Command term practice writing task**

Students write model answers to three exam-style questions using different command term levels (one Obj 1, one Obj 2, one Obj 3), based on a biological topic from their previous science education. Marked by teacher with written feedback on command term compliance. This baseline assessment also informs differentiation planning.

## 5. Microscopy Skills: Technique, Magnification and Scientific Drawing

**Parts of a compound light microscope:**

- Eyepiece (ocular lens): typically ×10; viewer looks through this
- Objective lenses: typically ×4, ×10, ×40 (and oil-immersion ×100); rotate on nosepiece
- Total magnification = eyepiece magnification × objective magnification
- Stage with stage clips: secures and positions the slide
- Condenser: focuses light from lamp onto specimen; adjust for brightness
- Iris diaphragm: controls amount of light; adjust for contrast
- Coarse focus: initial rough focusing; fine focus: final precise adjustment

**Magnification and actual size calculation:**

- Formula triangle: M = I / A (M = magnification; I = image size; A = actual size)
- Actual size = image size ÷ magnification (rearrange triangle: A = I / M)
- Scale bar method: measure scale bar on image (μm ruler), use as reference to find magnification
- Units: express answer in appropriate unit (μm for cells and most organelles; nm for molecules)
- Example: cell image = 40 mm wide at ×400 total magnification → actual size = 40 mm ÷ 400 = 0.1 mm = 100 μm

**Scientific drawing conventions (IB requirements):**

- Sharp pencil only (H or 2H); no shading, colouring or freehand curves
- Clear, ruled straight lines for labels; label lines must NOT cross each other
- Title: specimen name, stain used (if any), total magnification
- Scale bar drawn on the diagram, representing the actual measurement in μm or mm
- Proportions must accurately reflect the relative sizes of structures seen

**Types of microscopy — overview (NOS context):**

- Light microscope (LM): max resolution ~200 nm; max magnification ~×1,500; living and fixed specimens; coloured stains
- Transmission electron microscope (TEM): resolution ~0.1 nm; max magnification ~×500,000; thin-sectioned, dead specimens; black and white
- Scanning electron microscope (SEM): resolution ~1 nm; produces 3D surface images; dead specimens

☒ **Practical: Wet mount preparation and microscopy technique**

Students prepare wet mounts of: (a) onion epidermal cells (add iodine solution to stain nuclei and cell walls); (b) human cheek cells (add methylene blue). Working through ×4, ×10 and ×40 objectives, students focus each specimen, adjust the iris diaphragm for contrast, and identify cell structures. They sketch what they see at each magnification and record the total magnification. Students then calculate the actual size of one cell using the formula A = I/M.

☒ **Activity 7: EM image interpretation and scale bar calculation**

Students receive three TEM images (one prokaryote, one animal cell, one plant cell) with scale bars. For each image: (a) calculate the actual size of one named organelle, (b) identify and label six structures, (c) state whether the cell is prokaryotic or eukaryotic, justifying based on visible features. Teacher circulates to support scale bar reading.

☒ **Scientific drawing activity: formal IB-standard drawing**

Students produce a formal scientific drawing of an onion epidermal cell from their microscope observation. They apply all IB conventions: sharp pencil, no shading, ruled label lines, title (specimen, stain, magnification), and a correctly scaled scale bar. Drawing is peer-assessed using a 12-point marking checklist before teacher review.

☒ **Individual presentation / extension: Types of microscopy comparison**

HL students (or all as extension): research and present a 5-slide comparison of LM, TEM and SEM, addressing: resolution, magnification, specimen preparation, whether specimen is living or dead, and one specific IB Biology example of use. This introduces the NOS theme of how technology shapes biological knowledge and is referenced again in units A2.1, A2.2 and B2.2.

