

★ New for the ★  
2022 study design



## INTRODUCING THE UNITS 1-4 EDROLO BIOLOGY TEXTBOOKS

# VCE BIOLOGY

## Units 1 - 4

### What's new in the 2022 study design:

- **SAC Skill Questions** in every lesson focusing on the 4 SAC types:
  - » scientific methodology comparison
  - » case study analysis
  - » bioethical analysis
  - » data analysis
- An entire lesson on **bioethics** in each book. Additionally, every lesson includes an ethics question and SAC skills questions will include 'bioethical deep dives'.
- An entire section outlining **how to complete an investigation on a bioethical issue** for the Unit 2 AOS 3 assessment.
- A **Scientific Investigation** in every chapter to help support teachers in reaching the required 10 hours per unit of investigation time.
- **Key Science Skill questions** covered in a dedicated chapter and in every lesson
- Every lesson begins with explicit links to **prior knowledge and future application**
- **Teacher dashboards** to help track student understanding

### Alongside

- **VCAA-style questions** based on a thorough analysis of the past 10-15 exams
- **Exemplar answers** with a **checklist** and **video solution** for every short-answer exam-style question
- **Multiple-lesson questions** covering concepts from different areas of the study design
- **40-mark chapter review tests** for valuable SAC & exam practice
- **Chapter review activities** help students integrate the knowledge of the whole chapter in one exercise
- **Concise theory** covers the core knowledge required within the scope of the VCAA Study Design
- **Chapter review summaries** bring together all the important knowledge at the end of each chapter
- **Standard Edrolo videos** aligned directly to textbook chapters

# AT THE BEGINNING OF EACH LESSON YOU WILL FIND:

**Area of Study maps** show how the content and skills learnt in a single lesson connect with other concepts in the course.

**Key Knowledge dot-points** from the study design provide explicit links to the syllabus.

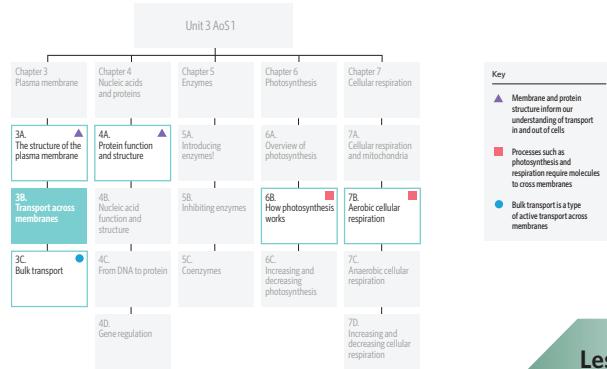
**Key Knowledge Units (KUs)** show a breakdown of the lesson.

**Knowledge Unit overview** provides a brief description of what will be covered next using basic terminology to introduce concepts.

## 3B THEORY

### 3B TRANSPORT ACROSS MEMBRANES

The plasma membrane is like a border control – it ensures only particular molecules enter and exit the cell.



In this lesson you will learn how molecules can be transported across the plasma membrane.

#### Study design dot point

- the fluid mosaic model of the structure of the plasma membrane and the movement of hydrophilic and hydrophobic substances across it based on their size and polarity

#### Key knowledge units

Passive transport	3.1.1.2
Active transport	3.1.1.3

#### Passive transport 3.1.1.2

##### OVERVIEW

Passive transport is the movement of molecules across a membrane without the use of energy. Diffusion, facilitated diffusion, and osmosis are the three types of passive transport.

##### THEORY DETAILS

A cell's plasma membrane is selectively permeable. This means that only certain substances can cross it, depending on their polarity, size, and concentration on either side of the membrane. This is important so that the cytosol can preserve an internal environment separately from the extracellular fluid.

