VCE Biology Units 1&2 Complete Study Guide

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This guide follows the VCAA **VCE Biology Study Design** (accredited from 2022, originally for the period 2022–2026; VCAA still lists it as the current study design for Units 1–4 at the time of writing in October 2026). It covers every key knowledge dot point in Unit 1 (How do organisms regulate their functions?) and Unit 2 (How does inheritance impact on diversity?), plus the student-designed investigation, the bioethics research investigation and the key science skills that run through every unit.

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About this guide

How to use it

Each main section matches one Area of Study (AoS) in the study design. Inside each section you will find plain-English explanations of every key knowledge dot point, definitions in **bold**, worked examples, summary tables, exam tips, common mistakes, and a "Check your understanding" set of original practice questions. Full worked solutions for every question are at the back.

A good routine for each topic is: read the section once, close the guide and write a one-page summary from memory, then do the practice questions under timed conditions and mark them against the worked solutions. Anything you got wrong goes onto a "fix list" that you revisit a week later.

> **Exam tip:** Biology marks are lost far more often through vague wording than through missing knowledge. Learn the bold definitions word for word and practise using them in full sentences.

Which study design does this guide follow?

The VCE Biology Study Design that took effect in 2022 is the one VCAA currently publishes for Biology. It was accredited for 2022–2026 and, as of October 2026, VCAA has not published a replacement for Units 1&2. If a new study design is released for 2027 or later, most of this guide will still apply: cell structure, membrane transport, the cell cycle, homeostasis, meiosis, Mendelian genetics, pedigrees, adaptations and the key science skills are core biology that appears in every version. Always check the VCAA Biology page for the latest version and any amendments.

How Units 1&2 are assessed

Units 1 and 2 are assessed by your school. There is no VCAA external exam for Units 1&2, and the scores do not count directly towards your ATAR. However, the content is the foundation for Units 3&4 (especially membranes, enzymes and genetics), and many schools run end-of-semester exams that copy the format of the Units 3&4 exam.

Unit	Outcome	What you must show	Typical school task
Unit 1	Outcome 1	Explain cell structure, function, membrane	Test, data analysis, practical report

		transport and the cell cycle	
Unit 1	Outcome 2	Explain plant and animal systems and homeostasis	Test, case study, data analysis
Unit 1	Outcome 3	Adapt or design and carry out a scientific investigation	Investigation with logbook and report
Unit 2	Outcome 1	Explain inheritance using genetic principles and data	Genetics problems test, pedigree analysis
Unit 2	Outcome 2	Analyse reproductive strategies, adaptations and interdependencies	Case study, fieldwork, data analysis
Unit 2	Outcome 3	Research and communicate a contemporary bioethical issue	Report, presentation or poster

Each unit is reported as S (satisfactory) or N (not satisfactory) based on achieving the outcomes. Schools also give levels of achievement for their own reports. Your school's assessment plan is the final word on task types and dates.

The Units 3&4 exam format (worth knowing now)

In Units 3&4 the written exam is 2.5 hours plus 15 minutes reading time, with Section A (40 multiple-choice questions, 1 mark each) and Section B (short-answer and extended-response questions). Many Units 1&2 school exams use a shorter version of this format, so the practice exam in this guide does too.

Eight-week revision plan

Week	Focus	Tasks
1	Cells, organelles, SA:V	Read Section 1 (first half); draw and label a plant and an animal cell from memory

2	Membranes, transport, cell cycle, apoptosis, cancer, stem cells	Finish Section 1; do Section 1 questions
3	Plant and animal systems, homeostasis	Read Section 2; draw the negative feedback loops for temperature, glucose and water
4	Investigations and key science skills	Read Section 3; write an aim, hypothesis and variables for three made-up experiments
5	Chromosomes, meiosis, genotypes and phenotypes	Read Section 4 (first half); practise meiosis diagrams
6	Crosses, pedigrees, linkage	Finish Section 4; do 15 genetics problems
7	Reproduction, adaptations, interdependence, bioethics	Read Sections 5 and 6; do their questions
8	Whole course	Practice exam under timed conditions; mark it; redo your fix list

Contents

1. Unit 1 AoS1: How do cells function?
2. Unit 1 AoS2: How do plant and animal systems function?
3. Unit 1 AoS3 and key science skills: scientific investigations
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7. Exam technique
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1. Unit 1 AoS1: How do cells function?

