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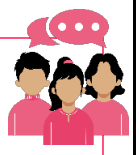
VCE Biology ¾
Cell Basics [1.1]
Workbook

Outline:

Section A: Tips for Success in VCE Biology

Key Takeaways: Top Tips!

- ☑ Break down chunky bits of content into manageable pieces - we will help with this!
- ☑ Be active in your learning - don't spend large parts of the year not studying!
- ☑ Keep testing your knowledge.
- ☑ Ask questions when you are unsure.
- ☑ Be sure to keep the bigger picture in mind - answering questions!
- ☑ Keep track of your mistakes with an error log.
- ☑ Try out creative ways of learning and remembering the content.
- ☑ Teaching friends!
- ☑ Creating mind maps and your own diagrams!
- ☑ Try to make your own diagrams and explanations!



Discussion: What are some things you can do from the start to help you succeed?

NOTE: A lot of these tips can be applied to other subjects as well, and likewise study advice for subjects can be applied to Bio!

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Section B: Cells

Exploration: What are cells?

→ smallest living unit

↳ basic unit of life

O → membrane

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Sub-Section: Cell Theory

Cell Theory

- The cell is the smallest unit of life (nothing smaller than them can be considered life).
- All cells are generated from previous cells – they cannot spontaneously generate.
- All living things arise from cells.

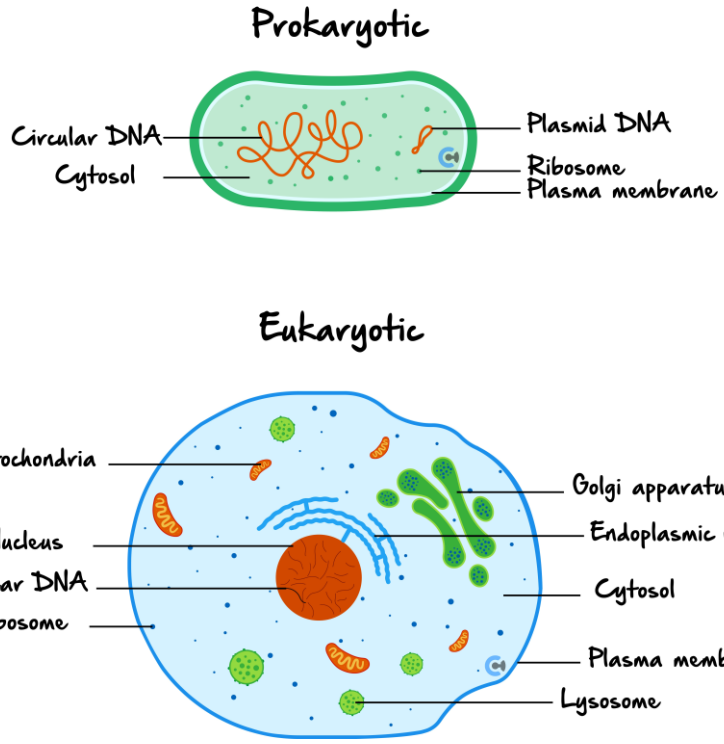
Function	Description
M_ovement	
2.2 R_espiration	producing energy from larger biomolecules → ATP
S_ensitivity	
G_rowth	
R_eproduction	
E_xcretion → getting rid of toxic waste products/materials	
E_quilibrium Homeostasis	
N_utrition	

Sub-Section: Types of Cells

Prokaryotic v/s Eukaryotic Cells

- In general, cells have a **membrane** that delineates their internal environment filled with fluid (**cytosol**), and genetic information in the form of **DNA.**
  - However, we can divide cells into 2 types - eukaryotic cells and prokaryotic cells.
- **Eukaryotic cells** have a nucleus and other membrane bound organelles
- **Prokaryotic cells** do NOT have a nucleus and other membrane bound organelles.

	Eukaryotes	Prokaryotes
Membrane-bound organelles	Present	Absent (except vesicles)
DNA organisation	More than one linear strand of DNA packaged in a chromosome in a nucleus	One circular chromosome and additional plasmids
Organism nature	Can be unicellular or multicellular	Unicellular
Size	Larger (-10-$100\ \mu m$)	Smaller (-0.1-$5\ \mu m$)
Method of cell replication	Mitosis and meiosis	Binary fission



NOTE: Understanding the main functional difference between prokaryotic and eukaryotic cells is important, as it can be indirectly in later topics such as 1.3 Gene Expression and the trp operon!

REMINDER: Don't forget!

- This content won't directly be assessed in Units 3 & 4, but is key to understanding it! Don't worry about grasping everything perfectly, focus on the bigger picture!

