VCE Biology
Frequently asked questions

Question: How is the study of the structure and function of ‘plasma membranes’ in Unit 1 different from its study in Unit 3?

**Answer:** In terms of plasma membrane structure, Unit 1 focuses on an understanding of the membrane functioning as a semi-permeable boundary between the external and internal environments of the cell, whilst in Unit 3 students consider the ‘fluid mosaic’ model of a plasma membrane as an explanation for the controlled movement of materials moving into and out of
a cell.

In terms of function, Unit 1 focuses on modes of transport of soluble substances across the membrane with specific attention to the mechanisms of simple diffusion, facilitated diffusion, osmosis and active transport. In Unit 3 the focus is on the chemical nature of the plasma membrane and how the size and charge of substances will determine how substances may or
may not pass across it since the phospholipid bilayer is impermeable to hydrophilic substances. However, in Unit 3, general reference to different types of transport modes is required in considering the chemical nature of substances entering/exiting the cell: simple diffusion enables passage of water and small hydrophobic substances between phospholipid molecules or through ion channels down their concentration gradient; facilitated diffusion enables passage of dissolved hydrophilic substances through channel proteins and carrier proteins down their concentration gradients; active transport enables passage of dissolved hydrophilic substances through ion pumps or carrier proteins against concentration gradients; and endocytosis/exocytosis enables bulk transport of larger molecules and liquids.

The role of proteins on the external surface of a plasma membrane is considered in more depth in Unit 3 Area of Study 2, particularly in relation to signal transduction. Endocytosis and exocytosis are considered in more depth in Unit 3 Area of Study 2, particularly in relation to apoptosis and immune responses.

Question: How does practical work related to plasma membranes differ in Unit 1 when compared with Unit 3?

**Answer**: Practical work in Unit 1 could include investigation of concentration gradients (hypotonic, hypertonic and isotonic solutions) whilst practical work in Unit 3 may involve comparisons of transport of simple molecules (hydrophobic versus hydrophilic, charged versus uncharged, large versus small) across membranes. Given the focus on the relationship between structure and function at a cellular level in Unit 3, modelling activities (hands-on and/or computer simulations) would also be suitable practical activities.

Question: Are students required to know the chemical structures of any molecules in
Unit 3?

**Answer**: Yes, some structures are required in order to understand how proteins are formed from amino acids. Although students are not expected to memorise structures for specific amino acids, they should be able to draw the dipeptide that results from the condensation reaction that occurs when the carboxylic acid group (-COOH) of one amino acid reacts with the amine group (-NH2) of another amino acid. They should know that the bond that is formed is a peptide bond. Students should apply their understanding of a condensation reaction to the formation of polypeptides, DNA and RNA.

Representations of the plasma membrane as a phospholipid bilayer (indicating the arrangement of hydrophilic heads and hydrophobic tails) with surface and/or integral and transmembrane (channel and carrier) proteins and interspersed cholesterol (in animals) do not require students to draw or recognise chemical structures.

Question: Are students required to know the names of specific regulatory proteins and regulatory genes in the *lac* operon in Unit 3?

**Answer**: No, students are not required to recall specific names of the regulatory proteins (also called transcription factors) and regulatory genes. However, students are expected to understand the combined regulatory function of the following general terms: repressor protein; promotor region; operator region; and RNA polymerase.

Question: Do students need to learn the different amounts of ATP produced at each stage in aerobic cellular respiration and anaerobic cellular respiration/anaerobic fermentation?

**Answer:** Yes. Students should recognise that there is variation between theoretical and actual amounts of ATP produced. Students are expected to understand the net yields of ATP for aerobic cellular respiration and anaerobic fermentation as being:

|  |  |
| --- | --- |
| **Process** | **ATP yield** |
| ***Glycolysis*** | ***Krebs Cycle*** | ***Electron Transport Chain*** |
| Aerobic cellular respiration  | 2 ATP | 2 ATP | Variable (32 or 34 ATP) |
| Anaerobic fermentation  | 2 ATP |  |  |

Question: Which anaerobic processes for breaking down glucose should be studied?

