BIOZONE

Student Workbook **2014**

# NCEA LEVEL 2 BIOLOGY

**FREE**

SAMPLE

SELECTED PAGES

*Dear biology educator,*

*We'd like to let you know what we've been working on lately.*

*In response to customer feedback, we have worked with a literacy specialist and practising teachers to improve the accessibility of our content to Level 2 students.*

*The result is a new **BIOZONE** NCEA **LEVEL 2** BIOLOGY Student Workbook, radically revised for 2014 to meet the reading levels and learning styles of today's biology students.*

## *Our goals of this revision were to:*

- ***Simplify the complex:** Biological information is presented accurately using language students can easily understand.*
- ***Guide student learning:** Each activity has a key idea clearly stating the learning focus for that activity.*
- ***Scaffold student learning:** New questions, with a direct questioning style, build student confidence and knowledge in biological concepts, processes, and vocabulary.*
- ***Test student knowledge:** New activities devoted to synoptic NCEA style questions (usually one or two per chapter) help students to consolidate their learning and practise exam responses.*
- ***Improved readability:** Significantly larger fonts, bigger diagrams, and focussed content help students meet specific achievement outcomes.*

## *Field-testing the new design:*

*The changes to the **BIOZONE** NCEA **LEVEL 2** BIOLOGY Student Workbook have been carried out in consultation with a literacy specialist and a review panel of teachers and education professionals. The draft material has been piloted in a number of schools, ranging from decile 1 to 10, and the changes have been well received by both teachers and students at all abilities.*

*Full flipbook previews can be viewed on our website in November, with main stock arriving in January 2014.*

*We would love to hear from you if you have any questions or comments: feedback@biozone.co.nz*

*Kind regards,*

*The **BIOZONE** writing team (Tracey, Lissa, and Kent).*

Tracey
*Senior Author*

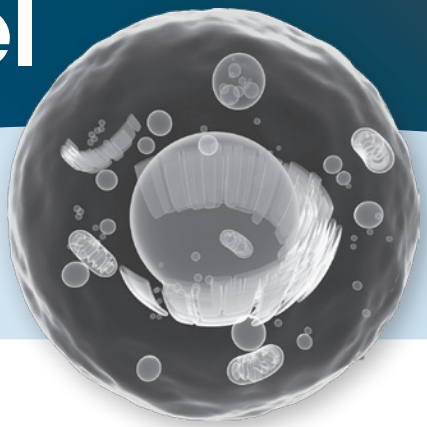
Lissa
*Author*

Kent
*Author*

Achievement Standard

2.4

# Life Processes at the Cellular Level



## Key terms

**active transport**
**ATP**
**diffusion**
**endocytosis**
**enzyme**
**eukaryotic**
**exocytosis**
**ion pump**
**organelle**
**osmosis**
**partially permeable**
**passive transport**
**plasma membrane**
**plasmolysis**
**prokaryotic**
**surface area: volume ratio**
**turgor**

## Achievement outcomes

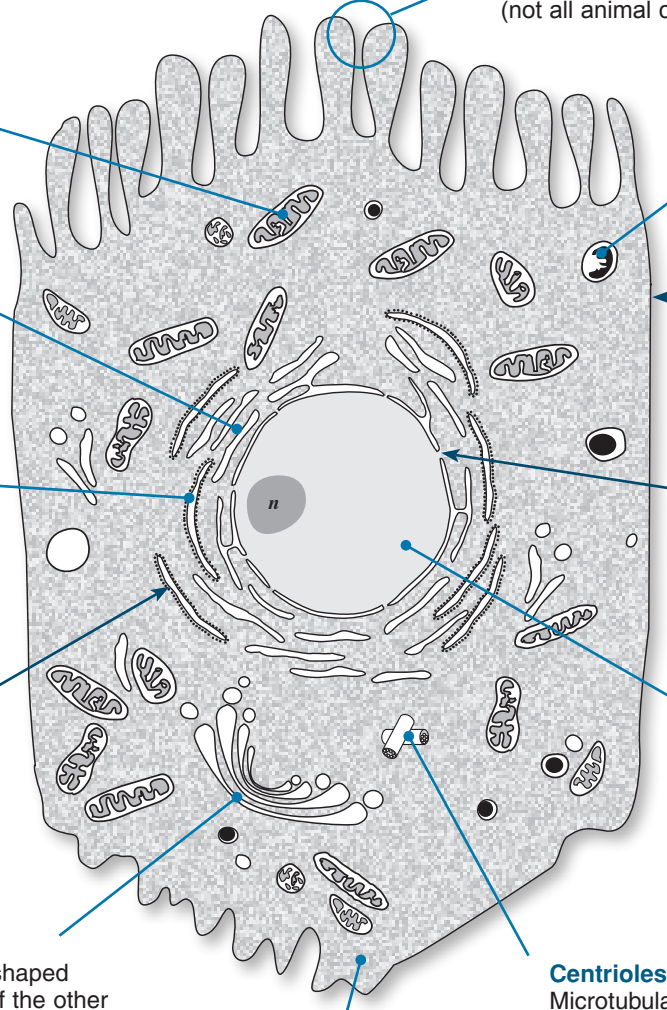
| | Activity number |
|---|---|
| **Cell structure** | |
| ☐ 1. Identify the features of **prokaryotic** and **eukaryotic** cells. What features identify plant and animal cells as eukaryotic? | 82 |
| ☐ 2. Describe the features of plant and animal cells. State which features are unique to plant cells and which are shared with animal cells. | 83 84 |
| ☐ 3. Explain why cells come in a large range of shapes and sizes. | 85 |
| ☐ 4. Identify **organelles** in a cell and state their main functions. | 86 89 |
| **Cell processes and transport** | |
| ☐ 5. Describe the structure of the **plasma membrane**. | 91 92 |
| ☐ 6. Describe the functions of the proteins embedded the plasma membrane. | 93 |
| ☐ 7. Describe the role of cellular membranes in the cell and its organelles. | 94 |
| ☐ 8. Define **diffusion**. Describe the difference between simple diffusion and facilitated diffusion. | 95 |
| ☐ 9. Define **osmosis** and describe where it occurs in a cell. | 96 |
| ☐ 10. Explain the cause and effect of **plasmolysis** and **turgor** in plant cells. | 97 |
| ☐ 11. Explain how efficiency of diffusion is affected by the **surface area to volume ratio**. How do large organisms solve this problem? | 98 99 |
| ☐ 12. Define **active transport** and use it to explain how **ion pumps** enable molecules and ions to move against their concentration gradient. | 100 101 |
| ☐ 13. Describe the processes of **endocytosis** and **exocytosis**. | 102 |
| ☐ 14. Distinguish between active and **passive transport** processes. | 103 |