##### ▼ Key terms

**diffusion** the passive movement of molecules from areas of high concentration to areas of low concentration (down the concentration gradient)

**facilitated diffusion** a type of passive transport where molecules move through a phospholipid bilayer with the aid of a membrane protein

**passive transport** the movement of molecules through a semipermeable membrane and down the concentration gradient, without an input of energy

**selectively permeable** a property of cell membranes that ensures only specific substances pass across them. Also known as semipermeable

in area of high concentration (e.g.  $H_2O$ ) and/or nonpolar across a membrane via diffusion. form of fatty acid tails of through the phosphate heads

**Key terms** are highlighted in bold and are defined in the margin for ease of reference. All key terms are collated in the glossary in the back of the book.

#### Apoptosis as a five step process 3.2.4.2

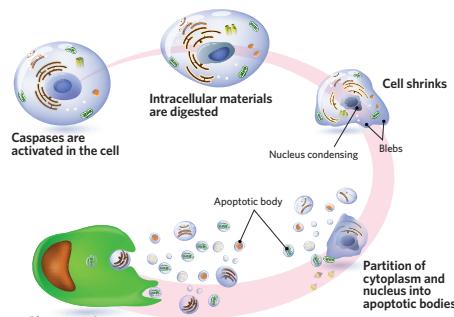
##### OVERVIEW

Following initiation, apoptosis is a five step process that involves: caspase activation, intracellular digestion, cell shrinkage, blebbing and breakage, and digestion by phagocytes.

##### THEORY DETAILS

After initiation by either the mitochondrial or death receptor pathway, apoptosis progresses as a five step process:

- Caspase activation:** both the mitochondrial and death receptor pathways initiate the activation of intracellular caspase enzymes by cleaving certain amino acid sequences from their structure. Once activated, caspase enzymes travel around the cell, digesting specific proteins.
- Digestion of cell contents:** the caspase-mediated digestion of proteins initiates a cascade of reactions that cause the digestion of all organelles.
- Cell shrinks:** the cell and nucleus shrink as intracellular material is digested.
- Blebbing and breakage:** as the cytoskeleton is digested, the structural integrity of the cell is weakened. The membrane warps and detaches from the cell in membrane-enclosed vesicles known as **apoptotic bodies** which contain the digested intracellular contents.
- Engulfment by phagocytes:** as the cell breaks apart, chemicals are released. These chemicals are recognised by **phagocytes**, which engulf and digest the free-floating apoptotic bodies by phagocytosis.



#### When apoptosis goes wrong 3.2.5.1

##### OVERVIEW

Too much apoptosis and we become sick and die. Too little apoptosis and we also become sick and die. It's all about the perfect balance.

##### THEORY DETAILS

When functioning properly, apoptosis is vital to the healthy functioning and development of almost all eukaryotic organisms. However, apoptosis-related malfunctions are the root cause of deviant cell production and some of the most deadly diseases that we know of.

Increasing apoptosis causes the death of too many cells and may lead to neurological disorders such as Huntington's disease and Alzheimer's (a type of dementia).

Insufficient apoptosis can allow cells to replicate exponentially, allowing the formation of tumours and **cancers**.

**Tips** T cytotoxic cells are extremely important and are heavily involved in the immune system's third line of defence. Their main roles include inducing apoptosis in abnormal, threatening, or infected somatic cells by releasing cytokines. T cytotoxic cells will be covered further in lesson 9D.

**Tip** Another way that cells can die is called 'necrosis'. Necrosis is the unregulated death of cells initiated by significant damage which causes the cell to swell, burst and release cell contents into the surrounding environment. This may lead to inflammation and damage of nearby cells and tissues. While not explicitly mentioned in the VCAA study design, concepts related to necrosis have been mentioned in previous exams, particularly distinguishing between apoptosis and necrosis.

**Tips** Phagocytic cells are part of the immune system's second line of defence. Their main role includes the digestion of foreign material and pathogens by phagocytosis. They will be covered further in lesson 9C.

**Tips** provide important insights into what VCAA assessors look for in exam responses.

**Lesson links** highlight the connection between theory across lessons to create a holistic understanding of the course.

# QUESTIONS, SOLUTIONS, & EXPERIMENTS

**Case studies** provide examples of how theory is applied in real life, including example scenarios commonly found in previous VCAA exams.