## 6. Academic Integrity and IA Introduction

**IB Academic Integrity policy — key principles:**

- Authentic: all work submitted must be the student's own original work
- Balanced: students must acknowledge the work of others through proper citation
- Fair: no action may give a student an unfair advantage over others

**Forms of malpractice (prohibited):**

☒ **Activity 8: Academic integrity case study discussion**

Students read four anonymised scenarios and decide whether each constitutes malpractice. Scenarios include: (a) copying a graph from a textbook without citing the source; (b) using ChatGPT to write the conclusion section of an IA; (c) sharing a raw data table with a classmate; (d) conducting a home experiment with a friend and submitting identical IA reports. Groups discuss and vote on each case. Teacher facilitates class discussion on

- Plagiarism: presenting another person's work, ideas or data as your own without acknowledgement
- Fabrication: inventing, falsifying or manipulating data in an IA or other assessment
- Collusion: working with another student on individual work that is then submitted as solely your own
- Duplication: submitting the same work for more than one IB assessment
- Misuse of AI: submitting AI-generated text as your own work in any assessed component is malpractice

**IA overview — early introduction:**

- Scientific Investigation (IA): 20% of final IB Biology grade; 3,000-word maximum (May 2026 onward)
- Four equal assessment criteria: Exploring, Investigating, Concluding, Evaluating (each /6, total /24)
- Teacher-assessed; externally moderated by IB examiners; one submission only
- Full IA guidance, timeline and RQ formulation to be covered in IA-INTRO (Year 1, Term 2)
- Students may begin thinking about potential IA topics from this unit onward

borderline cases, emphasising that intent is not a mitigating factor.

☒ **Activity 9: IA overview and Q&A session**

Teacher provides a concise overview of the IA: structure, four assessment criteria, timeline, and what constitutes an appropriate investigation. Students read the school's Academic Integrity Policy (1-page summary version). Students ask questions about what is and is not permitted. Teacher explains the school's referencing expectations (APA or MLA as per school policy). Students note the IA submission date in their course planner.

## SL / HL Differentiation within this Unit

**SL and HL students — combined activities:**

There is no HL-only content in this introductory unit. All students complete all activities and develop the same scientific skills foundation. Differentiation in this unit is by outcome and extension only.

**For SL students — scaffolding:**

- Provide a structured lab report template with sentence starters and headings pre-filled for the first practical report; progressively remove scaffolding
- Provide a laminated "command terms at a glance" reference card for folder use during early units
- Scaffold the graph construction activity with a partially completed example graph
- Bilingual English–Mandarin key vocabulary list (for Chinese-medium students)

**For HL students — extension:**

- Microscopy comparison presentation (LM vs TEM vs SEM): connects to NOS theme of how technology shapes knowledge
- Research the history of microscopy (Hooke, Leeuwenhoek, electron microscopy development) and write a 200-word NOS reflection
- Graph challenge: given a complex ecology dataset (population growth over time), choose the most appropriate graph type, justify the choice, construct the graph, and interpret trends using command terms
- Begin identifying a potential IA topic: identify one biological question you would like to investigate; note it in your course planner

**HL-only units (upcoming):**

Remind HL students that the following units will be taught during shared lesson time, during which SL students will self-study: A2.1, A2.3, A3.2, B3.3, C2.1, D2.2. Introduce the SL self-study activity menu for use during these sessions.

## Formative Assessment

**Low-stakes prior knowledge quiz:** "What do you already know about scientific skills and lab work?" — delivered at the start of the unit to inform teacher planning and differentiation (online via Kahoot or Mentimeter).

**Lab safety quiz:** 10-question quiz on lab rules and equipment locations; students must achieve 100% before any practical work begins. Immediate re-sit available. Results filed by teacher.

**Significant figures and units worksheet:** 20 problems; marked in class; teacher provides annotated model answers; common errors identified and addressed.

**Graph construction peer assessment:** Using a 10-point marking checklist before teacher review. Teacher collects graphs and provides written feedback.

**Command terms card sort:** Self-corrected against projected answers; students note in their notebooks which terms they found most difficult.

**Microscopy practical:** Teacher circulates and gives immediate oral feedback on technique. Scientific drawings are peer-assessed against the 12-point checklist.

**Periodic formative checks:** Mini-whiteboard responses, Exit tickets and Mentimeter word clouds used at end of lessons to identify misconceptions (especially: sig figs, error bars, describe vs explain).

## Summative Assessment

**End-of-unit test (30 min):** Section A — 15 MCQ on programme structure, safety, command terms and sig figs. Section B — 2 short-answer questions: (a) calculate actual cell size from a given image measurement and magnification; (b) identify 5 organelles from an EM image and state the function of two.