**BIOZONE** APP
Student Review Series
**Cell Structure**

# 84 The Structure of Animal Cells

**Key Idea:** Animal cells are eukaryotic cells. They have features in common with plant cells, but they also have several unique features.

## The structure of an unspecialised animal cell (a liver cell)




**Microvilli**
Small projections which increase the surface area for absorption (not all animal cells have these).

**Mitochondria**
Oval-shaped organelles bounded by a double membrane.

**Lysosome**
These contain enzymes that break down foreign material.

**Smooth endoplasmic reticulum** (smooth ER)
An interconnected network of membranes. A site for lipid and carbohydrate metabolism, including hormone synthesis.

**Plasma membrane**
Phospholipid bilayer with associated proteins and lipids. Controls the movement of substances in and out of the cell.

**Rough endoplasmic reticulum** (rough ER)
is ER an interconnected network of membrane with ribosomes attached to its surface. Proteins destined for transport outside of the cell are made here.

**Nuclear pore**
A hole in the nuclear membrane. It allows communication between the nucleus and the rest of the cell.

**Ribosomes**
These manufacture proteins. They may be free in the cytoplasm or associated with the surface of the endoplasmic reticulum.

**Nucleus**
A large organelle containing most of the cell's DNA. Within the nucleus, is the **nucleolus** ($n$). It is involved in ribosome synthesis.

**Golgi apparatus**
A series of flattened, disc-shaped sacs, stacked one on top of the other and connected with the ER. The Golgi stores, modifies, and packages proteins. It 'tags' proteins so that they go to their correct destination.

**Centrioles**
Microtubular structures associated with nuclear division.

**Cytoplasm**
A watery solution containing dissolved substances, enzymes, and the cell organelles and structures.

### Features of an Animal Cell

Animal cells are eukaryotic cells. Features that identify animal cells as eukaryotic cells include:

- Presence of a membrane-bound nucleus.
- Presence of membrane-bound organelles (e.g. mitochondria, Golgi apparatus, endoplasmic reticulum, lysosomes).

Animal cells share many of the same structures and organelles that plant cells have, but they also have several features not seen in plant cells. Features which can be used to identify an animal cell include:

- **Centrioles**
- **Irregular shape**
- **Lack of a cell wall**
- **Lack of chloroplasts**



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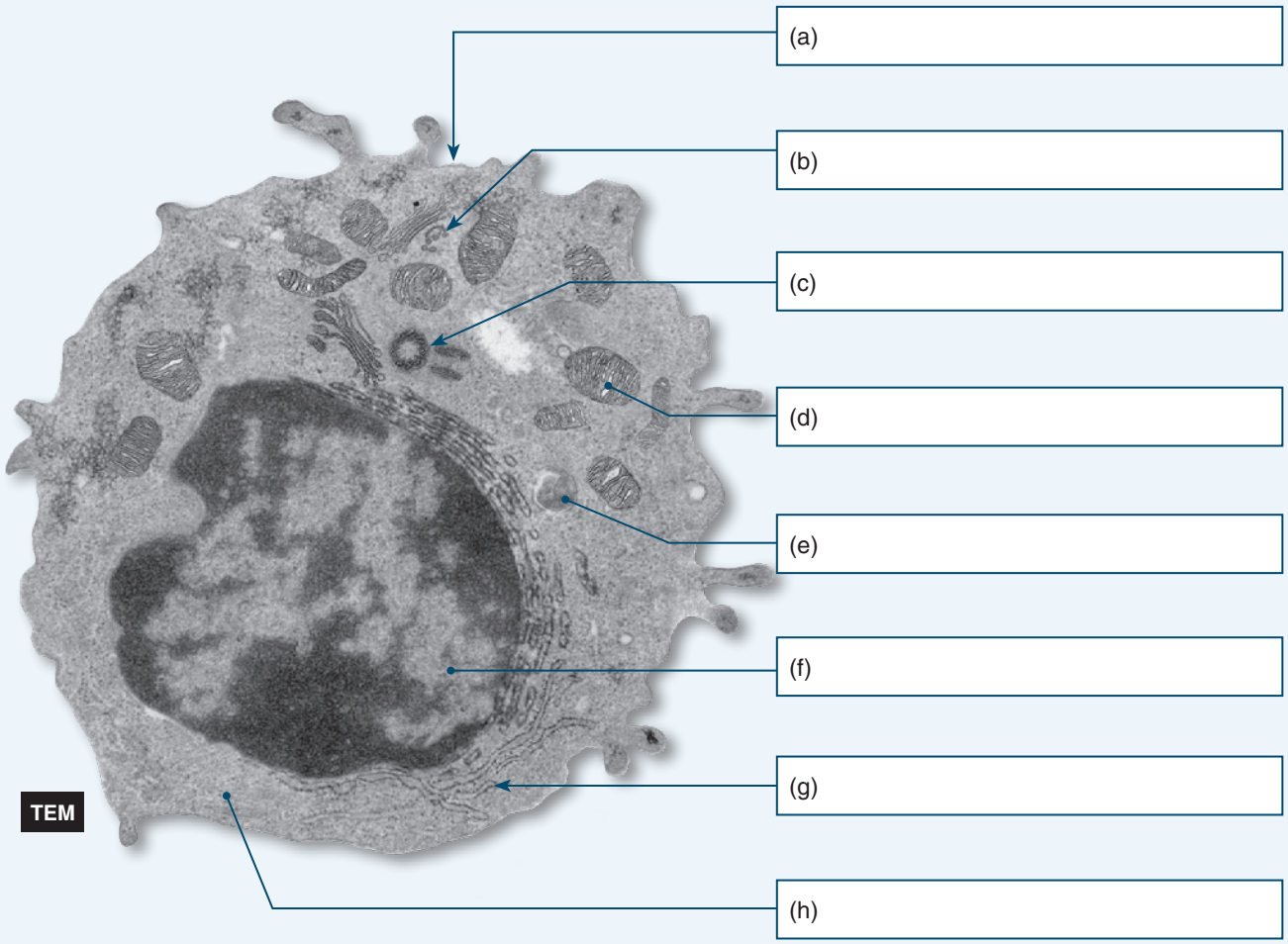
1. Study the diagram of an animal cell on the previous page to become familiar with the features of an animal cell. Use your knowledge to identify and label the structures in the transmission electron micrograph (TEM) of the cell above using the following list of terms: *cytoplasm, plasma membrane, rough endoplasmic reticulum, mitochondrion, nucleus, centriole, Golgi apparatus, lysosome.*