**Answer**: Fermentation is the only anaerobic process specified in the study design. Both lactic acid fermentation and alcoholic fermentation pathways should be compared in terms of location, inputs, outputs and ATP yield.

Question: To what depth should ‘factors affecting reaction rate’ be studied?

**Answer**: The consideration of reaction rate is specific to photosynthesis and cellular respiration. Students should explore the factors that affect the rates of photosynthesis and cellular respiration including a directional effect of each factor and the effect of enzymes. Students should understand the concept that the concentration of limiting reagents affects reaction rates; this is different from the total quantity of limiting reagent, which determines the maximum theoretical amount of product that can be produced for a given amount of reactant/s. They should understand the importance of light for photosynthesis and that varying the intensity of the incident light will affect the rate of photosynthesis up to a point at which a maximum rate of photosynthesis can occur. Students should understand that enzymes operate within narrow temperature ranges and that denaturation at high temperatures will result in a decrease in reaction rate for both photosynthesis and cellular respiration after optimum reaction rate has been reached due to heat-induced changes to the tertiary structures of the enzymes. Reference to collision theory is expected when considering the effects of temperature changes on reaction rate. No reference to energy profile diagrams is required. Students are expected to be able to interpret experimental data related to rates of photosynthesis and cellular respiration.

Question: To what depth should ‘enzymes’ be studied?

**Answer**: Students should consider the role of enzymes as protein catalysts in biochemical pathways. They should understand how enzyme action can be inhibited either reversibly or irreversibly by considering chemical competition at the active site, including the action of competitive and non-competitive inhibitors; use of the lock-and-key model of enzyme action is sufficient to explain this concept. Students should understand that anything that alters the shape of the active site will affect the enzyme’s capacity to bind to a substrate. They should understand how temperature and pH affect the rate of reaction and may lead to enzyme denaturation. Students should explore how enzyme activity is affected by varying enzyme and substrate concentrations in enzyme-controlled (biochemical) reactions. They should recognise that enzymes are a subset of proteins.

Question: Do students need to know the source, mode of transmission and effects of specific plant and animal hormones, neurotransmitters, cytokines and pheromones?

**Answer:** No specific molecules or physiological/other effects are required: the focus is on these molecules as initiating the process of signal transduction. Students should recognise that all of these are examples of signalling molecules and are produced in different locations and are transmitted in various ways. Students should understand that there are different types of signalling molecules (limited to plant/animal hormones, neurotransmitters, cytokines and pheromones, as specified in the study design) and that they are transmitted around the body in a variety of ways (for example, hormones are secreted by ductless glands of the endocrine system and may act locally or may be carried by the bloodstream to distant organs whilst neurotransmitters are secreted from neurons into the synaptic gap and bind to receptors on adjacent cells). Signalling molecules’ actions are mediated through the signal transduction steps of reception, transduction, and cellular response. A cellular response refers to the receptor cell changing in a particular way, for example, a change in the transcription level of particular genes, a change in the rate of protein synthesis or a change in activity of particular enzymes; this may then lead to further changes, for example, cell growth, apoptosis or cell migration. Teachers may choose their own examples, but should choose a selection that illustrates variation in source and mode of transmission. Students should be able to identify the appropriate signal transduction steps for hydrophilic and hydrophobic signalling molecules.

Question: To what depth should students study signal transduction of protein-based signalling molecules?

**Answer**: Students should focus on the general characteristics of signal transduction following recognition of the signalling molecule as being hydrophilic or hydrophobic. Protein-based signalling molecules are hydrophilic. For hydrophilic signals students should understand the position of the receptor molecule and its complementary shape, the binding of the signal to the receptor producing a change in configuration, followed by a second messenger molecule being activated leading to a signal cascade with amplification resulting in a cellular response. Specific names of molecules are not required.

