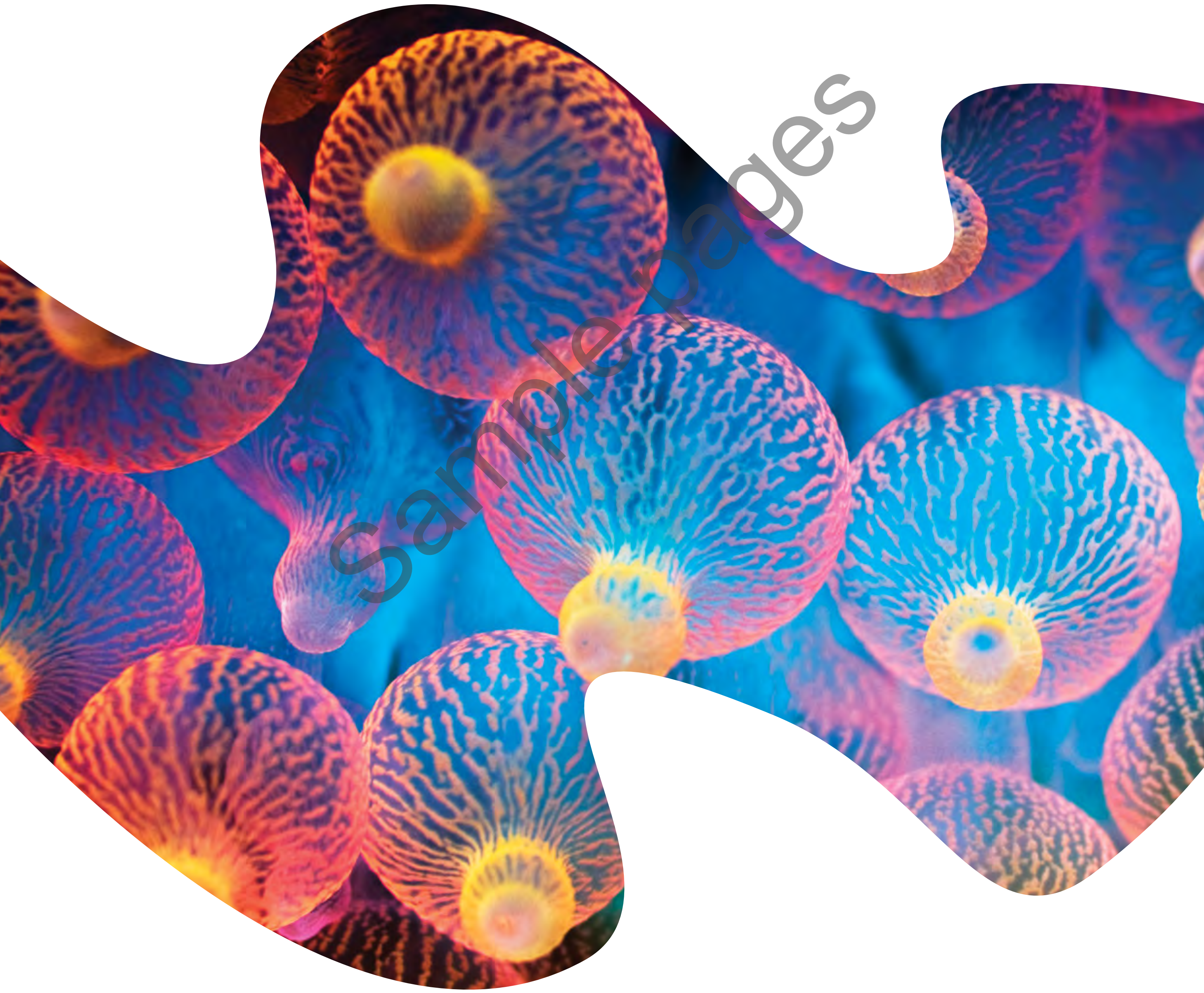
HEINEMANN BIOLOGY 1

SKILLS AND ASSESSMENT



Yvonne Sanders

VCE UNITS 1 AND 2 • 2022-2026

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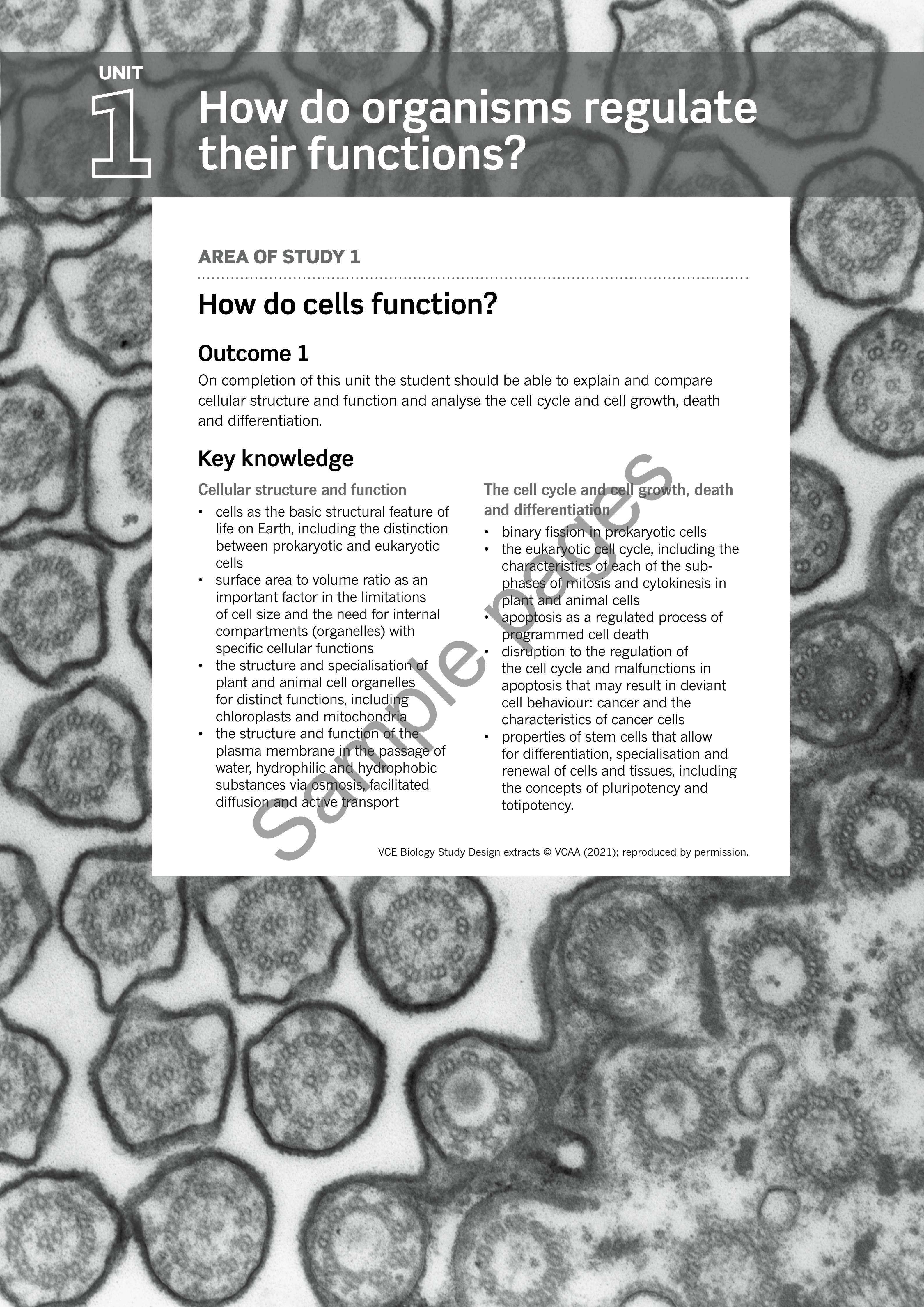