2. What features on the cell above identify it as an animal cell?_____

3. (a) Where is the plasma membrane located on an animal cell? _____

   (b) What is the function of the plasma membrane? _____

4. The cell above contains a large amount of rough ER. What does this tell you about the cell?

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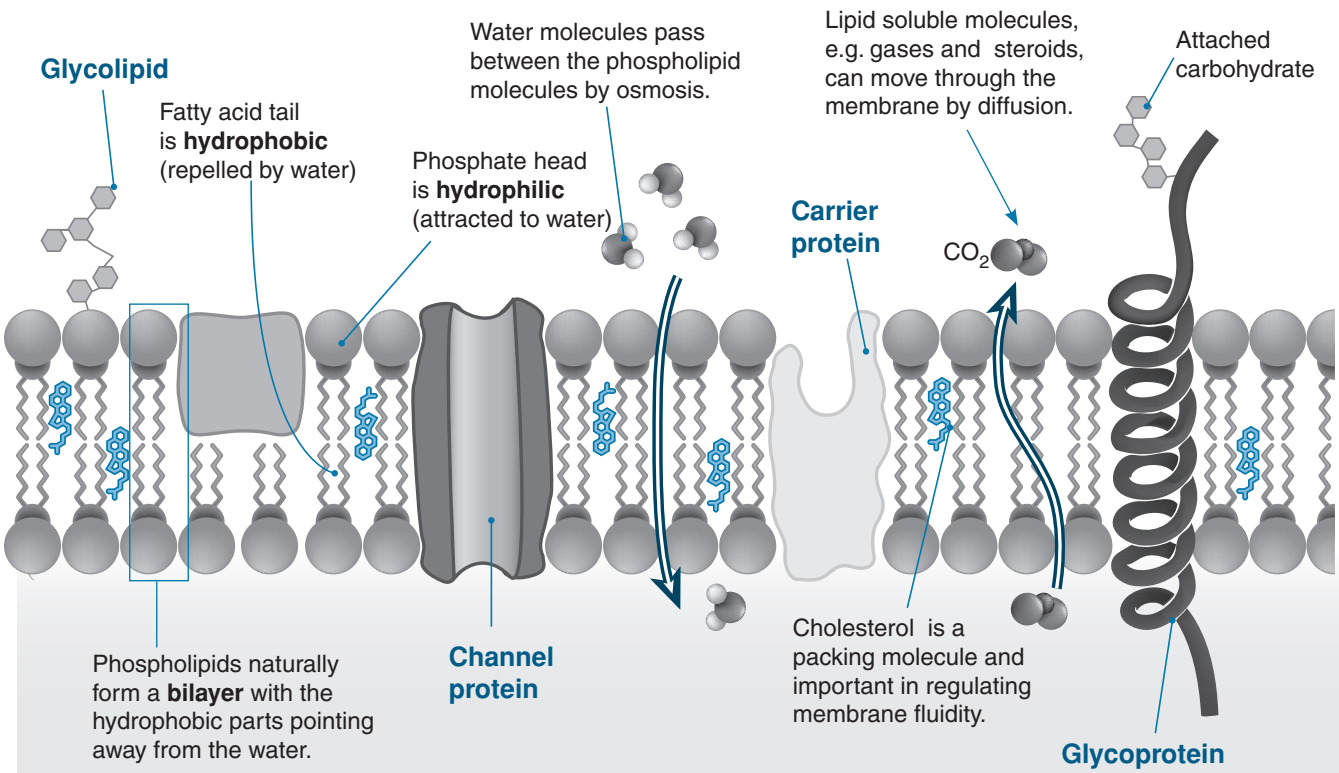
# 91 The Structure of Membranes

**Key Idea:** Plasma membranes are composed of a lipid bilayer with proteins moving freely within it.

## The fluid mosaic model of membrane structure




Based on a diagram in Biol. Sci. Review, Nov. 2009, pp. 20-21

The now-accepted **fluid-mosaic model** of membrane structure (above) describes a phospholipid bilayer with proteins of different types moving freely within it. The double layer of lipids is quite fluid. It is a dynamic structure and is actively involved in cellular activities.