A similar approach should also be applied to hydrophobic signals. Students are expected to apply their understanding of the process of signal transduction to unfamiliar examples of nominated hydrophilic and hydrophobic signals.

Question: To what depth should students study the two different pathways of apoptosis (mitochondrial and death receptor pathways)? Do they just need to know the common steps that occur once the signal is received, for example, that caspases are activated?

**Answer**: Students should understand that a signal may be generated within (intrinsic pathway – activated by internal signals or signs of cellular damage) or outside (extrinsic pathway – activated when extracellular signals bind to death receptors on the membrane surface) a cell and that, in either case, a three-step signal transduction process leads to the destruction of cells that are no longer needed or that may be a threat to an organism. Both processes involve caspases (protein digesting enzymes); specific names for the different caspases and other molecules involved in the process are not required. Students should be able to apply this understanding to unfamiliar situations.

Question: Is phagocytosis considered part of apoptosis?

**Answer**: No. Phagocytosis occurs after apoptosis. Apoptotic bodies (produced by blebbing during apoptosis) are engulfed by macrophages (phagocytes) through the process of phagocytosis at the end of the apoptotic process.

Further information about apoptosis and phagocytosis can be accessed at:
[www.ncbi.nlm.nih.gov/pmc/articles/PMC4826466/](http://www.ncbi.nlm.nih.gov/pmc/articles/PMC4826466/)

Question: Do students need to know all the different signalling molecules within the immune system?

**Answer**: No. Students are not expected to know the names and functions of all these signalling molecules. The generic name for signalling molecules within the immune system is ‘cytokines’. Cytokines are involved in chemical signalling between the various cells of the immune system.
All cytokines are soluble proteins or glycoproteins (hydrophilic) and therefore interact with cells via cell surface molecule receptors in signal transduction. Teachers may choose their own examples of cytokines.

Question: Which specific pathogens/pathogenic agents are students expected to study and in how much detail?

**Answer**: Students should distinguish between cellular and non-cellular pathogens as a source of non-self/foreign antigens to which animals and plants respond. Students should understand the preventative strategies that animals and plants have in dealing with the non-self antigens. Whilst teachers may choose their own examples of pathogens, examples of physical, chemical and microbiological barriers for each of animals and plants should be provided. Students are not required to know the life cycles of any pathogens.

Question: How much detail related to plant defences is required under each of the factors listed in the study design – physical, chemical, and microbiological barriers?

**Answer**: Students should know that plants have a variety of strategies (passive strategies, active strategies and hypersensitive responses) to prevent entry by invaders or kill invaders such as viruses, bacteria, fungi, various insects, and animal predators. Students should understand that although plants do not have an immune system comparable with animals, they do have cell surface receptors which identify the unique molecular patterns of invading organisms. Teachers should provide examples of plants’ structural, chemical and peptide-based defences that are adapted to stop invading organisms before they cause extensive damage.

Question: Are students required to know dates for the changes in life forms in Earth’s geological history, and which specific life forms should be considered?

**Answer**: No, although specific dates are not required students should understand geological
time is divided into sections, for example eras and periods.

Students should understand that Earth’s history can be represented on a geological time scale
as a ‘calendar’ of chronological events: different kinds of organisms do not appear randomly but appear in a constant order as the law of fossil succession. The fossil record shows the changes that have occurred in the types of organisms living over time.

Question: Are students required to understand why biodiversity has changed over time?

**Answer**: Yes, students should have a general understanding that major changes in Earth’s conditions such as available land masses (plate tectonics), atmospheric composition, temperature, climate and biodiversity have consequences. For example, the appearance of multicellular animals in the fossil record can be related to build up of oxygen in the atmosphere derived from photosynthetic cyanobacteria. As another example, flowering plants (angiosperms), birds, and mammals rapidly radiated into niches left vacant by the extinction of the dinosaurs.