UNIT 1

How do organisms regulate their functions?

AREA OF STUDY 1

How do cells function?

Outcome 1

On completion of this unit the student should be able to explain and compare cellular structure and function and analyse the cell cycle and cell growth, death and differentiation.

Key knowledge

Cellular structure and function

- cells as the basic structural feature of life on Earth, including the distinction between prokaryotic and eukaryotic cells
- surface area to volume ratio as an important factor in the limitations of cell size and the need for internal compartments (organelles) with specific cellular functions
- the structure and specialisation of plant and animal cell organelles for distinct functions, including chloroplasts and mitochondria
- the structure and function of the plasma membrane in the passage of water, hydrophilic and hydrophobic substances via osmosis, facilitated diffusion and active transport

The cell cycle and cell growth, death and differentiation

- binary fission in prokaryotic cells
- the eukaryotic cell cycle, including the characteristics of each of the sub-phases of mitosis and cytokinesis in plant and animal cells
- apoptosis as a regulated process of programmed cell death
- disruption to the regulation of the cell cycle and malfunctions in apoptosis that may result in deviant cell behaviour: cancer and the characteristics of cancer cells
- properties of stem cells that allow for differentiation, specialisation and renewal of cells and tissues, including the concepts of pluripotency and totipotency.

Cellular structure and function

Cells are the basic building blocks of all organisms (living things). The study of cells is called cytology.

The cell theory is one of the fundamental principles of biology. The cell theory states that:

- all organisms are made up of cells and/or the products of cells
- all cells are derived from pre-existing cells (**biogenesis**)
- the cell is the smallest organisational unit of a living thing.

Cells are composed of chemicals. The main molecule found in cells is water. Some plant cells are more than 90% water. In addition to water, cells consist of both inorganic and organic substances.

Inorganic compounds (including water) are relatively simple and do not contain hydrocarbon groups. **Organic compounds** are relatively complex and contain hydrocarbon groups.

Table 1.1.1 provides a summary of the features of major cell chemicals.

An understanding of the chemical composition of cell organelles and other structures makes it possible to further understand their function as well as their origin and synthesis within the cell.

Table 1.1.1 Major cell chemicals

Substance	Composition and examples	Function(s) in cells
water	• H_2O • inorganic	• All chemical reactions in organisms take place in solution in water. • Water has high heat capacity.
minerals	• nitrogen (N) • phosphorus (P) • iron (Fe) • magnesium (Mg) • all inorganic	• N is used for protein and nucleic acid synthesis. • P is used for nucleic acid synthesis and is an important component of plasma membranes. • Fe is a component of haemoglobin in red blood cells. • Mg is a component of chlorophyll.
carbohydrates	• basic building blocks are monosaccharides • contain C, H, O • organic	They provide an energy source to cells that can be accessed relatively easily.
lipids	• basic building blocks are glycerol and fatty acids • contain C, H, O • organic	Lipids are used for long-term energy storage and insulation, and are structural components of membranes.
proteins	• basic building blocks • contain C, H, O, N • organic	All enzymes are proteins. Proteins also play important structural roles.
nucleic acids	• in DNA and RNA • contain C, H, O, N, P • organic	• DNA carries the genetic code. • RNA is involved in transcription and translation of the genetic code.
vitamins	• vitamin C • vitamin D • organic	• Vitamin C is a cofactor for many enzymes and supports immune function. • Vitamin D facilitates uptake of calcium into bones. • Vitamins have important roles in enzyme function, e.g. as coenzymes.

CELL TYPES

There are two main types of cells.

1 **Prokaryotic cells** are relatively small and primitive. They do not possess membrane-bound organelles. This means they lack sophisticated internal detail. **Prokaryotes** are represented by two domains:
   - Bacteria (bacteria and blue-green algae). Bacterial cell walls are typically composed of a carbohydrate-protein material called **murein**.
   - Archaea (which includes extremophiles).

2 **Eukaryotic cells** (Figure 1.1.1) are relatively larger and more complex than prokaryotic cells. They possess membrane-bound organelles such as a nucleus, mitochondria and lysosomes (Figure 1.1.1). **Eukaryotes** (domain Eukarya) include the kingdoms:
   - Protista—unicellular organisms
   - Fungi
   - Plantae
   - Animalia.

KEY KNOWLEDGE

ORGANELLE STRUCTURE AND FUNCTION

Organelles are subcellular structures that have a specific function. Some organelles are membrane-bound compartments within the cytoplasm. The **cytoplasm** is all of the cell's contents, except for the nucleus, and consists of the **cytosol** (a gel-like fluid) and the organelles. Membrane-bound organelles are only present in eukaryotic cells (Figure 1.1.1).

Prokaryotic cells lack the membrane-bound structures listed in Table 1.1.2 on page 4. However, prokaryotic cells are capable of controlling their functions. They are also capable of generating energy. Some are even capable of photosynthesis, because they contain photosynthetic pigments.

Prokaryotic cells contain a single, coiled chromosome that contains all of the DNA (genes) necessary to control and direct all the activities of the cell. In addition, there are specialised regions within prokaryotic cells where cellular respiration can occur.