1. List the important components of the plasma membrane: _____

   _____

2. Identify the kind of molecule on the diagram that:

   (a) Can move through the plasma membrane by diffusion: _____

   _____

   (b) Forms a channel through the membrane: _____

   _____

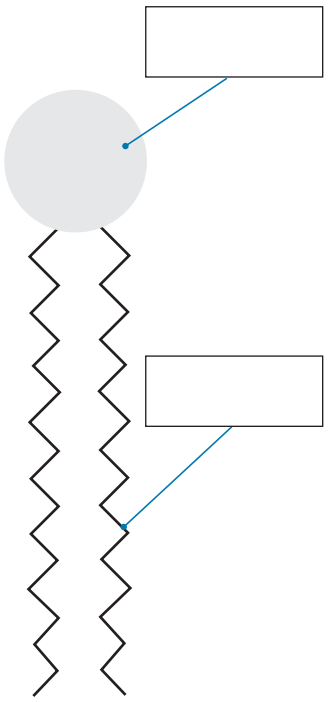
3. List the types of proteins pictured in the diagram: _____

   _____

   _____

   _____

4. On the diagram (right) label the hydrophobic and hydrophilic ends of the phospholipid and indicate which end is attracted to water:





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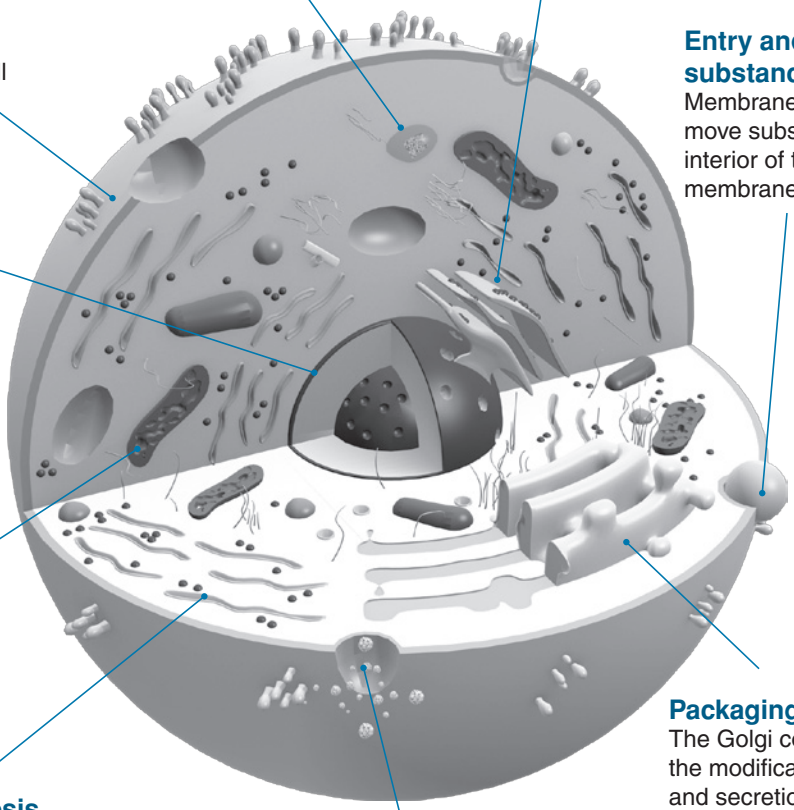
# 94 The Role of Membranes in Cells

**Key Idea:** Membranes create compartments, control entry and exit of substances from the cell and organelles, and enable cell communication.



**Isolation of enzymes**
Lysosomes and peroxisomes isolate destructive enzymes and peroxides.

**Role in protein synthesis**
Ribosomes attached to the membrane of the rough ER synthesise protein directly into the space within the ER.

**Cell communication and recognition**
The glycoproteins and glycolipids embedded in the membrane act as receptors for signalling molecules and as cell recognition markers.

**Entry and export of substances**
Membrane-bound vesicles move substances from the interior of the cell to the plasma membrane or vice versa.

**Containment of DNA**
The nuclear envelope is formed by a double-layered membrane and contains the DNA.

**Energy transfer**
The reactions of cellular respiration are catalysed by membrane-bound enzymes in the mitochondria. In plants photosynthesis occurs in chloroplasts.

**Packaging and secretion**
The Golgi compartmentalises the modification, packaging, and secretion of many substances, e.g. hormones.

**Role in lipid synthesis**
The smooth ER is the site of lipid and steroid synthesis.

**Transport processes**
Channel and carrier proteins are involved in selective transport of substances across the plasma membrane.

1. List the organelles shown above that have membranes: _____

_____

2. Explain the importance of glycoproteins and glycolipids in cellular membranes: _____

_____

_____

3. Explain the importance of membranes in cellular respiration: _____

_____

_____

_____

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RELATED 93 RELATED 91 WEB 94 KNOW

