Transport Across Plasma Membranes
A Cells Environment

External environment
Material outside the plasma membrane

Internal environment
Material inside the plasma membrane
Plasma Membrane overview

- Maintains internal environment of cell by controlling the entry of dissolved substances

- Contains a ‘fluid-like’ double layer of lipids and embedded proteins (**phospholipid bilayer**)

- Proteins form channels for substance movement over the membrane in each direction, which is known as the **fluid mosaic model**

- Membrane is **semi** or **partially permeable** *(allows some dissolved material to pass through)*

- Various processes are responsible for substance movement over the membrane *(E.g. Diffusion)*
“The **active boundary** around all living cells that consists of a **phospholipid bilayer** and associated **proteins** and which separates the cell contents from their external environment.”
Structure of Membranes

Proteins

Carbohydrates

Lipids (phospholipid)

Cholesterol

Proteins

extracellular environment

protein

carbohydrate

exterior surface of cellular membrane

intracellular environment

transport protein

receptor protein

recognition protein

adhesion protein

phospholipid bilayer
Phospholipid bilayer
Hydrophilic Vs. Hydrophobic

**Hydrophilic** ‘water loving’
- Substances that dissolve readily in water
- The phosphate group (head) of phospholipid molecules.

**Hydrophobic** or Lipophilic
- Substances that have low water solubility, or do not dissolve in water
- The fatty acid end (tail) of phospholipid molecules is made up of two strings of carbon and hydrogen atoms.
Membrane Proteins

Transport protein: allow substances to pass into and out of cell

Receptor protein: binds substances which cause changes in the cell, e.g. hormones

Recognition proteins: binds with carbohydrate to form a glycoprotein which acts as ‘self’ markers so the body can distinguish between ‘self’ and ‘non-self’

Adhesion proteins: act as a link between cells, allowing them to stick together
Have you been paying attention?

1. What are the two major components of a plasma membrane?
2. What part of the plasma membrane is responsible for its flexibility?
3. Is the plasma membrane impermeable, selectively permeable, or fully permeable?
4. What is the role of transport proteins?
Moving through Membranes

- Diffusion
- Osmosis
- Active Transport
- Endocytosis
- Exocytosis
Simple Diffusion

- The net movement of particles from a region of high concentration to a region of low concentration.
- The difference in concentration is known as the concentration gradient. This always takes place wherever a gradient exists until equilibrium is reached.
- Diffusion is a passive movement (does not require energy) Only O₂, CO₂, H₂O and small uncharged particles move via this way.
- High concentration, temperature, size of molecule and medium affect the speed of diffusion.
Osmosis

- Is the diffusion of water into or out of cell
- It is defined as the:

  "Net movement of a water (solvent)* from a region of low solute concentration to high solute concentration across a differentially permeable membrane"

  Low solute (high H₂O, low solute*) to high solute (low H₂O, high solute)

- Requires no energy
- H₂O moves to balance out solution concentrations.

* Solvent: a substance in which other substances can dissolve

* Solute: a substance that dissolves in a solvent
Osmosis Continued

There are three types of solutions:

- **Hypotonic** - Solution concentration outside is lower than inside. Water moves in

- **Isotonic** - Solution concentration inside and outside of cell are equal. No net movement of water. Cell stays the same size.

- **Hypertonic** - Solution concentration outside is higher than inside water moves out

Plant and animal cells have different reactions to these concentrations. Prokaryotes have contractile vacuoles to pump out water
**Animal cells**

- Cells placed in distilled water
  - Cells swell and burst
- Cells placed in concentrated salt solution
  - Cells shrink and shrivel

**Plant cells**

- Cell wall
- Plasma membrane
- Cytoplasm
- Nucleus
- Vacuole

- Cell placed in distilled water
  - Cell stiffens but generally retains shape
- Cell placed in concentrated salt solution
  - Cell body shrinks and pulls away from cell wall
Have you been paying attention?

What category of saline solution is each red blood cell in?

Saline is NaCl solution used in intravenous drips. It is an isotonic solution when compared with our blood.
Facilitated Diffusion

- This allows larger molecules such as glucose, and charged particles such as sodium and chloride ions to move through the membrane.

- In order to do this they need a bit of help from channel proteins and carrier proteins.

- **Carrier proteins**
  - bind to specific molecules or ions on one side of the membrane, change shape and release the particular molecule or ion on the other side of the membrane.

- **Channel proteins**
  - allow small ions to diffuse rapidly from a *high concentration to a low concentration* through the plasma membrane.

- A concentration gradient must exist.

- Facilitated diffusion does not require energy.
Channel Protein

Carrier Protein
Active Transport

- The movement of molecules or ions against a concentration gradient, and thus a region of low concentration to a region of high concentration.
- Requires energy (ATP) for molecules or ions to move against the concentration gradient.
- Involves pumps which transport specific substances. These have a transport function and an enzyme function to speed up the energy releasing reaction.
- Only works in one direction.
- Molecules transported this way include: glucose, cell waste, potassium, sodium, vitamins, amino acids.
### Summary

<table>
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<th>Diffusion</th>
<th>Osmosis</th>
<th>Active transport</th>
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<tbody>
<tr>
<td>Down a concentration gradient</td>
<td>✓</td>
<td>✓</td>
<td>✗</td>
</tr>
<tr>
<td>Against a concentration gradient</td>
<td>✗</td>
<td>✗</td>
<td>✓</td>
</tr>
<tr>
<td>Energy needed</td>
<td>✗</td>
<td>✗</td>
<td>✓</td>
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<tr>
<td>Substance moved</td>
<td>Dissolved solutes</td>
<td>Water</td>
<td>Dissolved solutes</td>
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<td>Notes</td>
<td>Gases also diffuse</td>
<td>Partially permeable membrane needed</td>
<td>Carrier protein needed</td>
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- **Diffusion** takes place down a concentration gradient and does not require energy. Substances moved are dissolved solutes.
- **Osmosis** is another form of diffusion that moves water across a partially permeable membrane, and it does not require energy.
- **Active transport** moves substances against a concentration gradient and requires energy. A carrier protein is needed.
Bulk Transport

- This involves the movement of large molecules across membranes via **endocytosis** and **exocytosis**
Endocytosis

- Movement of large molecules into a cell
- Two types:
  - Phagocytosis: moving solid material
  - Pinocytosis: moving liquid material

Membrane-bound vesicle
Exocytosis

- Movement of large molecules \textit{out} of a cell
- This process moves molecules such as enzymes, hormones, antibodies, and building materials of cells (which often come from the golgi apparatus)
1. What is the process whereby bulk materials are exported out of the cell?

2. Identify one difference between diffusion and active transport.

3. By which process do cells of the stomach lining manage to move hydrogen ions out of the cells to produce a highly acidic gastric secretion?

4. Give two factors that can increase the rate of diffusion.

5. If salad greens such as lettuce are left for a period of time, they become limp. To restore their crispiness they can be soaked in cold water. Explain the reason for this.
Websites

Diffusion
http://www.wisc-online.com/objects/index_tj.asp?objid=AP1903
http://cpr.molsci.ucla.edu/cpr/cpr_info/rsc_preview.asp?a_id=400233&r_id=res003&e=e

Osmosis
http://www.wisc-online.com/objects/index_tj.asp?objID=AP11003

Active Transport – Endocytosis and Exocytosis
http://www.wisc-online.com/objects/index_tj.asp?objID=AP11203
Homework

- Recap q.3 pg.23
- Recap q.2 pg.27
- Recap q.3 pg.30
- Recap q.3 pg.37
- Chapter Review q.2, 5, 8, 12, 13, 18, 29 pg.44-46