1.1 Cells: the basic unit of life

The **cell theory** has three parts: all living things are made of one or more cells; the cell is the basic unit of structure and function in living things; and all cells come from pre-existing cells. Every cell has a **plasma membrane**, **cytoplasm** (cytosol plus everything suspended in it), **ribosomes** and **DNA** as its genetic material.

Cells fall into two groups. **Prokaryotic cells** (bacteria and archaea) have no nucleus and no membrane-bound organelles. Their DNA is a single circular chromosome in a region called the **nucleoid**, and they often carry small extra rings of DNA called **plasmids**. **Eukaryotic cells** (animals, plants, fungi and protists) have a nucleus surrounded by a double membrane and many membrane-bound organelles.

Feature	Prokaryotic cell	Eukaryotic cell
Nucleus	Absent; DNA in nucleoid	Present; double membrane (nuclear envelope)
Membrane-bound organelles	Absent	Present (mitochondria, ER, Golgi etc.)
DNA	Single circular chromosome, plus plasmids	Several linear chromosomes with histone proteins
Ribosomes	Smaller (70S)	Larger (80S) in cytosol
Typical size	1–10 μm	10–100 μm
Cell division	Binary fission	Mitosis and cytokinesis (cell cycle)
Cell wall	Usually present (peptidoglycan in bacteria)	Plants (cellulose), fungi (chitin); absent in animals

Common mistake: Saying prokaryotes "have no organelles". They do have ribosomes, which are organelles without membranes. The correct statement is that prokaryotes have no **membrane-bound** organelles.

1.2 Surface area to volume ratio and cell size

A cell must exchange materials (oxygen, nutrients, wastes, heat) across its plasma membrane. The amount of exchange it can do depends on its **surface area**; the amount of exchange it needs depends on its **volume** (how much cytoplasm is carrying out reactions). The **surface area to volume ratio (SA:V)** compares the two.

As a cell grows, its volume increases faster than its surface area, so the SA:V ratio falls. Eventually the membrane cannot supply the cell's needs fast enough, and diffusion distances to the centre become too long. This is why cells are small, and why large organisms are multicellular.

Worked example: SA:V of cubes. For a cube with side length s: surface area = $6s^2$, volume = s^3, so SA:V = 6/s.

Side length (μm)	Surface area (μm^2)	Volume (μm^3)	SA:V
1	6	1	6 : 1
2	24	8	3 : 1
3	54	27	2 : 1
4	96	64	1.5 : 1
6	216	216	1 : 1

Doubling the side length from 1 μm to 2 μm halves the SA:V ratio from 6 : 1 to 3 : 1.

Cells increase their effective SA:V in several ways: being flat or thin (red blood cells are biconcave discs), having folds or projections (microvilli on cells lining the small intestine, root hair cells), and being long and thin (nerve cells). Shape matters as much as size. A flattened 4 μm × 4 μm × 1 μm cell has SA = 2 × (16 + 4 + 4) = 48 μm^2 and V = 16 μm^3, so SA:V = 3 : 1. A cube with the same volume (16 μm^3) has sides of about 2.52 μm, SA ≈ 38.1 μm^2 and SA:V ≈ 2.4 : 1. Same volume, but the flat shape gives about 26% more surface for exchange.

Eukaryotic cells also solve the size problem with **compartmentalisation**: membrane-bound organelles create separate internal spaces where specific reactions happen at high concentration, with their own conditions (for example, the low pH inside lysosomes). Internal membranes also give a large surface area for reactions, such as the folded inner membrane of mitochondria.

Exam tip: When explaining why cells are small, use the chain: larger cell → lower SA:V → membrane area too small relative to volume → rate of exchange cannot meet the demands of the cell → cell cannot survive. Name a specific substance (for example oxygen in, carbon dioxide out).

Common mistake: Writing that "a larger cell has a smaller surface area". A larger cell has a larger surface area; it is the **ratio** of surface area to volume that is smaller.