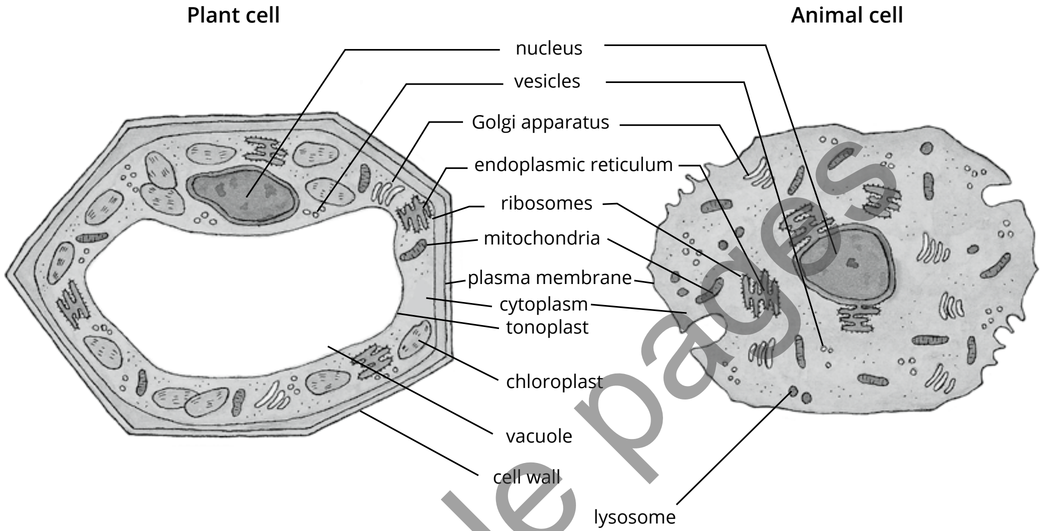


Figure 1.1.1 In eukaryotic cells, such as plant and animal cells, many of the functions that are essential to life occur within specialised structures called organelles.

SURFACE AREA TO VOLUME RATIO

The surface area of the plasma membrane around a cell and cellular compartments affects the rate of exchange that is possible between the cell organelle and its environment.

Larger cells have greater metabolic needs, so they need to exchange more nutrients and waste with their environment. However, as the size of a cell increases, the **surface area to volume ratio** of the cell decreases. By compartmentalising specific areas of the cell into organelles, the cell can maximise its efficiency in exchanging matter with its environment and its ability to undertake a variety of cellular processes.

Three ways of increasing the surface area of cells without changing cell volume are:

- cell compartmentalisation
- a flattened shape
- plasma membrane extensions.

Consider the two cells in Figure 1.1.2. Although cell A has a larger volume, cell B has a larger surface area compared to its volume. This means cell B will be more efficient at taking in and exporting substances through its plasma membrane per unit time.

In general, the surface area to volume ratio of an organism decreases as size increases. Cells and organisms have structural adaptations to overcome this. Such adaptations include microvilli on absorptive cells, and the ribbon-like body shape of tapeworms.

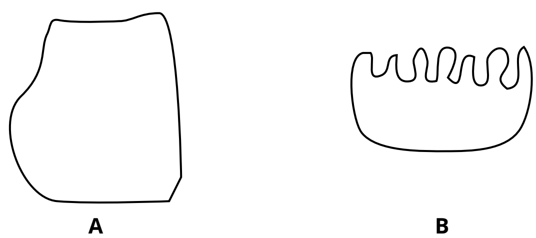


Figure 1.1.2 Two cells (A and B) with a different volume but similar surface area. Cell B has a greater surface area to volume ratio.

Table 1.1.2 Cellular organelles and their functions

Organelle	Description and function	Found in both plants and animals
nucleus	• large spherical organelle • membrane-bound • contains DNA and controls cell activities	yes
mitochondrion	• features folded inner membrane • membrane-bound • site of aerobic stages of cellular respiration • contains DNA	yes
ribosome	• tiny spherical organelle • non-membrane-bound • site of protein synthesis	yes
endoplasmic reticulum (ER)	• network of membranes involved in protein transport within cells • ER with ribosomes attached is called 'rough' ER	yes
Golgi apparatus	• stacks of flattened membranous sacs • modifies and packages substances in preparation for secretion from cell	yes
chloroplast	• membrane-bound • site of photosynthesis (contains chlorophyll) • contains DNA	plant cells only
lysosome	• membrane-bound • produces digestive enzymes • breaks down complex compounds into simpler molecules	animals plants (some evidence)
vacuole	• membrane-bound compartment • keeps a variety of substances separate from cytosol (large in plant cells, small in animal cells)	yes
cell wall	• rigid structure surrounding cell; composed of cellulose in plants • limits cell expansion when fully turgid; contributes to structural support of plant	plant cells only
plasma membrane	• partially permeable, flexible barrier • controls cell inputs and outputs	yes

PLASMA MEMBRANE STRUCTURE AND FUNCTION

The **internal environment** of cells is the intracellular fluid—the medium inside cells. The **external environment** of cells is the extracellular fluid—the watery medium surrounding cells.

The **plasma membrane** separates the internal environment of the cell from the external environment, and controls entry and exit of substances into and out of cells. It controls which substances enter and leave, when and how much. It responds to instructions from the nucleus. It can detect and respond to external stimuli.

The plasma membrane is described as a **semi-permeable membrane** (also called partially permeable) because it allows some substances to cross it but not others.

The composition of the plasma membrane is basically the same as that of all membranes within cells (including the membranes of the nuclear envelope, mitochondria, Golgi apparatus, endoplasmic reticulum, vacuoles, lysosomes and chloroplasts).

The plasma membrane consists of a double layer of special lipid molecules called **phospholipids**. This is called the **phospholipid bilayer**. The bilayer has protein molecules scattered through it in a random pattern (Figure 1.1.3). The total structure is fluid. This means that the molecules can move around relative to each other. The **fluid-mosiac model** is used to describe these important characteristics of the plasma membrane.

In summary, the plasma membrane is a flexible, partially permeable barrier between the intracellular and extracellular environments.