4

## CHAPTER 3: PLASMA MEMBRANE

**Case study****The Sodium-Potassium ( $\text{Na}^+/\text{K}^+$ ) ion pump**

The  $\text{Na}^+/\text{K}^+$  protein pump maintains ideal concentrations of  $\text{Na}^+$  and  $\text{K}^+$  in the cell. It also plays a role in controlling the voltage of cell membranes, which is vital for passing on signals in neurons. The  $\text{Na}^+/\text{K}^+$  pump works in four steps:

- 1 The cycle starts with the pump open to the cytoplasm, where it binds three  $\text{Na}^+$ .
- 2 ATP is hydrolysed into  $\text{ADP} + \text{P}_i$ , and the ATP is released. Energy from this reaction causes the pump to change shape and open to the extracellular space. In this new conformation, the pump does not have a high affinity for  $\text{Na}^+$  so these ions are released.
- 3 Two  $\text{K}^+$  are bound to the pump, and this triggers the release of the free-floating phosphate (left over from step 2).
- 4 The pump changes shape again, opening to the cytoplasm and releasing  $\text{K}^+$ . The cycle can start again.

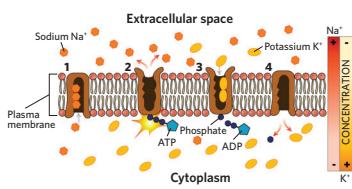
Figure 6 The mechanism of the  $\text{Na}^+/\text{K}^+$  pump**Theory summary**

Table 1 Summary of the different types of transport across the plasma membrane

	Requires energy?	Down or against concentration gradient?	Protein required?	Molecules involved
Osmosis	No	Down	No	$\text{H}_2\text{O}$
Diffusion	No	Down	No	Small, nonpolar molecules e.g. $\text{O}_2, \text{CO}_2$
Facilitated diffusion	No	Down	Channel or carrier protein	Large and/or polar molecules e.g. glucose, $\text{Na}^+$
Active transport	Yes	Against	Protein pump or carrier protein	Large or polar molecules

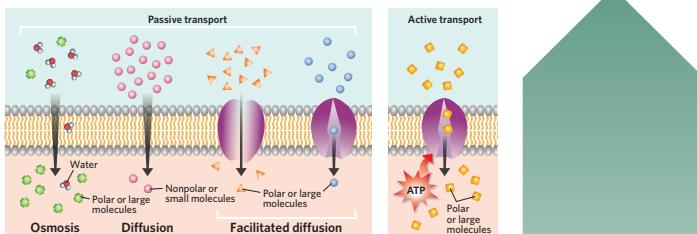


Figure 7 Diagrammatic summary of the types of transport across membranes

**Theory summaries** at the end of each chapter reiterate the key points.

FOR MORE INFO SEE THE TEXTBOOK TRAINING VIDEO IN YOUR EDROLLO ACCOUNT.

**3B Transport across membranes****Theory review questions**

- |                         |                         |
|-------------------------|-------------------------|
| 1 a Osmosis             | b Selectively permeable |
| c Facilitated diffusion | d Active transport      |
| e Hypotonic             | f ATP                   |
| g Solute                |                         |
| 2 B                     | 3 B                     |
| 4 C                     | 5 D                     |

**Exam-style questions****Within lesson**

- 6 C      7 C      8 C      9 D

**Multiple lessons**

- 10 a [It enters straight through the plasma membrane, not through a channel or pump.]<sup>1</sup>

- b i I have identified a piece of evidence from the diagram.<sup>1</sup>

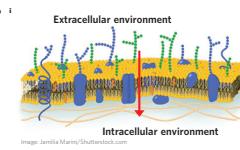


Image: Jamie Marie/Shutterstock.com

- b ii I have drawn an arrow through the phospholipids.<sup>1</sup>

- b iii I have not drawn an arrow through a transport protein.<sup>1</sup>

- b iv I have drawn an arrow from the extracellular environment to the intracellular environment.<sup>1</sup>

