Biology Unravelled

Comprehensive summary notes
and exam study plan

ARIANA FABRIS

Your seven-week exam study plan

Introduction

First of all, please note that *Biology Unravelled* is **not** meant to be a replacement for your biology textbook. As you move through the course, your textbook will provide numerous examples, case studies and detailed information to help you better understand important biological concepts, processes and pathways. It's important to read this material thoroughly and seek assistance from your teacher where necessary.

In the lead-up to your exam, however, what you need is a comprehensive **summary** of all the important information, and this is where *Biology Unravelled* can really help. The content in these pages thoroughly addresses the VCAA Units 3 and 4 Biology Study Design, *without* being overwhelming. It's also written in simple language, making it easier to understand, *and* contains more than 100 diagrams, photos and charts to illustrate content and assist the visual learner.

How to use this book

The following is a series of steps you can take to help you get the most out of this book and assist in your exam preparation. It is recommended that you begin this study program about seven weeks before the exam date.

1. Read each section thoroughly

Biology Unravelled is divided into 16 sections (plus vocabulary lists). Read each section *at least* three times (the more the better) and make your own hand-written notes. Why? Because while this book does provide ready-made summaries of course content, writing information by hand can help you retain it better. Also, pay particular attention to the diagrams; examine them carefully, including *all* labels and captions. Note that you should be aiming to revise around three sections per week.

2. Learn some things 'by heart'

While there has definitely been a strong movement away from 'rote learning' (memorisation) as a learning technique, there are still certain facts and processes in biology that you'll need to learn almost by heart, such as the inputs and outputs of photosynthesis and cellular respiration; steps involved in transcription, translation and the lac operon, functions of the various types of immune cells and meanings of terms such as 'genetic drift', 'gene flow' and 'founder effect'. If you're unsure about the sorts of information or facts that need to be memorised, check with your teacher.

3. Make flash cards

At the end of each section you will find a list of suggested flash card questions, as well as some space to write your own. Flash cards are a great study tool and they're easy to make. Simply write the question on one side of a small card and the answer on the other side (you can purchase packets of 'study cards' from office supply stores such as Officeworks).

Note that there are no actual lists of answers to the flash card questions provided here; this is because it's important that you read the content in the preceeding pages in order to find the answers yourself. If you have any trouble at all, ask your teacher for help.

Make as many flash cards as you can, keep them handy and use them often; on the train or bus, while waiting in a cue, or even during the ad break on TV. Using flash cards not only helps you to retain information, but can also assist in identifying any areas of weakness that you need to focus on.

4. Complete as many VCAA sample exam questions as you can

At the end of each section is a table that lists useful multiple choice (MC) and short answer (SA) questions from VCAA sample exams dating back to 2002. The importance of completing as many of these as possible cannot be overemphasized; in fact, your exam preparation should be at least 50% exam practice (your teacher will probably also provide you with exams produced by other organisations, such as STAV, NEAP, Lisachem, QATs and Insight). VCAA sample exams can be downloaded from the VCAA website, along with the *examination reports*, which not only provide the answers but also useful feedback on how students performed and where common errors were made. Read these reports carefully so that you can analyse your results and correct any mistakes.

5. Check that you know your terminology

At the end of this book is a list of all the important terms from each section. Look through these and make sure you understand what each one means and - where appropriate - how to define it, explain it in your own words and importantly, how to *apply* it, which means being able to use the term in new, unfamiliar situations. Also, make sure you know how to spell it!

Tying it all together

Once you've completed steps 1-4 above for all 16 sections of the book, there should still be some time before the exam to continue reading, revising and using your flash cards, particularly for any areas that you've identified as needing extra attention. It will also be important for you to complete one or two recent sample exams *under exam conditions*, including the standard reading time of 15 minutes followed by the allotted two and a half hours to complete the paper. This will give you a good idea of how quickly you will need to work through the exam in order to finish it on time.

Best of luck with your studies.

During the year

The following is a list of things you can do throughout the year to help you achieve your very best in biology:

1. Read, read, read

Read from your textbook or class notes/handouts whenever you can. Go over what you learnt in class and if you have time, read the next section of your textbook as well to give you a bit of a heads-up on what's coming. It takes an enormous amount of discipline to keep this up, particularly when you have other homework and SACs to prepare for, but it can make studying for the exam a lot easier so the rewards are great.