**Formal microscopy practical report:** One complete microscopy investigation (onion epidermal cells), written using the IB lab report structure. Includes: RQ, method summary, raw data table with units/sig figs/uncertainty, scientific drawing with scale bar, calculation of actual cell size, brief conclusion and identification of two sources of error with suggested improvements. Marked by teacher against IA-style criteria.

**Command terms written task (homework):** Students write full-mark answers to 3 exam-style questions using different command term levels (Obj 1, 2 and 3), based on biological topics they studied at their previous school. Marked by teacher; used to identify students who need targeted support.

## Differentiation

### ⊠ Affirming identity and building self-esteem

- Acknowledge openly that students come with different prior scientific experiences. State explicitly that no prior knowledge is assumed and all students start from the same point in IB Biology.
- Celebrate diversity in scientific tradition: in the NOS discussion on microscopy history, acknowledge contributions from Chinese scholars to the history of observation and natural science.
- Use varied modes of contribution in discussions: oral, written notes, drawing, mini-whiteboard — so that students who are less confident in spoken English can still participate fully and visibly.
- For Chinese-medium students: provide a bilingual English–Mandarin key vocabulary list for all scientific terms introduced in this unit (see Resources). Validate the use of Mandarin as a thinking language alongside English.

### ⊠ Valuing prior knowledge

- Begin with a KWL chart (“Know / Wonder / Learned”): students record what they already know about scientific skills and laboratory work. Use responses to plan differentiation.
- Allow students with strong prior microscopy skills (e.g. from IGCSE Double Award or national curriculum biology) to support peers during the practical, building their confidence and consolidating their own understanding.
- Students from IB MYP backgrounds may already be familiar with ATL skills — activate

### ⊠ Scaffolding learning

- Provide a structured lab report template with sentence starters for the first practical report. Progressively remove scaffolding across subsequent units.
- For the significant figures worksheet, begin with teacher-annotated worked examples before moving to independent practice.
- Provide a laminated “command terms at a glance” reference card (English and Mandarin). Students keep this in their biology folder throughout Year 1.
- Share a one-page unit roadmap (all 6 topics as a visual timeline) at the start of the unit; revisit at the beginning and end of each lesson to show “where we are.”
- Use the Think–Pair–Share routine (Project Zero) for discussions, giving all students preparation time before public sharing.

### ⊠ Extending learning

- Students research the history of microscopy (Hooke 1665, Leeuwenhoek, development of electron microscopy) and write a 250-word NOS reflection on how technology changes scientific knowledge.
- Graph extension: students analyse a complex published ecology dataset, choosing the appropriate graph type, justifying their choice, constructing the graph with error bars, and writing a 3-sentence interpretation using command terms.
- Students write their own “linking questions” connecting the scientific skills from this unit to a specific biological topic they are most interested in exploring during the two-year course.

this prior knowledge explicitly in the ATL discussion.

| Common Misconceptions — Teacher Reference (from IB Examiner Reports) | |
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| **Misconception 1: More decimal places = more accurate**<br>Reality: Reporting more decimal places than the instrument can measure creates false precision. A ruler reading to 1 mm cannot give 25.43 mm. Precision is set by the instrument, not by the student's choice of decimal places. Counter: show examples and discuss what ± means.<br><br>**Misconception 2: Error bars represent mistakes**<br>Reality: Error bars represent natural biological variability in data (standard deviation of repeated measurements). They are evidence of thorough investigation, not errors. A graph without error bars is actually considered incomplete in IB Biology. Counter: use the analogy of measuring the heights of 20 students — variation is expected and informative.<br><br>**Misconception 3: "Describe" and "Explain" are interchangeable**<br>Reality: Describe = state what is observed (what, where, how much — no mechanism). Explain = give reasons for what is observed (why, how, what causes — mechanism required). Students who explain when asked to describe waste time; students who describe when asked to explain lose marks. Counter: the "spot the difference" command terms activity directly addresses this. | **Misconception 4: Actual size = image size × magnification**<br>Reality: Actual size = image size ÷ magnification (divide, not multiply). The magnified image is LARGER than the actual specimen, so dividing gives the real, smaller size. Counter: use a memory triangle (M = I/A); practice 5 numerical examples before any practical work.<br><br>**Misconception 5: Higher magnification is always better**<br>Reality: Higher magnification gives a smaller field of view, often less light, and does not improve resolution beyond the instrument's limit. Resolution (minimum resolvable distance) is the key limiting factor. Counter: demonstrate this practically by going from ×10 to ×40: the image gets larger but may become blurry.<br><br>**Misconception 6: Every investigation must start with a hypothesis**<br>Reality: In IB Biology, a hypothesis is only appropriate when there is an existing theoretical basis to make a prediction. Exploratory and observational investigations (including some IA approaches) may not require a hypothesis. Counter: discuss the difference between a hypothesis-based IA and a database-based or observational IA. |