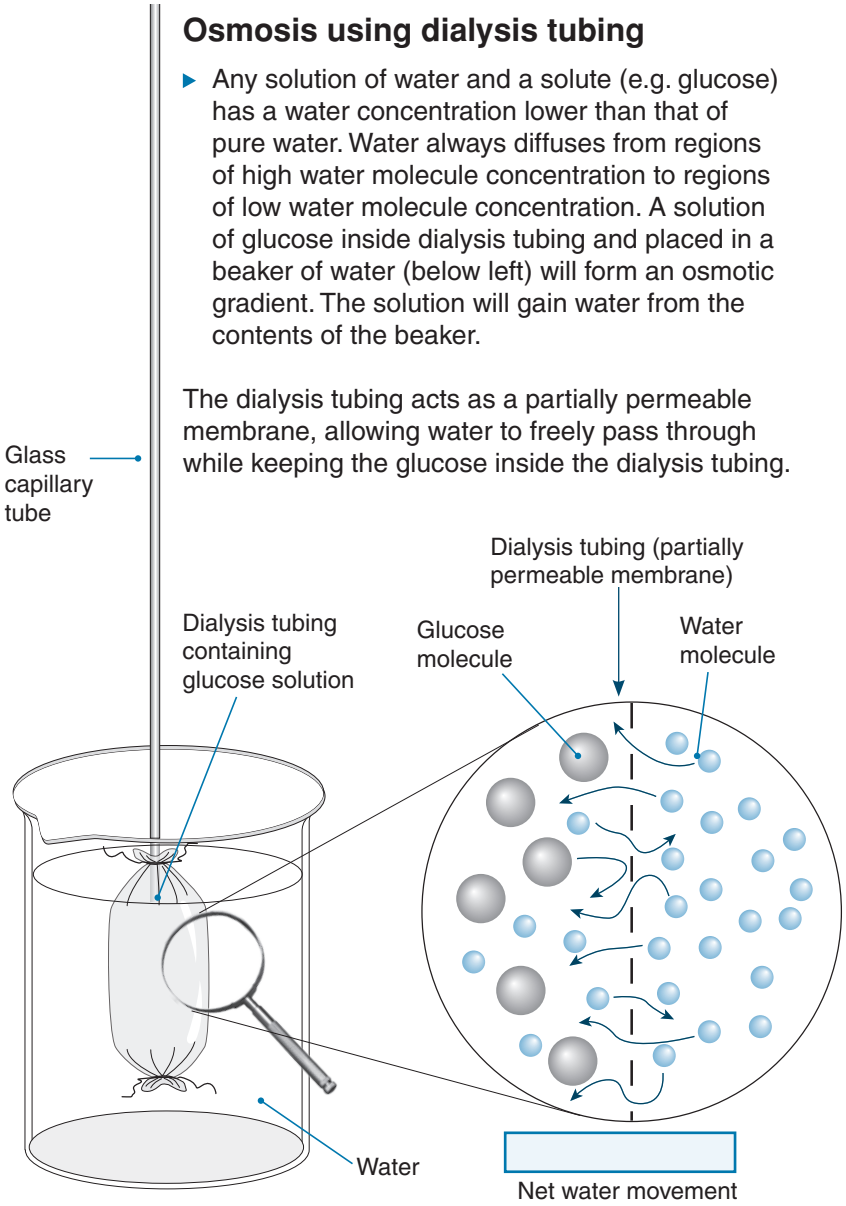
# 96 Osmosis in Cells

**Key Idea:** Osmosis is the diffusion of water molecules across a partially permeable membrane, from higher to lower concentration of water molecules.

## Osmosis using dialysis tubing

- Any solution of water and a solute (e.g. glucose) has a water concentration lower than that of pure water. Water always diffuses from regions of high water molecule concentration to regions of low water molecule concentration. A solution of glucose inside dialysis tubing and placed in a beaker of water (below left) will form an osmotic gradient. The solution will gain water from the contents of the beaker.

The dialysis tubing acts as a partially permeable membrane, allowing water to freely pass through while keeping the glucose inside the dialysis tubing.




## Osmotic potential

The presence of **solutes** (substances that dissolve) in a solution increases the tendency of water to move into that solution. This tendency is sometimes called the **osmotic potential** or osmotic pressure. The greater the solution's concentration the greater the osmotic potential. The osmotic potential is the pressure required to prevent the flow of water into the solution.

## Cells and tonicity

**Tonicity** is a measure of the difference between two solutions separated by a partially permeable membrane. A solution is described relative to another:

- **Hypertonic** solutions have a higher solute concentration compared to another solution. A cell placed into a hypertonic solution will lose water via osmosis and shrink.
- **Hypotonic** solutions have a lower solute concentration compared to another solution. A cell placed into a hypotonic solution will gain water and swell (possibly bursting).
- When two solutions have the same solute concentration they are called **isotonic**.

1. In the blue box below the diagram above, draw an arrow to show the direction of the **net water movement**.
2. (a) Study the diagram above. What will happen to the water level in the glass tube over time?

   _____

   (b) What would happen if a more concentrated solution of glucose was used? _____

   _____
3. Explain why you would see the results you predicted in question 2 (b): _____

   _____

   _____
4. What would happen to a cell if it was placed into an isotonic solution? _____

   _____



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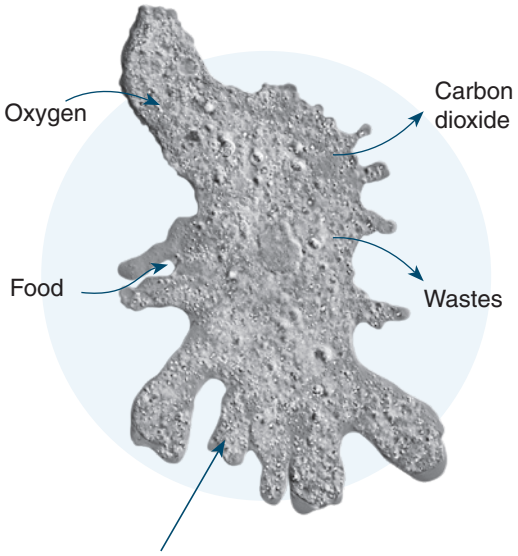
# 98 Diffusion and Cell Size

**Key Idea:** Diffusion is less efficient in cells with a small surface area relative to their volume than in ones with a large surface area relative to their volume.

## Diffusion in organisms of different sizes

### Single-celled organisms

Single-celled organisms (e.g. *Amoeba*), are small and have a large surface area relative to the cell's volume. The cell's requirements can be met by the diffusion or active transport of materials into and out of the cell (below).