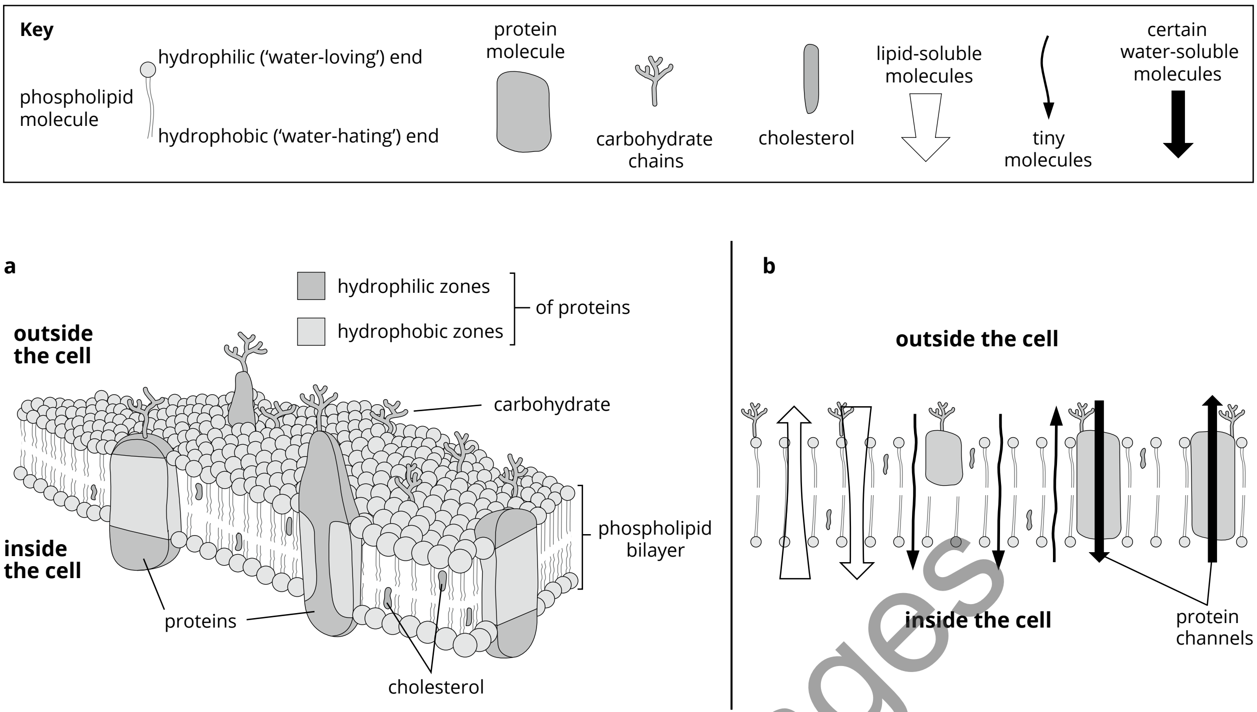


Figure 1.1.3 (a) Biological membranes are composed of a phospholipid bilayer with large protein molecules embedded in the bilayer. These proteins provide channels for the passive and active movement of certain molecules across the plasma membrane. (b) Short carbohydrate molecules attached to the outside of the membrane are involved in cell adhesion and cell recognition.

TRANSPORT ACROSS THE PLASMA MEMBRANE

The movement of substances into and out of cells depends on several factors, including size, configuration and concentration.

Simple diffusion

Diffusion is a passive process in which particles move from an area of high concentration to an area of low concentration along a **concentration gradient**.

For very small molecules and lipid-soluble substances, movement directly through the lipid bilayer is possible. The concentration of the substance determines its net movement. This is known as **simple diffusion**.

Osmosis

Diffusion of water is a special case. It is called osmosis. **Osmosis** is a process in which water molecules move across a semi-permeable membrane from a region of high concentration of water molecules to a region of low concentration of water molecules. Osmosis is a passive process—water molecules move along a concentration gradient. The rate of osmosis is determined by the relative concentration of solutes on either side of the semi-permeable membrane. As the membrane is fully permeable to water (simple diffusion), the only factor that can 'control' its passage is the osmotic pressure exerted by the concentration of solutes such as sugars and salts on either side of the membrane.

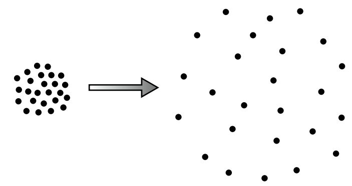
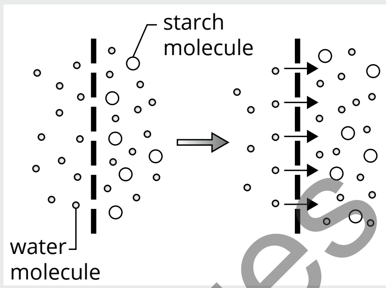
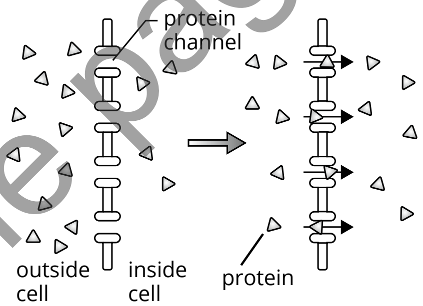
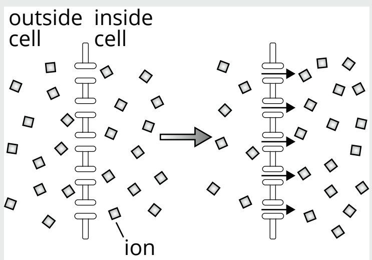
Facilitated diffusion and active transport

For larger molecules that are not lipid soluble (e.g. glucose and mineral ions), movement through the plasma membrane is made possible by special protein molecules embedded in the lipid bilayer. These proteins act as channels or carrier molecules. If the substance moves through the membrane from an environment of high concentration to one of lower concentration (i.e. along the concentration gradient), the movement is called **facilitated diffusion**. If the substance moves against the concentration gradient, the movement is called **active transport** because it requires an expenditure of energy by the cell.

It is also possible for very large substances to move through the plasma membrane. This type of movement requires a physical disruption to the membrane. Entry to the cell under these circumstances is called **endocytosis**. Exit is called **exocytosis**.

Table 1.1.3 on page 6 summarises entry to and exit from cells.

Table 1.1.3 Movement across the plasma membrane

Process	Description	Active or passive	Diagram	Example in organism
Diffusion	movement of particles from an area of high concentration to an area of low concentration, along a concentration gradient	passive (does not require energy)		oxygen enters body cells (low in O_2 since continually using O_2 in cellular respiration) from the capillaries where it is in high concentration (O_2 replenished at lungs)
Osmosis	special type of diffusion that involves movement of water molecules across a partially permeable membrane; water moves from an area of high concentration of free water molecules to an area of low concentration of free water molecules, i.e. low solute concentration to high solute concentration	passive		cells in kidney medulla absorb water by osmosis due to osmotic gradient between ion concentration in tissue fluid and the kidney tubules
Facilitated diffusion	movement of particles from high to low concentration through protein channel in plasma membrane	passive		small molecules such as amino acids and glucose enter the cell via a protein channel
Active transport	movement of particles from an area of relatively low concentration to an area of high concentration, against a concentration gradient	active (requires input of energy)		uptake of ions by root hair cells of plants and uptake of nutrients by gut epithelium cells of animals, so that concentration within cells exceeds concentration in external medium

The rate at which substances move across the plasma membrane is determined by a number of factors. These include:

- concentration (steep concentration gradient increases the rate of diffusion)
- temperature (higher temperature increases the rate of movement of molecules)
- surface area to volume ratio ($SA : V$).