- b v [Most of the plasma membrane is hydrophobic.<sup>1</sup>] [because of the fatty acid tails of phospholipids.<sup>1</sup>] [Therefore, other hydrophobic substances like the signalling molecule can pass straight through the membrane without the aid of transport proteins.<sup>1</sup>]

- b vi I have described the polarity of the plasma membrane.<sup>1</sup>

- b vii I have referred to the structure of the plasma membrane.<sup>1</sup>

- b viii I have explained the consequences of membrane structure on the movement of the signalling molecule.<sup>1</sup>

- b ix [It is a phospholipid. Phospholipids arrange themselves into a bilayer that forms a stable barrier around the cell. They have a role in regulating transport across membranes, and are the structure in which proteins and carbohydrates are embedded.<sup>1</sup>] [K is a carbohydrate attached to a glycoprotein. Its function may be involved in receiving or sending signals and cell-cell adhesion.<sup>1</sup>] [L is the cytoskeleton. The cytoskeleton gives shape and support to the cell and transports molecules around the cell.<sup>1</sup>]

- ✓ I have identified and described the role of  $\text{K}^+$ .<sup>1</sup>

- ✓ I have identified and described the role of  $\text{L}$ .<sup>1</sup>

- iv [Facilitated diffusion involves glucose moving down its concentration gradient through a protein channel like GLUT2.<sup>1</sup>] [GLUT2 is required because glucose is a relatively large and polar molecule,<sup>1</sup> but no energy is required in the process.<sup>1</sup>]

- ✓ I have described the direction of movement of glucose during facilitated diffusion.<sup>1</sup>

- ✓ I have explained why a channel is necessary.<sup>1</sup>

- ✓ I have stated if energy is required in the process.<sup>1</sup>

- ✓ I have referred to the scenario using terms such as: GLUT2, glucose.

- v [Phospholipids are amphiphilic, meaning that they are polar at one end (phosphate head) and nonpolar at the other end of the molecule (fatty acid tails).<sup>1</sup>] This results in the spontaneous formation of a bilayer, where the fatty acid tails face inwards, protected from the aqueous environment by the phosphate heads on the outside of the bilayer.<sup>1</sup> [The bilayer is an ideal structure to form the barrier of the cell because it is stable but fluid.<sup>1</sup> It won't break apart when molecules are embedded in it or transported across it.<sup>1</sup>]

Other acceptable responses include:

- The nonpolar nature of the membrane allows it to be selectively permeable.

- ✓ I have described the charge of the phospholipid bilayer.<sup>1</sup>

- ✓ I have described the structure of the phospholipid bilayer.<sup>1</sup>

- ✓ I have stated that the bilayer is stable but fluid.<sup>1</sup>

- ✓ I have stated that these properties mean that molecules can be embedded in and transported across the bilayer.<sup>1</sup>

**Key science skills**

- ii a [That more concentrated corn syrup solutions<sup>1</sup>] will lead to smaller, lighter, and less firm eggs.<sup>1</sup>

- ✓ I have referred to the independent variable.<sup>1</sup>

- ✓ I have referred to the dependent variables.<sup>1</sup>

- ✓ I have indicated the direction of the relationship using terms such as: more, smaller, lighter.

- b [The mass of the eggs at the beginning of the experiment, the amount the solutions were mixed, and the scales used to weigh the eggs.<sup>1</sup>] [These three things should be the same across treatments or measured and noted.<sup>1</sup>]

Other acceptable responses include:

- The amount of distilled water
- The brand of corn syrup used

**TEXTBOOK QUESTIONS:**

- **Theory review questions** are multiple-choice questions that assess a student's comprehension of the theory covered in the lesson.
- **Exam-style questions** provide frequent, valuable exam practice with questions covering content from within the lesson and also from previous lessons to reinforce the interconnected nature of the curriculum.
- **Key Science Skills questions** assess skills outlined in the VCAA Study Design through experimental design or data analysis questions.