## Nature of Science (NOS) Connections

| NOS Theme | Connection to this unit and forward link |
|---|---|
| **Use of models and their limitations** | Significant figure rules and uncertainty notation are models of the real limits of measurement instruments. Models simplify reality; students learn that all data involves judgement and that models have limitations (revisited in A1.1, B2.1 and throughout). |
| **Reproducibility and reliability** | During the measurement workshop, students observe that repeated measurements of the same object give slightly different values. This introduces the fundamental principle that scientific conclusions require repetition, and that uncertainty is inherent in all empirical work. |
| **Technology changes what we can know** | The development of the microscope from Hooke and Leeuwenhoek (1600s) to TEM (1930s) and cryo-EM (1970s–present) shows how instruments expand the boundaries of biological knowledge. This theme recurs in A2.2 (cell structure), B2.1 (membrane models) and D1.1 (DNA replication). |

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| **Falsifiability** | A scientific hypothesis must be falsifiable — it must be possible to design an experiment that could prove it wrong. Introduced here in the context of designing biological investigations; revisited in the IA-INTRO unit. |
| **Collaborative nature of science and peer review** | The Group 4 Project, introduced here, models collaborative science. The academic integrity discussion illustrates why honesty and reproducibility are essential: science works because it is verifiable by others. Forward link: Group 4 Project (Year 1, T2). |

## Skills in the Study of Biology

| Skill / AoS Reference | Description and application in this unit |
|---|---|
| **Inquiry 2: Collecting and processing data** | **Data collection:** Measurements are recorded with correct SI units, appropriate sig figs and uncertainty (± notation). Raw data organised in clearly headed, consistently formatted tables. **Data processing:** Mean and standard deviation calculated; error bars (SD or range) added to all graphs. Students use a scientific calculator for SD; formula not memorised. |
| **Inquiry 3: Concluding and evaluating** | **Graph interpretation:** Students describe trends (referencing specific data values from axes), identify anomalies, and evaluate the reliability of a conclusion. They distinguish between strong and weak conclusions based on the size of error bars and the range of the data. |
| **Applying general mathematics** | **Required mathematical skills introduced here:** sig figs in calculations; percentage change = (final − initial)/initial × 100%; scale calculation (actual size = image size / magnification); mean and SD using a calculator; interpreting overlapping error bars. Students are not required to memorise SD formulae but must be able to calculate using a provided formula or calculator function. |
| **Technology** | **Experimental technology:** digital balance, graduated cylinder, thermometer, compound light microscope — correct use, zeroing, reading to appropriate precision. **Data technology:** Microsoft Excel or Google Sheets: AVERAGE(), STDEV(), chart construction with error bars, correct axis labelling. |

## Approaches to Learning (ATL)

☒ **Thinking skills**

Students apply critical and creative thinking to identify errors in poorly-formatted graphs, distinguish between similar command terms, analyse EM images, and evaluate risk assessments. The command terms card sort and graph critique activities are explicitly thinking-focused. Students practice transferring measurement skills from the workshop to subsequent practical activities throughout the course.

☒ **Social skills**

Students work collaboratively during the risk assessment workshop, graph peer-assessment and microscopy practical. Groups are mixed (not self-selected) to ensure students from different

SL/HL streams and different prior learning backgrounds work together. The teacher explicitly models respectful collaborative behaviour and discusses norms for group work.

☒ **Communication skills**

Students practise written scientific communication (lab report, data tables, graphs) and oral communication (command term explanation activity, group risk assessment presentations). Scientific precision in language is emphasised: distinguish 'accuracy' from 'precision', 'error' from 'mistake', 'describe' from 'explain'. Both English-language and Mandarin-language scientific vocabulary are validated.