The cell cycle and cell growth, death and differentiation

We know from the cell theory that all cells are derived from pre-existing cells. Prokaryotic cells replicate by a process known as **binary fission** in which the cell and its contents are divided into two. Eukaryotic cells replicate by a process known as **mitosis** (the division of the nucleus) followed by the splitting of the entire cell into two (**cytokinesis**). In both cases the parent cell divides to form two genetically identical **daughter cells**.

Cell replication is responsible for the production of new cells within an organism for the purposes of maintenance, growth and repair (Table 1.1.4).

Table 1.1.4 Purpose of cell replication

Cell replication contributes to	Example(s)
maintenance	replacement of old cells as they 'wear out'
growth	enables part of organism or whole organism to increase in size
repair	replacement of damaged cells after injury

BINARY FISSION

Prokaryotic cells are simpler than eukaryotic cells, possess a single circular chromosome and no membrane-bound nucleus. They do not follow the same processes as eukaryotic cells when undergoing cell replication. Cell replication in prokaryotes such as bacteria follows the process of binary fission. In this process the cell grows, doubling in size as its contents are duplicated. The circular chromosome is also duplicated. Chromosome replication begins at a point called the origin and following replication the identical copies of the chromosomes separate. Binary fission is complete once the two newly formed cells have completely separated, with their own fully formed cell wall. The process of binary fission is shown in Figure 1.1.4.

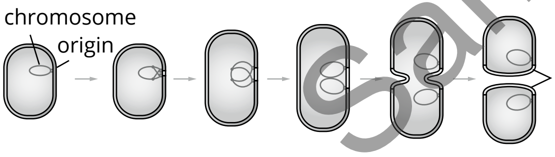


Figure 1.1.4 Division of a prokaryotic cell. Replication of the chromosome begins at a point called the origin, after which a new cell wall and plasma membrane form, dividing the cell in two.

THE EUKARYOTIC CELL CYCLE

Cells are in a constant state of activity that includes all the chemical reactions that make up the cell's metabolism, as well as growth and reproduction. Cell growth includes the replication of DNA that will be organised and divided for distribution to daughter cells during cell division. This cyclical activity of cells is called the **cell cycle** (Figure 1.1.5).

The eukaryotic cell cycle has three main phases:

- **Interphase:** Replication of the chromosomes occurs. Without this, the daughter cells would not receive the appropriate type and number of chromosomes. Interphase consists of three main phases: G_1 (pre-DNA synthesis), S (DNA synthesis) and G_2 (post-DNA synthesis). A cell spends most of its time in interphase.
- Mitosis: The nucleus divides.
- Cytokinesis: The cytoplasm divides, forming two genetically identical daughter cells.

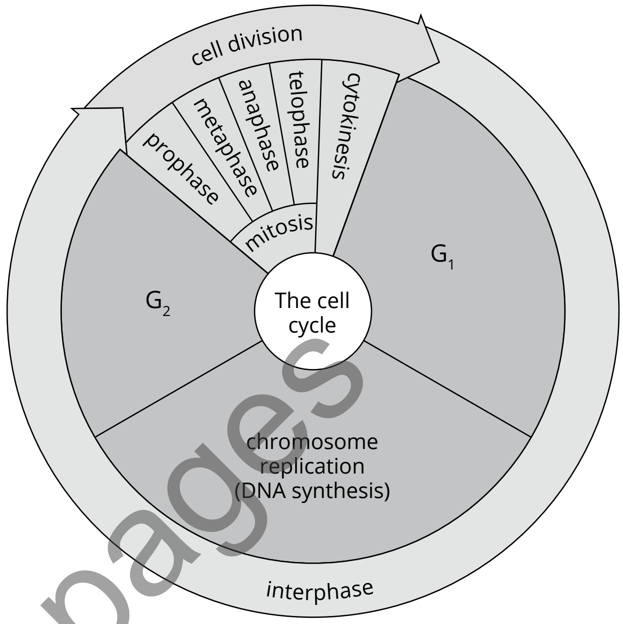


Figure 1.1.5 The cell cycle takes approximately 24 hours to complete in mammalian cells.

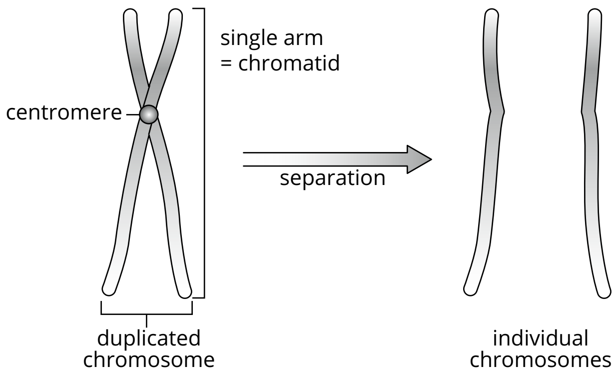


Figure 1.1.6 Anatomy of a chromosome

Interphase: DNA replication

The genetic information in the cells of eukaryotic organisms is packaged into threads of DNA called chromosomes (Figure 1.1.6). Chromosomes carry all of the information needed for cell structure and function. During the cell cycle the chromosomes are organised so that the resulting daughter cells each receive precisely the same genetic material as the parent cell from which they are derived. Before this can occur, the genetic material must be duplicated. This copying process is called **DNA replication** (Figure 1.1.7 on page 8). During DNA replication, the two strands of DNA that form the double helix 'unzip' or separate.

The enzyme **DNA polymerase** then moves along the exposed template strands adding nucleotides according to base-pairing rules to build the new strands.

DNA replication is called semi-conservative because the parental strand is conserved or retained in the new DNA molecule.