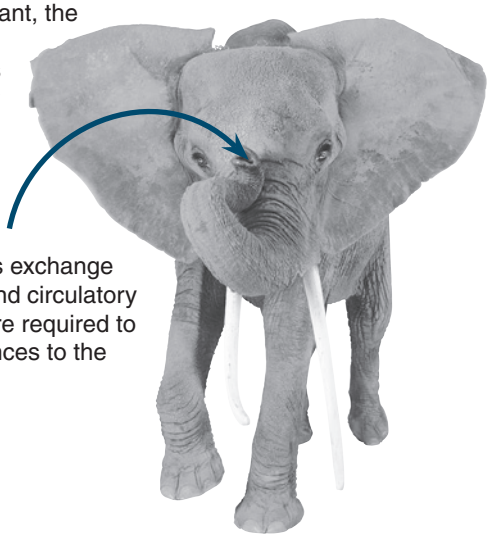



The **plasma membrane**, which surrounds every cell, regulates movements of substances into and out of the cell. For each square micrometer of membrane, only so much of a particular substance can cross per second.

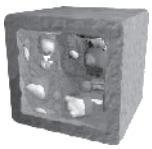
### Multicellular organisms

Multicellular organisms (e.g. plants and animals) are often quite large, and large organisms have a small surface area compared to their volume. They require specialised systems to transport the materials they need to and from the cells and tissues in their body.

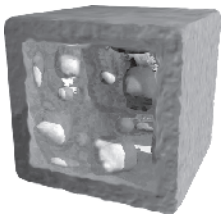
In a multicellular organism, such as an elephant, the body's need for respiratory gases cannot be met by diffusion through the skin.



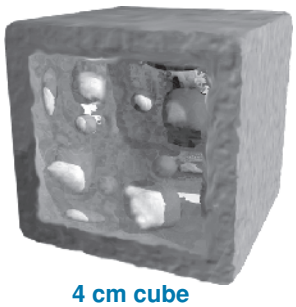
A specialised gas exchange surface (lungs) and circulatory (blood) system are required to transport substances to the body's cells.



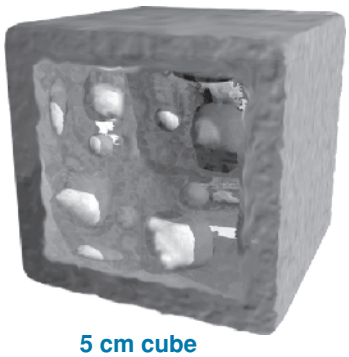
2 cm cube



3 cm cube



4 cm cube



5 cm cube

1. Calculate the volume, surface area and the ratio of surface area to volume for each of the four cubes above (the first has been done for you). When completing the table below, show your calculations.

| Cube size | Surface area | Volume | Surface area to volume ratio |
|---|---|---|---|
| 2 cm cube | 2 x 2 x 6 = 24 $cm^2$ (2 cm x 2 cm x 6 sides) | 2 x 2 x 2 = 8 $cm^3$ (height x width x depth) | 24 to 8 = 3:1 |
| 3 cm cube | | | |
| 4 cm cube | | | |
| 5 cm cube | | | |

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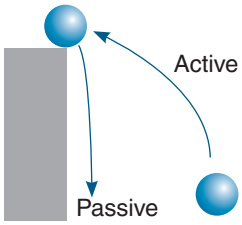
RELATED 95 DATA

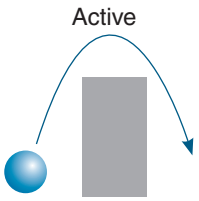
# 100 Active Transport

**Key Idea:** Active transport is a process that uses energy to transport molecules across the plasma membrane against their concentration gradient. The energy comes from ATP.

- **Active transport** is the energy-using process of moving molecules (or ions) **against** their concentration gradient.
- The energy for active transport comes the from the molecule **ATP** (adenosine triphosphate). Energy is released when ATP is hydrolysed (water is added) forming ADP (adenosine diphosphate) and inorganic phosphate (Pi). The energy is used by a transport protein to move a target molecule across a membrane against its concentration gradient.
- The work of active transport is performed by specific transport proteins. These proteins move molecules across a membrane from a lower to a higher concentration. ATP may be used directly by a transport protein to move a molecule or ion across a membrane (below and top right), or it may be used indirectly by coupling molecule transport to the passive movement of other molecules or ions down a concentration gradient produced by transport proteins (right).

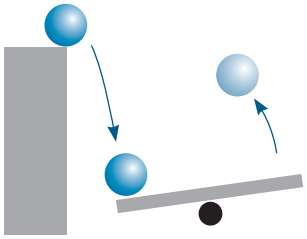



A ball falling is a passive process. Replacing the ball requires active energy input.