Question: In relation to the human fossil record, do students need to know which species evolved from which?

**Answer**: No. Students should understand that the human fossil record has strengths and limitations as an example of a biological classification scheme; it is open to interpretation and
may change based on available evidence. New fossils are always being discovered adding to
the evidence currently available. Students are encouraged to consider open questions such as,
‘Is it possible that *Homo sapiens* and *Homo neanderthalensis* interbred?’

Question: Are students required to know which species was the first to use fire?

**Answer:** No.Rather than specifics such as which species was the first to use fire, students should examine evolutionary trends over time. Students should understand that the different structural, functional and cognitive changes over time have led to cultural evolution.

Question: Do all students need to perform completely different experiments for the Unit 4 Area of Study 3 Student Practical Investigation?

**Answer**: No. In some schools it may not be practical to have all students performing completely different experiments, due to student numbers and/or availability of resources. Further, scientific investigation is often a collaborative exercise. However, for VCE Biology, all students must complete the write up of investigation results individually and should be assessed on their capacity to design investigations, either prior to undertaking their own investigation or at the conclusion of their investigation in suggesting an extension or coupled experiment. Teachers should note that it may not be possible for students to undertake some proposed student-designed investigations due to factors including time and/or space feasibility, availability of resources, safety and ethics.

Question: Do students need to complete a risk assessment for their practical investigation?

**Answer**: This will depend on the nature of the investigation and the individual policy at the school. However, teachers are responsible for ensuring that all practical experiments meet with health and safety regulations and follow bioethical guidelines as specified on pages 7 and 8 of the study design. It is expected that students will understand and manage any risks associated with their

own investigations. Teachers should note that the national Science ASSIST website <https://assist.asta.edu.au> contains useful resources related to laboratory safety and provides an online advisory service for teachers and laboratory technicians. A variety of commercial products are also available.

Question: To what extent do student have to be able to analyse sources of error in experiments?

**Answer**: Students should be able to understand the difference between systematic and random errors; a qualitative (rather than quantitative) treatment is required. Teachers should refer to the ‘Cross-study specifications’ on pages 10 and 11 of the study design and in particular to the elaborated key science skills under the sub-heading ‘Analyse and evaluate data, methods and scientific models’. Further advice can be found at the VCAA Biology *Advice for teachers* in the left side navigation panel ‘Measurement in Science’.

[www.vcaa.vic.edu.au/Pages/vce/adviceforteachers/biology/experimentaluncertanderrors.aspx](http://www.vcaa.vic.edu.au/Pages/vce/adviceforteachers/biology/experimentaluncertanderrors.aspx)

Teachers are reminded that key science skills should be linked to key knowledge as appropriate.

Question: What is meant by ‘reliability’ in relation to biological investigations, and how is reliability related to repeatability, reproducibility, accuracy and precision?

**Answer**: Reliability can relate to both primary data and to secondary sources of information and data. With reference to secondary sources and data, reliability is understood as relating to the credibility of the source.

For primary data, reliability is the degree of consistency, or repeatability, of a measure. Other investigators must be able to perform exactly the same investigation under the same conditions to generate the same results, noting that it could be the same inaccurate results. If the results from an investigation are consistently close to each other, then they can be described as being ‘reliable’. Reliability is affected by the precision of results: if investigation results show a large degree of variation, then the investigation will be less reproducible, thereby making it less reliable. Reliability of results can be evaluated by repeating the investigation and determining the degree to which the results vary.

For VCE Biology purposes, reliability of primary data can be considered in terms of ‘repeatability’ (see the *VCE Biology Advice for teachers*:

[www.vcaa.vic.edu.au/Pages/vce/adviceforteachers/biology/measurementterms.aspx](http://www.vcaa.vic.edu.au/Pages/vce/adviceforteachers/biology/measurementterms.aspx)).