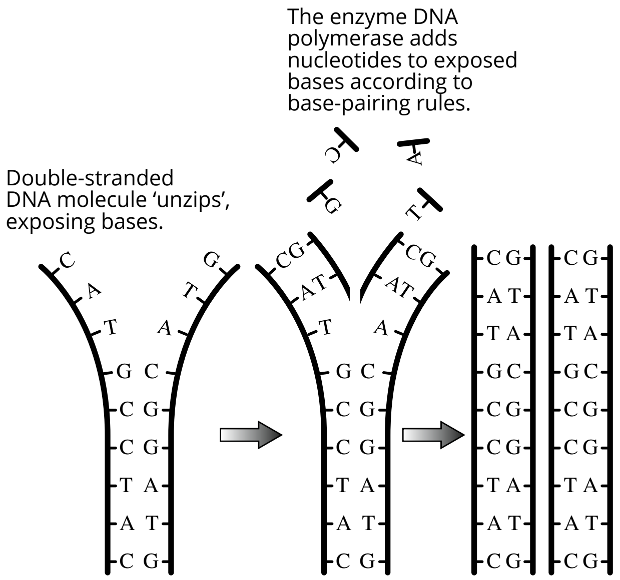


Figure 1.1.7 DNA replication—DNA polymerase adds nucleotides to build copies of the original DNA strands.

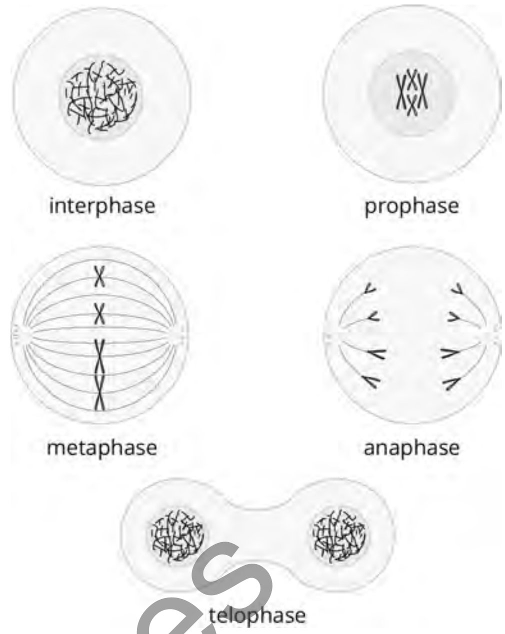


Figure 1.1.8 During mitosis, DNA replicated during interphase is divided into two new nuclei.

Mitosis

Mitosis is the process of nuclear division that results in two genetically identical daughter cells. Mitosis is divided into four phases (Figure 1.1.8):

- **Prophase:** Chromosomes shorten and thicken, and become visible under the light microscope. The nuclear envelope dissolves and a structure called the spindle starts to form. The spindle consists of fibres that radiate across the cell from centrioles at each pole.
- **Metaphase:** Chromosomes line up along the equator of the cell. Each chromosome attaches to a spindle fibre by its centromere.
- **Anaphase:** The spindle fibres contract, causing the centromeres to split and pull the sister chromatids towards opposite poles. (Remember, each chromosome was replicated during interphase and the two copies of each have remained joined until now.)
- **Telophase:** New nuclear membranes form around each of the two new groups of chromosomes.

Cytokinesis occurs after telophase.

REGULATING THE CELL CYCLE

The eukaryotic cell cycle is a highly regulated process. This regulation is critical to the normal development and function of organisms. The cell cycle is regulated by internal and external factors.

Mutagens are agents that alter the DNA molecule in cells. Because DNA sequences are responsible for controlling cell processes including growth, development and differentiation as well as programmed cell death (apoptosis), any interference in the structure or sequence of the DNA can also interfere with its regulatory role. The disruption to the regulation of the cell cycle may lead to the formation of developmental abnormalities or cancers.

Apoptosis

Sometimes a cell's response to a signal is the death of the cell. Programmed cell death is called **apoptosis**. Enzymes called caspases are responsible for a cascade of cellular signals that lead to shrinkage of the nucleus and then the cell. The degradation of the cell's internal structure causes bulges in the plasma membrane called **blebs** to form (Figure 1.1.9). The cell then breaks up and the fragments are consumed by **phagocytic cells**.

Cell death is a natural event in the cycle of many different kinds of cells, for example skin cells, red blood cells, and in the management of infection; for example, some virus-infected cells are targeted for destruction. Apoptosis can follow one of two pathways:

- The mitochondrial pathway occurs when cell death is initiated from inside the cell, usually due to cell damage from factors such as radiation, toxins or viral infection.
- The death receptor pathway occurs when cell death is initiated from outside the cell; for example, a signalling molecule such as a cytokine triggers apoptosis.

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Occasionally malfunctions occur in the regulatory pathways that involve apoptosis. In some such circumstances cells otherwise programmed to die fail to do so, instead continuing to reproduce so that more cells are produced than die. When cells proliferate in this way, tumours and/or cancers result.

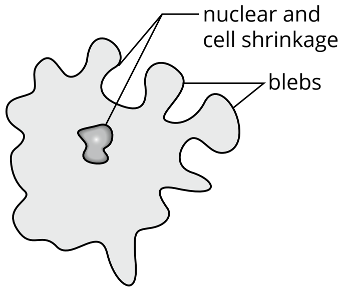


Figure 1.1.9 Apoptic cell

CELL GROWTH AND DIFFERENTIATION

Cell division is followed by cell growth. As cells mature they develop the features that allow them to take on specialised roles. This is called **cell differentiation**. The structure and features of cells are related to their function. For example, cells lining the small intestine have microscopic finger-like projections (microvilli) on their surface, which increase the surface area to volume ratio of the cells, making them efficient at absorbing nutrients.

Types of stem cells

Undifferentiated cells are called **stem cells**. Stem cells can develop into many different cell types. Stem cells can be broadly classified as **embryonic stem cells** and **adult stem cells**, but can also be categorised based on their potency. Cell **potency** is a cell's ability to differentiate into other cell types.

- **Totipotent** stem cells have the potential to differentiate into any cell type in the body. The **zygote** formed at fertilisation is totipotent until three to four days after fertilisation, when it consists of 16 cells and is known as a morula. As development continues from zygote to embryo, the potential of embryonic cells to differentiate into different kinds of cells becomes more limited. After the 16-cell stage, the embryo is no longer totipotent.
- **Pluripotent** stem cells have the ability to form a range of cell types, but not all cell types. The cells of the blastocyst (from five days after fertilisation until implantation in the uterus) are pluripotent because they can differentiate into any of the three germ layers: the endoderm, mesoderm and ectoderm (Figure 1.1.10). Once this germ layer differentiation has occurred, the cells are no longer pluripotent.
- **Multipotent** stem cells have the ability to give rise to multiple, but limited, cell types. Following implantation in the uterus, the blastocyst undergoes gastrulation and becomes a gastrula with three distinct layers of cells. The cells from the three germ layers are multipotent because they can only give rise to certain types of cells. Adult stem cells are more limited in their ability to differentiate than embryonic stem cells. Some adult stem cells, such as blood-forming cells, are multipotent—they can differentiate into white blood cells, red blood cells and platelets, but not other kinds of cells.
- **Unipotent** stem cells can divide repeatedly, but they can only reproduce one cell type. Skin cells are an example of unipotent cells—they only give rise to new skin cells.