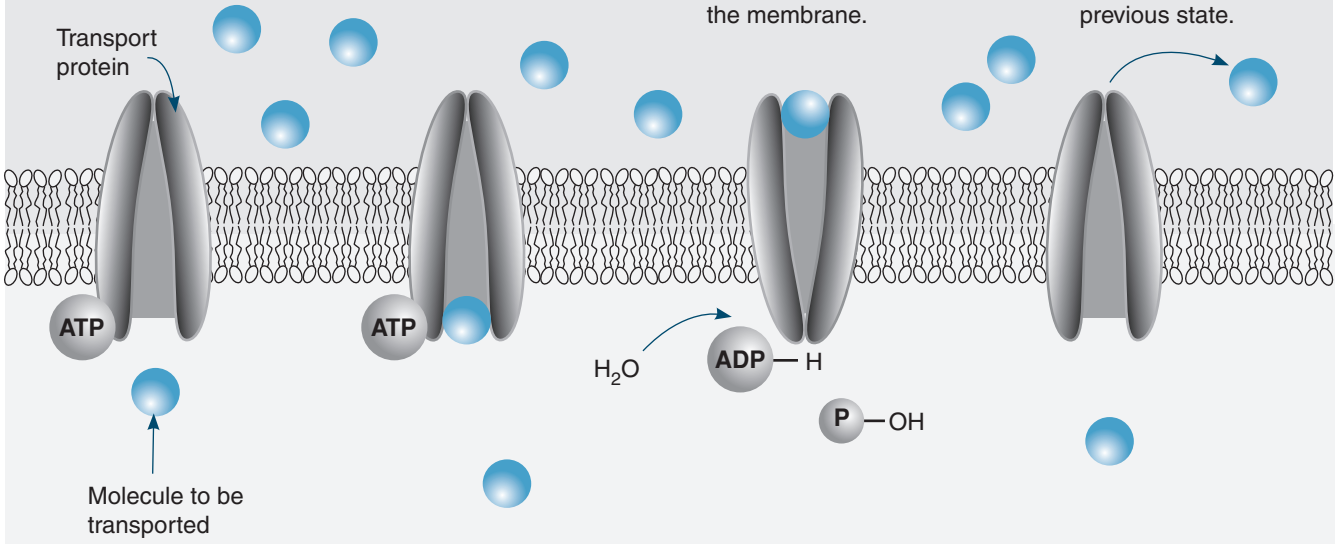

Energy is needed to move an object over a physical barrier.

Sometimes the energy of a passively moving object can be used to actively move another, e.g. a falling ball can be used to catapult another.



## ATP and active transport

1. ATP binds to a transport protein.
2. A molecule or ion to be transported binds to the transport protein.
3. ATP is hydrolysed and the energy released is coupled to the transport of the molecule or ion across the membrane.
4. The molecule or ion is released and the transport protein reverts to its previous state.




1. Define **active transport**: _____

_____

_____

2. Where does the energy for active transport come from? _____

_____

_____



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# 105 NCEA Style Question

Organisms use a variety of transport processes to move materials in and out of the cell. These include osmosis and active transport.

1. Describe the processes of osmosis and active transport. You may use extra paper if required:

   (a) Osmosis: _____

   (b) Active transport: _____

2. Explain why these processes are needed and describe examples of where they may occur in an organism:

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# NEW FEATURES

**BIOZONE**'s NCEA **LEVEL 2** BIOLOGY Student Workbook boasts many new features designed to engage and connect with biology students achieving at all levels. A substantial rewrite of the content and an extensively revised layout focus student learning to meet specific achievement outcomes.

### Activity number
Activities are numbered to make navigation through the workbook easier, and to help students find related activities.

### Content organisation
The content is presented in logically organised blocks making it easier for students to access and engage with the information.

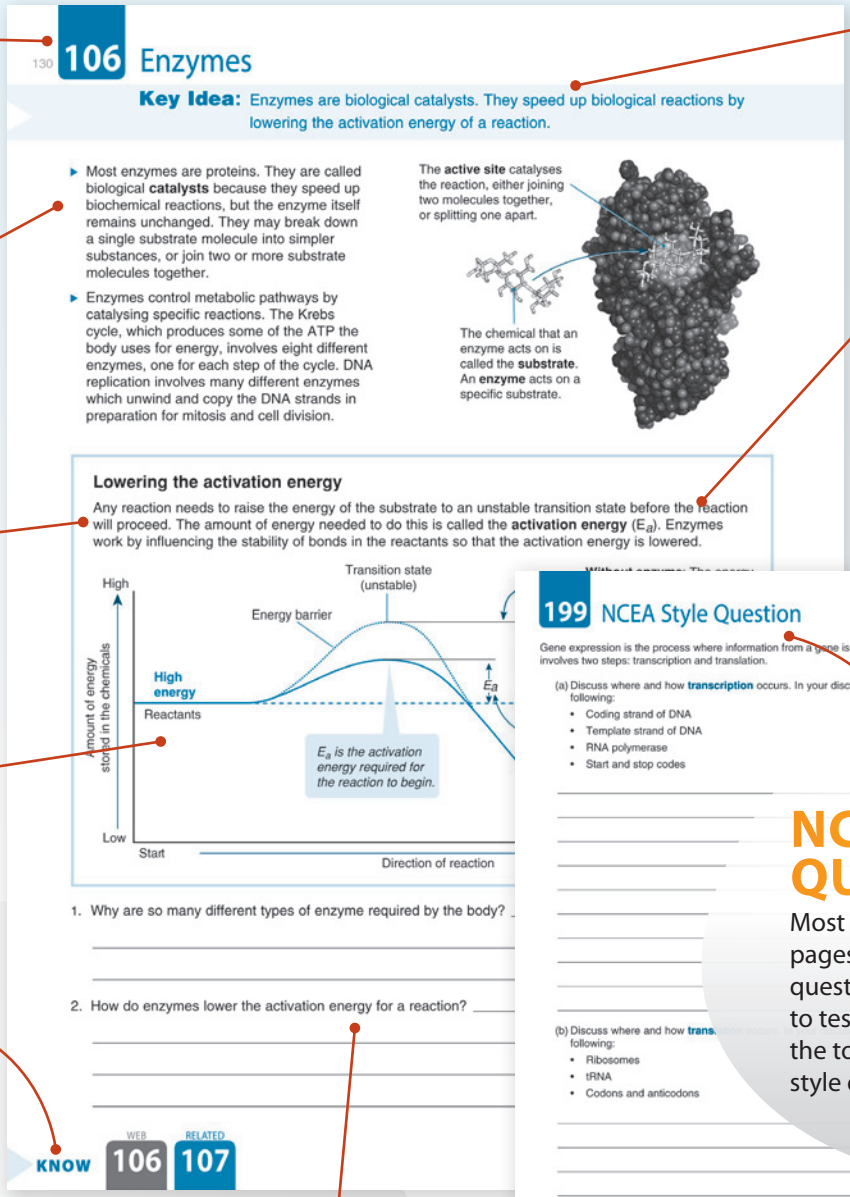
### Larger font size
A significantly larger font size improves the accessibility of the information.