2. Use visual aids

The benefits of using visual aids to enhance learning have been well documented. The Units 3 and 4 biology exam will most likely include lots of diagrams, graphs, charts and photos and you may even be asked to draw a simple diagram, so it follows that you should be getting plenty of practice. Try constructing flow charts, Venn diagrams, mind maps, concept maps and anything else that helps you to comprehend and/or reinforce important biological pathways and processes. Also, don't forget that other great visual resource, **YouTube**, where you can find lots of very useful programs and can be a bit like having your own private tutor!

3. Complete sample exam questions regularly

While completing sample exam questions forms part of your seven-week study plan described above, this can really be started as soon as you finish the first topic in biology. Even if you can only manage a few questions per week, it's a good habit to get into.

4. Keep an eye on the media

From time to time articles appear in newspapers that relate to what you're learning in biology, such as recent developments in cancer treatment, the emergence of a particularly nasty new flu virus, the solving of a cold case crime using the latest DNA manipulation techniques, or an exciting new fossil discovery. These articles not only provide examples of how biological knowledge is used and applied in the real world, they can also help keep you interested and motivated.

5. Attend a lecture

There are a number of organisations that provide biology lectures, such as ACED, ATAR Notes, TSFX, Connect Education and TSSM. These lectures present information from a new perspective, which can help improve your understanding, while some of them also focus on developing useful examination strategies, such as helping you make the most effective use of the two and a half hours you're given to finish the paper. Visit the organisation's website to find out more about these lectures, including how to book a place.

Last-minute tips

Here are a few tips to help you during the exam:

1. Make good use of the reading time

Read each question carefully and don't let your mind wander; absorb as much of the information as you can. This is especially important for those questions that contain background information that may need to be included in the answers you give. Try not to panic if you come across a question that appears difficult, or a term you don't recognise; sometimes the most complex-looking questions turn out to be quite simple! Also, don't ignore the diagrams, graphs, tables and flow charts here; look at them carefully so you get a good idea of what they convey.

2. Think before you write

Many students make the mistake of rushing their answers, which can lead to careless errors. Take a little time to think about what you want to write before putting pen to paper. It's also a good idea to check how many marks a question is worth and how much space has been provided for you to write your answer; this gives you an idea about the amount of detail you need to include.

3. Answer the question asked

Read the question carefully and underline the key words. This can help you avoid including irrelevant information in your answer, for example, if you're asked to simply describe the *structure* of the *rough endoplasmic reticulum*, there's no need to relate the structure to its function, or to compare it with smooth ER.

4. Use the information provided

Data and background information provided in a question are there for a reason, so don't ignore any part. Even a single sentence, no matter how insignificant it might seem, *could* contain the answer to a question, or part of a question.

5. Use dot points where appropriate

Dot points are useful particularly when outlining the steps involved in a process, such as natural selection, apoptosis or protein synthesis. They're also useful for those questions that are worth a lot of marks because if you allocate one dot point per mark, it helps ensure that you've included everything.

6. Use common abbreviations

It's okay to write 'DNA', 'RNA', 'NADPH' and 'ATP' rather than the complete name in words, plus they're a lot easier to spell!

7. Be aware of time

During the exam it's important to keep an eye on the clock (without becoming obsessed). A good plan would be to aim to spend around 40 to 45 minutes on the multiple choice section (part A) and about 90 minutes on the short answer section (part B), leaving 15 to 20 minutes at the end to check your answers. Don't panic if you find you're going a bit over; just step it up and try to make up the time later.

CONTENTS

1. Plasma membranes

The plasma membrane is a soft and flexible layer surrounding all cells. It consists of a double layer (bilayer) of phospholipid molecules with numerous proteins embedded throughout. Each phospholipid molecule is made up of a phosphate head which is **hydrophilic (**'water-loving'), as well as two fatty acid chains which are **hydrophobic** ('water-fearing') (see figure 1).

Phospholipid molecules in the plasma membrane are orientated so that the hydrophobic fatty acid chains lie in the **middle** of the membrane, between the two layers of hydrophilic phosphate heads, rather like a sandwich (see figure 2). This is because both the outside and inside of a cell consist of a watery environment (remember that the phosphate heads are *water-loving*).