Stem cells are important in therapeutic medicine because their ability to differentiate means stem cells from a healthy person may be used to treat patients with certain diseases. For example, bone marrow (which contains blood stem cells) can be transplanted to donate healthy blood-forming cells to leukaemia patients.

Embryonic stem cells that are used in scientific research and medicine are derived from the pre-implantation (blastocyst) stage when they are still pluripotent and have the ability to differentiate into any embryonic cell type and self-renew.

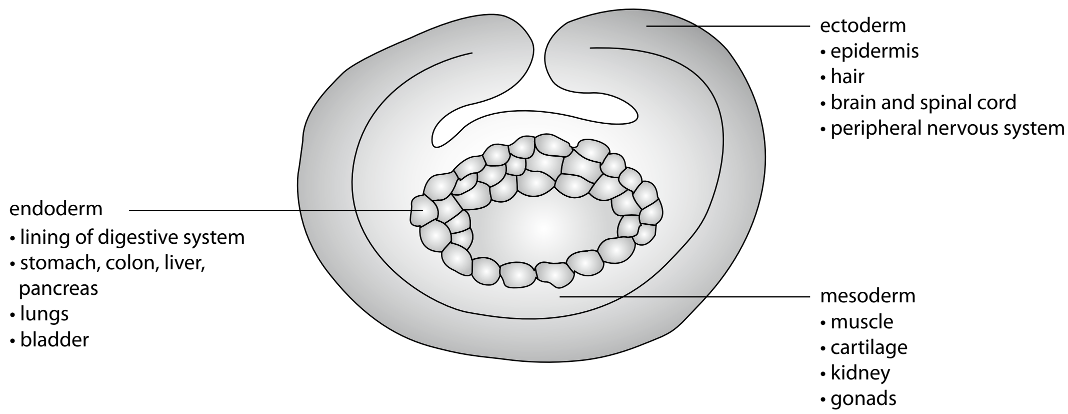
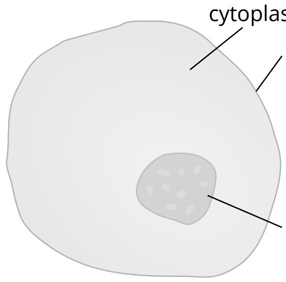
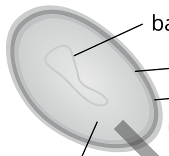


Figure 1.1.10 Stem cell pluripotency of embryo germ layers

Knowledge review—cells and cell processes

The instructions below address foundation ideas in biology that you have studied before and on which the key ideas in this first topic are built. Follow the instructions to complete these introductory summaries. Remember to be resourceful, and refer to text material or class notes as needed.

	Instruction	Response	
1	Draw and label a typical plant cell to show the basic similarities and differences as compared to the typical animal cell shown.	animal cell  	plant cell
2	The prefix *pro* comes from the Greek word for 'before' and also translates as 'early' or 'primitive'. The prefix *eu* comes from the Greek word for 'true'. The word *karyon* is Greek for 'nut' and is used to describe the shape of the nucleus in certain cells. Use this information to complete the description of eukaryotic organisms and how they compare to prokaryotic organisms already described. Include a labelled diagram.	Prokaryotic organisms have cells that are characterised by the lack of a distinct, membrane-bound nucleus. Bacteria are prokaryotic organisms.  	eukaryotic organisms
3	All organisms have specific nutritional requirements that must be met so they can survive. Consider the list of requirements shown for animals, then recall and complete the list for typical plants.	animal requirements: • oxygen (for cellular respiration) • water • carbohydrates • proteins • lipids • vitamins • minerals	plant requirements:

4 The cell theory is a universally accepted idea in biology. Recall the three parts of the cell theory.

a ____________________

b ____________________

c ____________________

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WORKSHEET 2

Controlled scientific experiments

A biology student designed and conducted the following controlled experiment to test a hypothesis. Read the student's experimental procedure and cast a critical eye over the results obtained.

AIM

To investigate the effect of sunlight on green plants.

HYPOTHESIS

Green plants need sunlight to survive.

METHOD

The student:

1. obtained two seedlings of the same species that were the same in other respects, including size, height and weight
2. labelled two same-size pots 'Pot plant 1' and 'Pot plant 2' (Figure 1.1.11)
3. potted the seedlings using a commercial potting mix, but ran out of potting mix for Pot plant 2 and topped it up with some soil from the school garden
4. gave both plants 100 mL of water
5. placed Pot plant 1 on the window sill with plenty of exposure to sunlight and Pot plant 2 in a dark cupboard below the sill to ensure it had no access to sunlight.

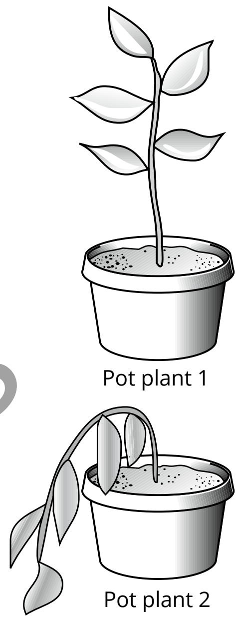

Figure 1.1.11 The two pot plants

The student watered Pot plant 1 on the window sill every two days for a period of two weeks but forgot about Pot plant 2, which was out of sight in the cupboard. At the end of the two-week period, Pot plant 1 was thriving but Pot plant 2 was dead.

The student wrote the following **conclusion**:

Pot plant 2 was not exposed to sunlight and it died. The plant must have died due to lack of sunlight. The hypothesis 'Green plants need sunlight to survive', is supported by the results of the experiment.

1 Which pot plant represented the control in this experiment? Explain your choice.

2 **a** How many variables did the student include in the experiment? What were they?

b How many factors should be varied in a controlled experiment? What should the variable be in this instance?

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3 Are the student's conclusions accurate? Explain.

4 Outline the conclusions that could be drawn from the student's experiment.

5 **a** Describe the changes you would make to this experiment to make it a properly controlled experiment.

b In the light of the changes you would make, outline the results you would expect and the conclusions you could draw.

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PRACTICAL ACTIVITY 1

Suggested duration: 100 minutes

INTRODUCTION

This activity provides an opportunity to design and carry out a practical investigation into the similarities and differences between cells of different kinds of organisms. You will need to be familiar with the use of the light microscope and accompanying equipment. You will also need to prepare some of your own slide specimens. If you are a little rusty on the procedures involved, your teacher will be able to arrange some refresher lessons and practice for you before you begin this activity. The information about using the light microscope on pages xxii–xxiii of the Toolkit will be a useful starting point.