### Visual impact
Larger diagrams illustrate the main ideas of the activity. Clear diagrams provide support and reinforce the text based content.

### New activity codes
Simplified page codes indicate the type of activity on each page (e.g. KNOW indicates that the main focus of the activity is understanding the content. Other codes indicate a focus on practical tasks, testing, data handling, or literacy skills.

### New coding system
A new code system makes it easier for students to find related activities elsewhere in the workbook.

Weblinks codes refer to an external URL supporting the material in this activity.


130

106 Enzymes

**Key Idea:** Enzymes are biological catalysts. They speed up biological reactions by lowering the activation energy of a reaction.

- Most enzymes are proteins. They are called biological **catalysts** because they speed up biochemical reactions, but the enzyme itself remains unchanged. They may break down a single substrate molecule into simpler substances, or join two or more substrate molecules together.
- Enzymes control metabolic pathways by catalysing specific reactions. The Krebs cycle, which produces some of the ATP the body uses for energy, involves eight different enzymes, one for each step of the cycle. DNA replication involves many different enzymes which unwind and copy the DNA strands in preparation for mitosis and cell division.

The **active site** catalyses the reaction, either joining two molecules together, or splitting one apart.

The chemical that an enzyme acts on is called the **substrate**. An **enzyme** acts on a specific substrate.

**Lowering the activation energy**

Any reaction needs to raise the energy of the substrate to an unstable transition state before the reaction will proceed. The amount of energy needed to do this is called the **activation energy** ($E_a$). Enzymes work by influencing the stability of bonds in the reactants so that the activation energy is lowered.



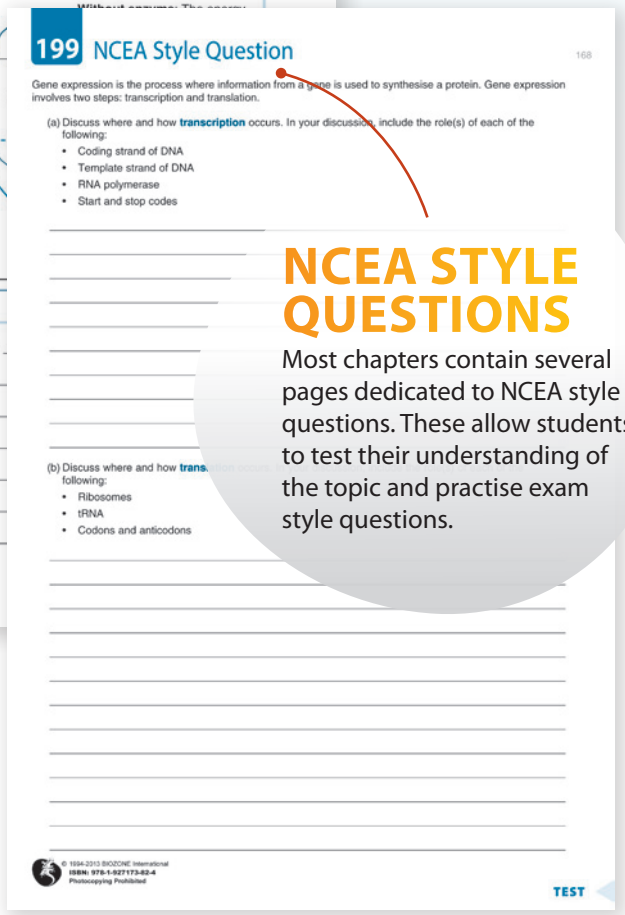
1. Why are so many different types of enzyme required by the body?

2. How do enzymes lower the activation energy for a reaction?

KNOW WEB 106 RELATED 107

### Key idea
Each activity has a key idea summarising its primary focus. The key idea is designed to help facilitate student understanding of the message of the page.

### Revised content
All content has been critically reviewed for relevance and rewritten in language students can easily understand.


199 NCEA Style Question

Gene expression is the process where information from a gene is used to synthesise a protein. Gene expression involves two steps: transcription and translation.

(a) Discuss where and how **transcription** occurs. In your discussion, include the role(s) of each of the following:

- Coding strand of DNA
- Template strand of DNA
- RNA polymerase
- Start and stop codes

(b) Discuss where and how **trans**... following:

- Ribosomes
- tRNA
- Codons and anticodons

TEST

## NCEA STYLE QUESTIONS

Most chapters contain several pages dedicated to NCEA style questions. These allow students to test their understanding of the topic and practise exam style questions.

### Direct questioning style
The questions are designed to help students consolidate their understanding of biological vocabulary, processes, and principles.

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BIOZONE

# Student Workbook

The new **BIOZONE NCEA Level 2 Biology Student Workbook** has been completely rewritten for 2014. Developed in consultation with an expert in student literacy and a panel of practicing teachers, it is focussed on delivering learning outcomes in a way that meets the learning styles of today's biology students.

## Features and benefits of this regularly updated workbook:

- **Full alignment** to the NZ Curriculum and structured on the NCEA Level 2 Achievement Standards.
- A **new chapter structure** scaffolds student learning.
- A **key idea** introduces each activity.
- New activities provide **NCEA style practice questions**.
- Student-friendly language, with less text and larger fonts.
- Specific, clear **achievement outcomes** provide student guidance and support.
- Extensive use of clear, **annotated diagrams** and photographs.
- **Scientific literacy** is supported in a student-friendly way throughout.
- Comprehensive **model answers book** provides suggested answers for each activity.

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