☒ **Self-management skills**

Students set up their two-year course folders with the course planner, assessment schedule, command terms reference card and notes sections. They practise checking their own work (self-assessment of the sig figs worksheet against model answers). Independent study strategies — spaced retrieval, Bioninja, command terms flashcards — are introduced and modelled.

☒ **Research skills**

Students use CLEAPSS Student Safety Sheets online to look up chemical hazard information (a skill required for every practical write-up). The microscopy extension and NOS research tasks introduce literature searching and source evaluation. The academic integrity session explicitly teaches citation conventions and how to evaluate the reliability of online biological information.

## Cross-curricular Connections

| Language and Learning | Theory of Knowledge (TOK) | Creativity, Activity, Service (CAS) |
|---|---|---|
| ☒ **Activating prior knowledge**<br>KWL chart ("Know / Wonder / Learned") at unit start surfaces prior scientific knowledge and language. Teacher uses responses to pitch explanations at the right level and identify students who need language scaffolding.<br><br>☒ **Scaffolding for new learning**<br>Bilingual English–Mandarin vocabulary glossary distributed at the start of this unit. Key terms include: significant figures (有效数字), measurement uncertainty (测量不确定度), error bars (误差棒), magnification (放大倍数), resolution (分辨率), hypothesis (假说), independent variable (自变量 / 引变量), | **TOK connections in this unit:**<br><br>**Shared knowledge vs personal knowledge:** Scientific knowledge is built through collaborative, verifiable empirical work. Students discuss how personal observations become shared scientific knowledge. (NOS link: peer review, reproducibility.)<br><br>**Technology and knowledge:** To what extent is biological knowledge shaped by the instruments we use? The development of the microscope from Hooke to cryo-EM shows how technology expands the boundaries of what we can observe and therefore what we can claim to know. | ☐ **Creativity**<br>☐ **Activity**<br>☐ **Service**<br><br>No formal CAS connections are made in this introductory unit.<br><br>**Possible future CAS links identified in this unit:**<br>• Lab safety and risk assessment skills developed here support future CAS activities in field biology, environmental monitoring or community science projects<br>• Students who develop confidence in scientific |

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| dependent variable (因变量).<br><br>☒ **Extending language**<br>Students produce their own illustrated command terms glossary with definitions and example answers in both English and Mandarin, which they keep in their biology folder throughout the course.<br><br>☐ **Affirming identity**<br>See Differentiation section above for identity-affirming strategies specific to this unit. | **Objectivity and measurement:** Is all scientific measurement objective? Significant figures, uncertainty notation and error bars show that even quantitative data involves human judgement and convention. What does this imply about the objectivity of science?<br><br>**NOS link:** The nature of science themes in this unit — falsifiability, reproducibility, the role of technology — are directly relevant to the IB TOK Natural Sciences Area of Knowledge. This unit provides concrete scientific examples that students can use in TOK presentations and essays. | communication during this unit may use these skills for science outreach CAS service activities (e.g. peer tutoring in science, science communication at local schools)<br>• The Group 4 Project (Year 1, T2) has potential CAS activity connections |

## Resou rces

**COURSEBOOKS**

- Clegg, C.J. & Davis, A. (2023). Biology for the IB Diploma (3rd ed.). Hodder Education. ISBN: 978-1398364240. — Introduction chapter (pp. i–xii) and Tools and Inquiry section (pp. 1–27): scientific method, measurement, graphing, microscopy, data analysis.
- Allott, A. (2023). Oxford Resources for IB DP Biology Course Book. Oxford University Press. — Skills and Practice chapter; Microscopy and Measurement sections.

**FREE ONLINE RESOURCES** ✓

- Bioninja (new 2023 syllabus): https://ib.bioninja.com.au/ — Course overview, scientific skills, unit-by-unit content summaries. [Free | English]
- CLEAPSS Student Safety Sheets: https://science.cleapss.org.uk/resources/student-safety-sheets/ — Hazard and risk information on all common lab chemicals and procedures. Essential reference for risk assessments. [Free | English | UK-based]
- Biology for Life (T. Cheng): https://www.biologyforlife.com/ — Lab safety, IA analysis, error bars, statistical tests; IB-specific and aligned with FA2025 guide. [Free | English]
- Mr Green's Science: https://www.mrgscience.com/ib-command-terms.html — IB Biology command terms with definitions. [Free | English]
- Tiber Tutor Command Terms: https://tibertutor.com/ib/biology/useful-resources/command-terms — All IB Biology command terms with definitions and examples. [Free | English]
- i-Biology (S. Taylor): https://i-biology.net/ict-in-ib-biology/statistical-analysis/ — Statistical analysis resources, Excel StatBook, worked examples of SD, SE, t-test, error bars, chi-squared. [Free | English]