1.3 Organelles: structure and function

Organelle	Structure	Function	Found in
Nucleus	Double membrane with pores; contains chromatin and nucleolus	Stores DNA; controls cell activities; site of DNA replication and transcription	Eukaryotes
Ribosome	Two subunits of rRNA and protein; no membrane	Site of protein synthesis (translation)	All cells
Rough endoplasmic reticulum	Network of flattened membrane sacs studded with ribosomes	Makes and modifies proteins for export or for membranes; transports them	Eukaryotes
Smooth endoplasmic reticulum	Tubular membranes, no ribosomes	Synthesises lipids (including steroids); detoxifies some chemicals	Eukaryotes
Golgi apparatus	Stack of flattened membrane sacs	Modifies, sorts and packages proteins into vesicles for secretion or delivery	Eukaryotes
Vesicles	Small membrane-bound sacs	Transport substances within the cell and to the membrane	Eukaryotes
Mitochondrion	Double membrane; inner membrane folded into cristae; own circular DNA	Site of aerobic cellular respiration; produces most of the cell's ATP	Most eukaryotes
Chloroplast	Double membrane; stacks of thylakoids (grana) in stroma; own DNA	Site of photosynthesis; converts light energy into chemical energy	Plants and algae

		in glucose	
Lysosome	Membrane sac of digestive enzymes	Breaks down worn-out organelles, food particles and pathogens	Mainly animal cells
Vacuole	Membrane-bound sac (large central vacuole in plants, bounded by the tonoplast)	Stores water, ions and wastes; keeps plant cells turgid	Plants (large); animals (small)
Cell wall	Rigid layer of cellulose outside the membrane	Support and protection; stops the cell bursting	Plants, fungi, most prokaryotes
Cytoskeleton	Network of protein filaments	Shape, movement of organelles, cell division	Eukaryotes
Centrioles	Pair of cylinders of microtubules	Help organise spindle fibres in cell division	Animal cells

The **endomembrane system** links the nucleus, rough ER, Golgi apparatus, vesicles and plasma membrane. A protein for export (for example insulin) follows this path: made on ribosomes on the rough ER → enters the ER and is folded → carried in a transport vesicle to the Golgi → modified and packaged into a secretory vesicle → vesicle fuses with the plasma membrane → protein released by exocytosis.

Chloroplasts and mitochondria both have a double membrane, their own circular DNA and their own ribosomes. Mitochondria release energy from glucose by aerobic respiration (glucose + oxygen → carbon dioxide + water + ATP). Chloroplasts capture light energy to make glucose by photosynthesis (carbon dioxide + water → glucose + oxygen, using light). Cells with high energy demands, such as muscle and sperm cells, contain many mitochondria. Leaf palisade cells contain many chloroplasts.

Feature	**Typical plant cell**	**Typical animal cell**
Cell wall	Present (cellulose)	Absent
Chloroplasts	Present in green tissue	Absent
Vacuole	Large central vacuole	Small, temporary vacuoles
Shape	Fixed, often rectangular	Variable, often rounded

Centrioles	Absent in most	Present
Energy storage	Starch	Glycogen

Common mistake: Saying plant cells have chloroplasts "instead of" mitochondria. Plant cells have both. Photosynthesis makes glucose; respiration in mitochondria still has to release the energy as ATP.

1.4 The plasma membrane

The plasma membrane is described by the **fluid mosaic model**. It is a **phospholipid bilayer** with proteins scattered through it ("mosaic"), and its components can move sideways ("fluid").

Each **phospholipid** has a **hydrophilic** (water-loving) phosphate head and two **hydrophobic** (water-fearing) fatty acid tails. In water they form a bilayer with the heads facing the watery cytosol and extracellular fluid, and the tails facing each other in the middle. Other parts:

- **Channel proteins** form water-filled pores that let specific ions or water (aquaporins) pass through.
- **Carrier proteins** bind a specific molecule and change shape to move it across.
- **Cholesterol** (in animal cells) sits between phospholipids and stabilises fluidity across temperatures.
- **Glycoproteins** and **glycolipids** carry carbohydrate chains on the outer surface, acting in cell recognition and signalling.

The membrane is **semi-permeable** (selectively permeable). Small non-polar (hydrophobic) molecules such as O_2, CO_2 and steroid hormones dissolve through the hydrophobic core easily. Water, despite being polar, crosses slowly through the bilayer and much faster through aquaporins. Ions and large polar (hydrophilic) molecules such as glucose cannot pass through the hydrophobic core and need protein channels or carriers.

1.5 Moving substances across the membrane

Diffusion is the net movement of particles from a region of high concentration to a region of low concentration, down a concentration gradient. It is **passive** (needs no ATP). **Simple diffusion** happens directly through the phospholipid bilayer.

Facilitated diffusion is passive movement down a concentration gradient through a channel or carrier protein. It is used by hydrophilic substances such as glucose and ions. It shows **saturation**: once all the carriers are in use, the rate cannot increase further.

Osmosis is the net movement of water across a semi-permeable membrane from a region of low solute concentration (high free water concentration) to a region of high solute concentration.

End of free sample

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