**TEXTBOOK SOLUTIONS:**

- **Exemplar response:** written responses to every exam-style question provide students with an example of a full-mark answer.
- **Other acceptable responses:** other possible responses included under the exemplar response.
- **Checklists** provide a breakdown of the exemplar response to guide students when self-marking their answers.
- **Video solutions** in your Edrolo account explain and deconstruct every single exam-style question.

**SCIENTIFIC INVESTIGATIONS AND EXPERIMENTS:**

- **Unit 4 Area of Study 3:** a designated chapter to teach students Key Science Skills, how to design a valid, ethical, and safe experiment, and how to structure their scientific investigation poster.
- **Practical experiments:** For every chapter in Unit 3 Area of Study 1, including discussion-based questions for SAC preparation:
  - Chapter 3: Plasma Membrane
  - Chapter 4: Nucleic acids and proteins
  - Chapter 5: Enzymes
  - Chapter 6: Photosynthesis
  - Chapter 7: Cellular respiration

# NAVIGATING YOUR EDROLO TEXTBOOK ONLINE

PLANNING  
AHEAD AND  
ACCESSING THE  
TEXTBOOK

## VCE BIOLOGY UNITS 3&4 [2020 TEXTBOOK]

[Bookmarks](#) [All videos](#) [View printable unit plan](#) [Download textbook PDF](#)

To assist with planning,  
there is an editable and  
downloadable unit plan  
available for your course.

You can find a PDF version of  
the entire textbook here.

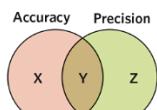
ACCESSING THE  
DIGITAL TEXTBOOK  
QUESTIONS AND  
SOLUTIONS

Chapter 4	17 min video	23 questions	
4A Protein function and structure	19 min video	26 questions	
4B Nucleic acid function and structure	16 min video	29 questions	

All questions found in the text are also available as interactive digital questions. To access these, click on the X questions button next to the corresponding theory lesson.

**Q3**

Which of the following options correctly describes X, Y, and Z?



	X	Y	Z
A	Measurements close to the 'true' value	Increases the number of replicates	Measurements that are close together
B	Measurements that are close together	Increases validity of results	Measurements close to the 'true' value
C	Measurements close to the 'true' value	Measurements that are close together	Removes uncertainty from experiments
D	Measurements close to the 'true' value	Increases reliability of results	Measurements that are close together

Row A

Row B

Row C

Row D

I'm confident in my understanding

If I came across this question again I'm confident I'd succeed

I need help, or more study

I'm not confident enough with the concepts to succeed on this question in future

For short-answer questions, students self-mark their work using the exemplar response and digital checklist.

### Exemplar Response

A control group was not used in this experiment.<sup>1</sup> Control groups are not exposed to the IV.<sup>2</sup> An example of a control group would be setting up two fields of non-GM crops next to each other, and measuring the percentage of seeds produced at various positions as a result of cross-pollination.<sup>3</sup>

For multiple-choice questions, students receive immediate feedback.

CHECKING STUDENT  
RESPONSES

**Q2dii**

Responses	Understands	Answered correctly
12/12	1/12	9/12
Name	Understands?	A B C D
Ashamed Antelope		✓
Casual Caribou		✗
Comfortable Chimpanzee		✓
Global Gerbil		✓
Material Monkey		✓
Main Mosquito		✓
Misleading Mouse		✗
Ready Rabbit		✓
Small Sheep		✓
Separate Sow		✓
Swift Sow		✗
Written Wallaby		✓

**Q13b**

I have described what the cytosol is.

7/8

1/8

I have described what the cytoplasm is.

6/8

2/8

Intelligent Impala's response

cytosol is not contained by organelles, and the cytoplasm is contained in the entire membrane of the cell

**Multiple-choice results:** see each student's answer and reflection on their understanding as well as a summary of your whole class.

**Extended response:** see how each student self-assessed against the checklist. Click on any of the checklist items and click a student's name to view their response.



**Edrolo**