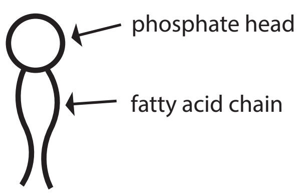


Figure 1. Phospholipid molecule

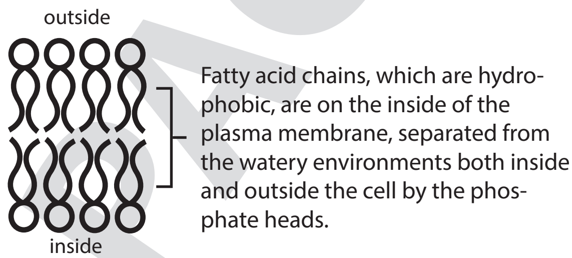


Figure 2. Arrangement of phospholipid molecules in the plasma membrane

Embedded in the plasma membrane are various proteins. These come in two main types:

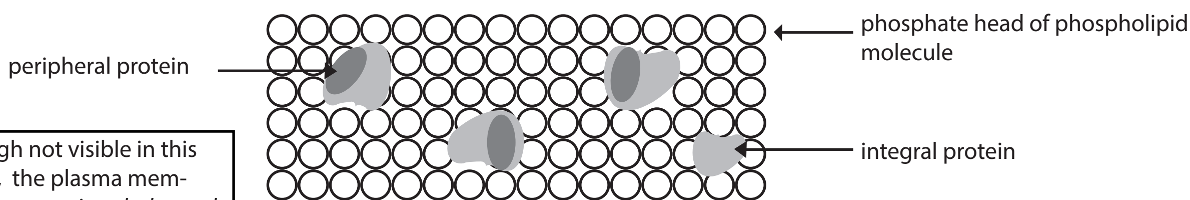
1. Integral proteins, which can be described as 'trans-membrane' because they span the entire width of the plasma membrane. Some integral proteins join with other substances, such as sugar. When a protein and sugar group combine, it is known as a 'glycoprotein'.

2. Peripheral proteins, which are usually found attached to integral proteins on the outside of the membrane.

The fluid mosaic model

To help us understand the structure of the plasma membrane, scientists use what is known as the **fluid mosaic** model. The membrane is thought to be *fluid* because of the nature of the fatty acid chains, which instead of being solid, have the consistency of a thick, oily fluid (this feature gives certain cells - those without a cell wall - flexibility and allows them to change their shape).

The plasma membrane also has the appearance of a *mosaic* when its external structure is viewed from above. This is due to the pattern formed by the phosphate heads and the various proteins that appear at intervals (see figure 3).



* Although not visible in this diagram, the plasma membrane also contains *cholesterol* molecules, which maintain the membrane's flexibility and also keep it from breaking apart.

Figure 3. When viewed from above, the plasma membrane looks like a mosaic.

Transport across the plasma membrane

There are many ways in which substances move across the plasma membrane:

1. Simple diffusion: Some substances are able to pass through the plasma membrane by moving between the phospholipid molecules (see figure 5). These include hydrophobic (lipophilic) substances such as alcohol and steroid hormones, which simply dissolve through the lipid bilayer. Small, non-polar[1] molecules like carbon dioxide and oxygen, as well as small, polar[2] molecules such as ethanol, urea and water are also able to cross the plasma membrane by simple diffusion.
Note that because this process involves movement from a high concentration to a low concentration, *no energy is required*.

2. Facilitated diffusion (channel-mediated): Large molecules, as well as charged molecules of any size, are unable to pass through the plasma membrane by simple diffusion. Ions such as H^+, Na^+, K^+, and Cl^- are hydrophilic, and therefore cannot pass between the hydrophobic fatty acid chains of phospholipid molecules. These ions require special proteins known as *channel proteins* to assist them (figure 5). Channel proteins enable ions to cross the plasma membrane without having to interact with its hydrophobic interior. Furthermore, this sort of transport is very rapid and because it is a type of diffusion, no energy is required.