MATERIALS

- light microscope
- microscope slides
- coverslips
- onion
- *Elodea* (pond weed)
- iodine/potassium iodide staining solution
- white tile or cutting board
- paper towelling
- forceps
- scalpel
- selected prepared slides, e.g.:
  - protozoan
  - leaf epidermis
  - nerve cells
  - bacteria
  - white blood cells
  - cheek cells
  - cross-section of green plant stem
  - root hair tissue

AIM

- To design and carry out a practical investigation into the structural features of cells from different kinds of organisms.
- To investigate the similarities and differences between cells from different kinds of organisms.

METHOD

Caution: Follow your teacher's instructions for the safe use of hazardous chemicals and sharp equipment.

1. Use the materials listed to design a practical activity that will allow you to conduct an investigation of the structural features of cells from different kinds of organisms. You may wish to add further specimens to the suggested list—check this with your teacher.
2. Set out your procedure in a numbered, step-by-step format. Write your instructions clearly so that another student could follow them effectively.

   Your procedure should include instructions related to:

   - mounting slides
   - viewing fresh and prepared slides under the microscope
   - preparing drawings of each specimen.
3. When you have completed the experimental design, have it checked by your teacher before proceeding with the laboratory work itself.

EXPERIMENTAL DESIGN

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4 ▪ The following table includes a number of features found in eukaryotic cells. Complete the table by indicating whether or not you were able to identify the features listed for each specimen you observed.

▪ Decide upon a key to indicate that particular features were identified. For example, a tick may indicate that a feature has been clearly identified, a dash might be used to indicate that a feature was not observed.

Key

Summary of cell features or organelles

Cell type	Features or organelles observed										Type of organism
	Plasma membrane	Cell wall	Nucleus	Cyto-plasm	Chloro-plast	Mitochon-dria	Ribo-somes	Vacuoles	ER	Golgi apparatus	

1 Suggest why it might not be helpful to use a cross to indicate that a feature has not been observed in a particular specimen.

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EXAM-STYLE QUESTIONS

Multiple-choice questions

Question 1

Recall that prokaryotic cells:

A. lack membranes

B. lack internal membrane-bound organelles

C. have internal membrane-bound organelles

D. have only a nucleus that is membrane bound

Question 2

Recognise the cellular features common to both prokaryotes and eukaryotes.

A. ribosomes, plasma membrane, cell wall, cilia

B. ribosomes, plasma membrane, large size, membrane-bound organelles

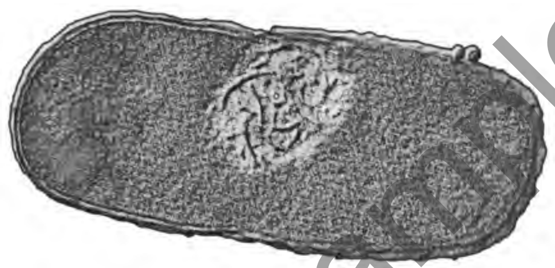
C. ribosomes, plasma membrane, DNA

D. ribosomes, cilia, large size

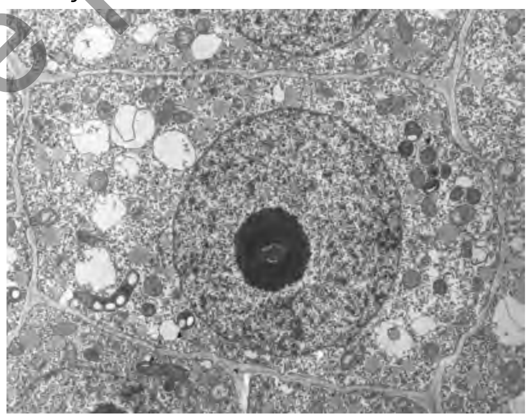
Question 3

Examine the two cells shown.

Prokaryotic cell



Eukaryotic cell



What difference can be seen between the prokaryotic and eukaryotic cell?

A. The eukaryotic cell contains ribosomes and the prokaryotic cell does not.

B. The prokaryotic cell contains ribosomes and the eukaryotic cell does not.

C. The eukaryotic cell contains a membrane-bound nucleus and the prokaryotic cell does not.

D. The prokaryotic cell contains a membrane-bound nucleus and the eukaryotic cell does not.

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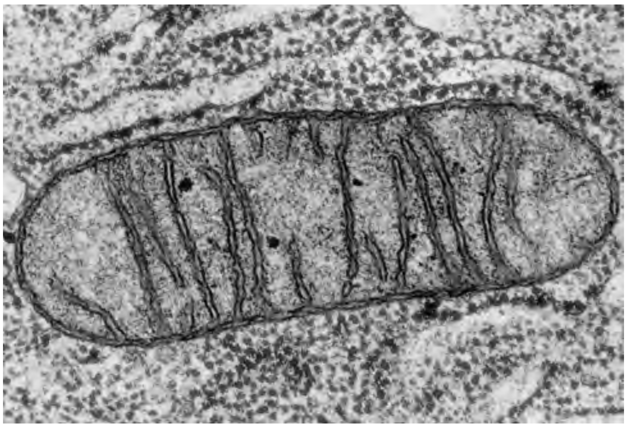
EXAM-STYLE QUESTIONS

Question 4

Identify the cell organelle shown.



A. chloroplast

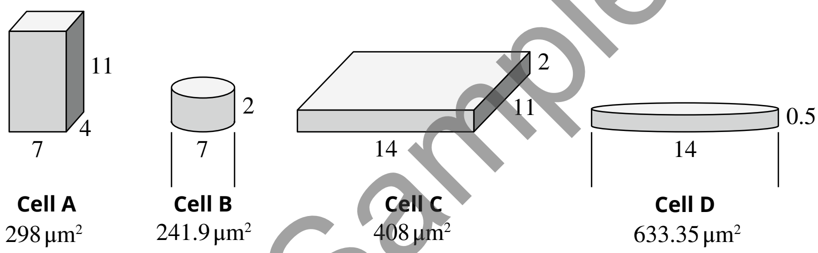
B. mitochondrion

C. endoplasmic reticulum

D. Golgi apparatus

Question 5

The ratio between surface area and volume is critical to cell survival as it determines how quickly materials can be exchanged between the internal and external environments. Examine the cells below. All lengths are in μm. The surface area of each cell is shown beneath it. All of the cells have a volume of 308 μm^3.



The cell that will exchange materials most rapidly with its environment is:

A. Cell A

B. Cell B

C. Cell C

D. Cell D