- Khan Academy Biology: https://www.khanacademy.org/science/biology — Video lessons on scientific method, measurement, introductory biology. [Free | English]
- Cells Alive!: https://www.cellsalive.com/ — Cell size and scale interactive; microscope image galleries; useful visual reference for microscopy unit. [Free | English]
- PhET: Build an Atom / Molecule Shapes: https://phet.colorado.edu — Interactive simulations; useful background for polarity (connects to A1.1 Water and B2.1 Membranes). [Free | English | Multiple languages]

**IB SUBSCRIBER RESOURCES ⚠ (Requires IB OCC / PRC access)**

- [⚠ IB PRC] IB Biology Guide — First Assessment 2025: Tools and Inquiry section (pp. 1–27). Primary syllabus reference for all scientific skills and inquiry requirements.
- [⚠ IB PRC] Biology Teacher Support Material (TSM): sample unit planners, additional teaching ideas, IA exemplars.
- [⚠ IB PRC] IBQuestionbank (https://questionbank.ibo.org/): past paper questions by topic; data-based question examples; command term usage in context.
- [⚠ IB PRC] IB DP Approaches to Teaching and Learning guide: full ATL skills framework and subject-specific guidance.
- [⚠ IB PRC] IB Academic Integrity Policy (current version): primary reference for the academic integrity session.

**MANDARIN-LANGUAGE SUPPLEMENTS (For Chinese-medium students)**

- [ ZH|Free]可汗学院(KhanAcademyChinese):https://zh.khanacademy.org/—Chinese-languagevideolessonsonscientificmethodandintroductorybiology.
- [ ZH|Free]知乎·IB生物topicpage:https://www.zhihu.com/topic/19596023—MandarindiscussionforumforIBBiologystudents;usefulforclarifyingconceptsinChinese(verify content quality before directing students).
- [ ZH|Teacher-produced]BilingualEnglish–MandarinKeyVocabularyListforthisunit:significantfigures(有效数字),measurementuncertainty(测量不确定度),errorbars(误差棒), magnification (放大倍数), resolution (分辨率), hypothesis (假说), independent variable (引变量 / 自变量), dependent variable (因变量), controlled variable (定量 / 控制变量), accuracy (准确性), precision (精确性), systematic error (系统误差), random error (随机误差).
- [ ZH|Free]国家高等教育智慧教育平台(xuetangx.com):https://www.xuetangx.com/—Chineseuniversity-levelbiologycoursevideos;usefulsupplementarycontentforadvanced students.

**LABORATORY EQUIPMENT (this unit)**

- Compound light microscopes (minimum one per pair of students); stage micrometers for calibration (if available)
- Microscope slides and cover slips; lens tissue; immersion oil (if using ×100 oil-immersion objective)
- Onion bulbs (pre-cut pieces) and iodine solution for staining; cotton buds and methylene blue solution for cheek cells
- Digital balances (one per lab bench; 0.01 g precision); 10 $cm^3$, 25 $cm^3$ and 100 $cm^3$ graduated cylinders; 0–100°C thermometers; 30 cm rulers (mm scale)
- Safety goggles, lab coats and nitrile gloves for entire class; eye wash station confirmed operational
- Computer or iPad access for each student (Microsoft Excel or Google Sheets for graph construction activity)
- Printer access for: lab safety contract, risk assessment worksheets, command term card sort cards (laminated), bilingual vocabulary list

## Reflection: Considering the planning, process and impact of the inquiry

| What worked well | What did not work well | Notes / changes / suggestions |
|---|---|---|
| List the portions of the unit (content, assessment, planning) that were successful. | List the portions of the unit (content, assessment, planning) that were not as successful as hoped. | List any notes, suggestions or considerations for the future teaching of this unit. |

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