3. Facilitated diffusion (carrier-mediated): Larger, uncharged hydrophilic substances such as glucose and amino acids cross the plasma membrane with the help of another type of transport protein, the *carrier protein* (figure 5). There are different types of carrier proteins and each is specific, allowing only one type of molecule to pass through. Diffusion involving carrier proteins is not as rapid as that involving channel proteins because the carrier protein must undergo a change in shape before it can allow the molecule to pass through and be released on the other side of the membrane. Carrier-mediated facilitated diffusion does not require energy.

4. Active transport: This process involves the transport of substances into or out of cells *against* their concentration gradient. Special proteins called *pumps* are involved (figure 5) and as this is an energy-requiring process, ATP (adenosine triphosphate) is also required. During this process, ATP is broken down and the energy released is used to transport molecules across the plasma membrane to an area of *higher* concentration; this is useful for those substances that are needed in high amounts by cells, such as glucose.

5. Osmosis: When describing the movement of water across the plasma membrane, the term 'osmosis' is used (see figure 4). Osmosis is a form of diffusion involving *solvents* - usually water - rather than solutes. The solvent moves across a 'semipermeable' membrane from an area of low solute concentration to an area of high solute concentration (because the solvent itself moves *along* its own concentration gradient, no energy is required).

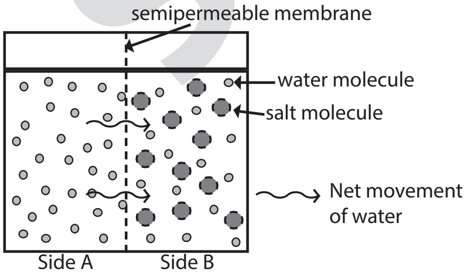


Figure 4: The process of osmosis. In this case, there will be a net (overall) movement of water molecules from side A, where there is a lower solute concentration, to side B, where there is a higher solute concentration. Note that a semipermeable membrane is one that will allow only some substances to move across it. Plasma membranes are semipermeable.

1 **Non-polar:** describes molecules with an even distribution of electrons, and therefore, an even distribution of charge.
2 **Polar:** describes molecules with an uneven distribution of electrons, and therefore, an uneven distribution of charge. The result is that one side of the molecule may be more negative (or positive) than the other.

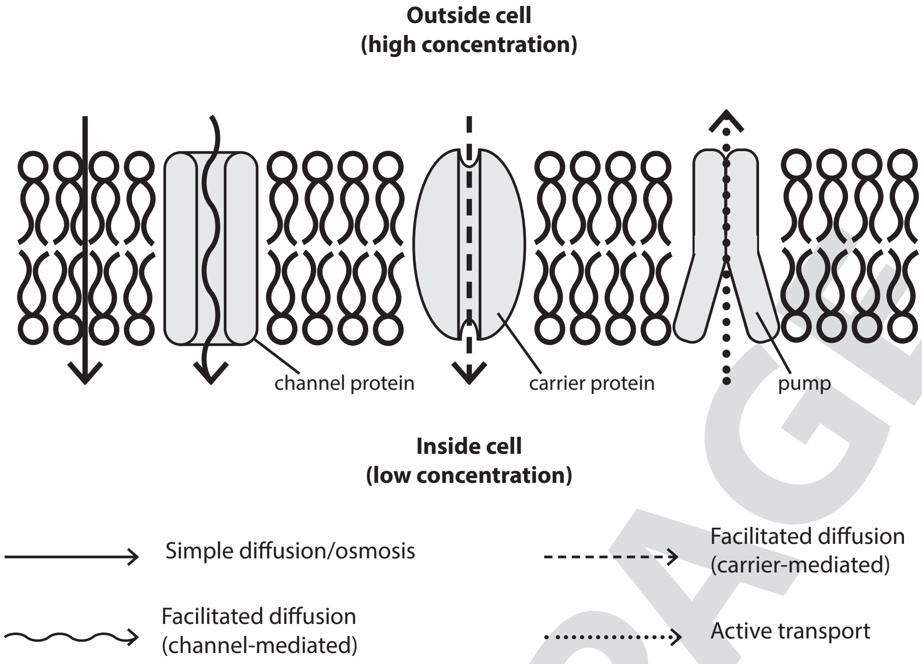


Figure 5. How substances move across the plasma membrane

6. **Endocytosis and exocytosis**: Very large molecules, such as proteins, will not be able to enter or exit cells by either simple or facilitated diffusion. These molecules will require the processes of *endocytosis* and *exocytosis*. Note that both of these processes require energy in the form of ATP.
In endocytosis (see figure 6), the flexible plasma membrane closes around materials that need to be brought into the cell, forming a vesicle that then pinches off and moves into the cell cytosol:

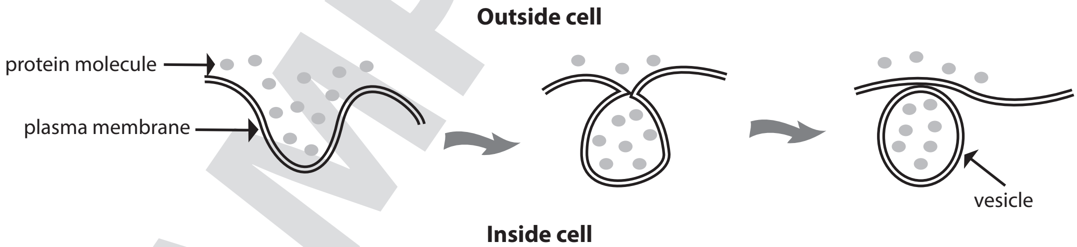


Figure 6. The process of endocytosis

In exocytosis (see figure 7), materials that need to exit a cell are enclosed within a vesicle that forms in the cytosol. This vesicle moves towards the plasma membrane and fuses with it. Contents of the vesicle are then released from the cell:

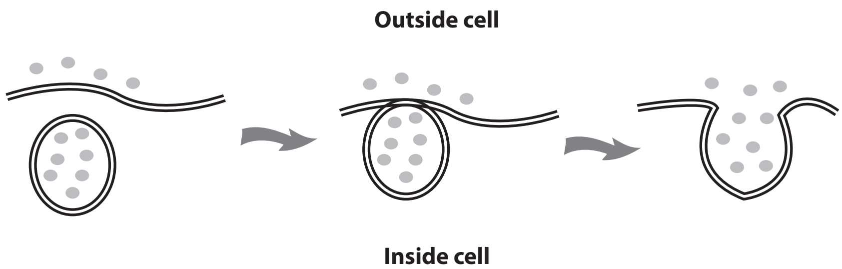


Figure 7. The process of exocytosis

Suggested flash card questions: plasma membrane

Create some flash cards using the following questions (write your answer on the back of the card).

1. What are the two main parts of a phospholipid molecule?
2. Which part of a phospholipid molecule is *hydrophilic* and which part is *hydrophobic*?
3. Draw a simple diagram showing the arrangement of phospholipid molecules in the lipid bilayer.
4. What is an *integral protein*?
5. What do you get when a protein is combined with a sugar?
6. What gives the plasma membrane its fluidity?
7. What is *simple diffusion*?
8. Name three substances that can cross the plasma membrane by simple diffusion.
9. What's the difference between *simple* diffusion and *facilitated* diffusion?
10. Name three substances that can cross the plasma membrane by facilitated diffusion (channel mediated).
11. What sort of diffusion involves carrier proteins?
12. Name two substances that require carrier proteins to transport them across the plasma membrane.
13. What type of transport uses pumps and requires an input of energy?
14. What is *osmosis*?
15. How do very large molecules like proteins get into and out of cells?

Now make up some questions of your own:

Useful VCAA sample exam questions
(you can download exams from the VCAA website)

The plasma membrane

Year	Questions	Year	Questions
2017	SA 1a	**2009 (1)**	____
2016	MC 5, 6, 8	**2008 (1)**	MC 15, 20 SA 1
2015	MC 2	**2007 (1)**	MC 2
2014	MC 6, 11 SA 3b	**2006 (1)**	MC 4, 20, 24
2013	MC 11	**2005 (1)**	MC 3, 12 SA 7c
2012 (1)	SA 1a	**2004 (1)**	MC 4, 9 SA 1b
2011 (1)	SA 4a, 5a	**2003 (1)**	MC 5, 6
2010 (1)	MC 12, 21 SA 2a	**2002 (1)**	SA 1b-e

***2018**: MC 1
SA 4a

* new

MC - multiple choice   SA - short answer