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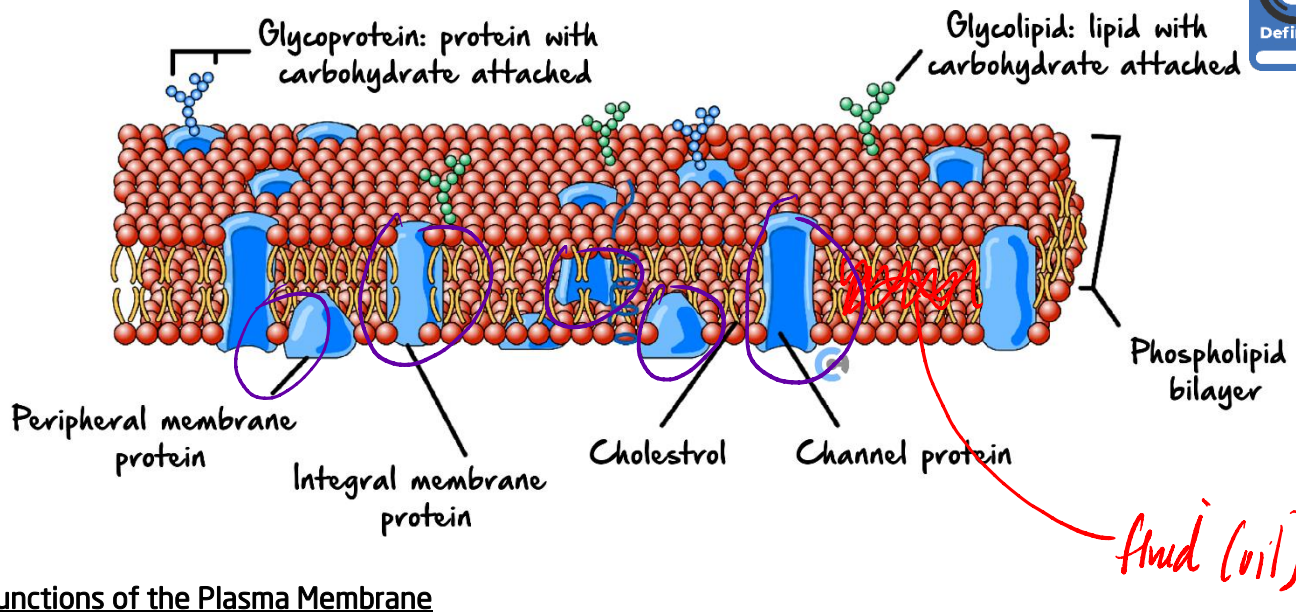
Sub-Section: The Plasma Membrane



Functions of the Plasma Membrane

- Cellular Integrity: keeps everything together
- Selective Permeability: chooses what enters and exits
- Bulk Transport: _____
- What else can the plasma membrane do?

chooses

Components of the Plasma Membrane

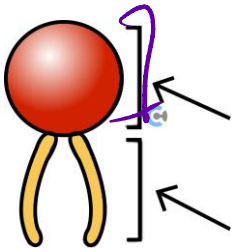
- 'Fluid mosaic model': Everything is mashed together (_____) and moves around randomly throughout the membrane. (_____)
- The components are held together by _____.

NOTE: Again, not directly assessed, but very useful to visualise conceptually important processes like cellular signalling!

Sub-Section: Phospholipids

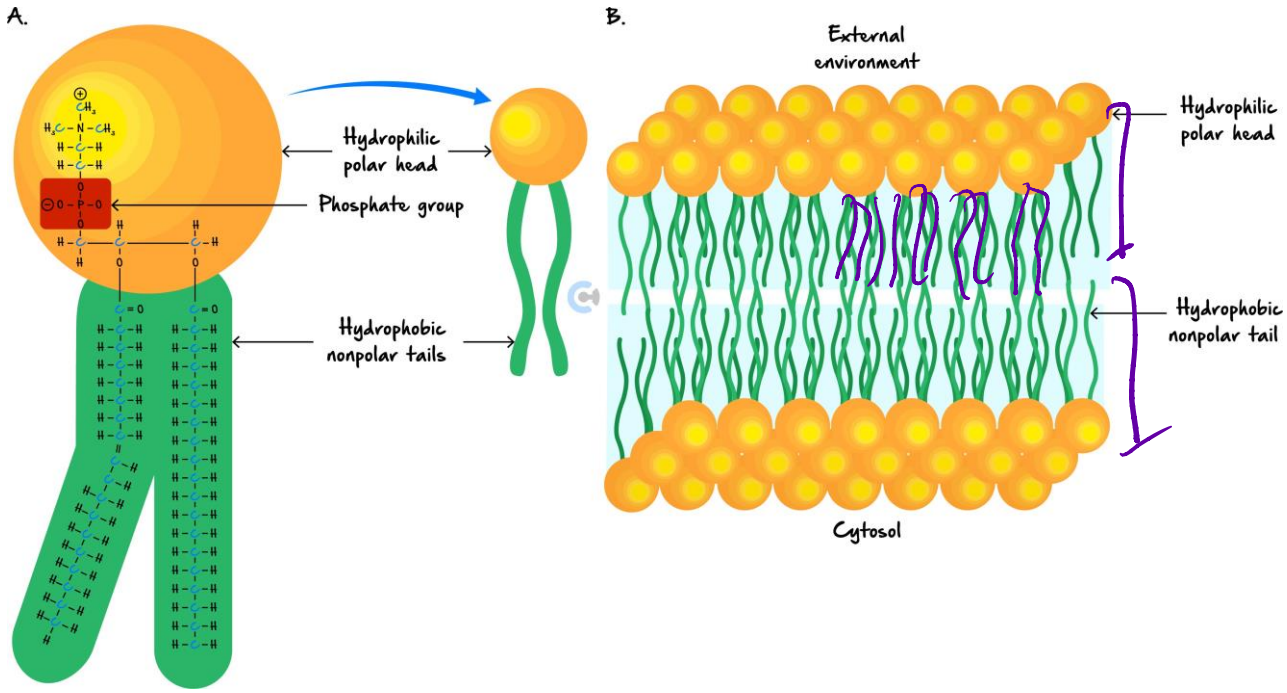
Phospholipids

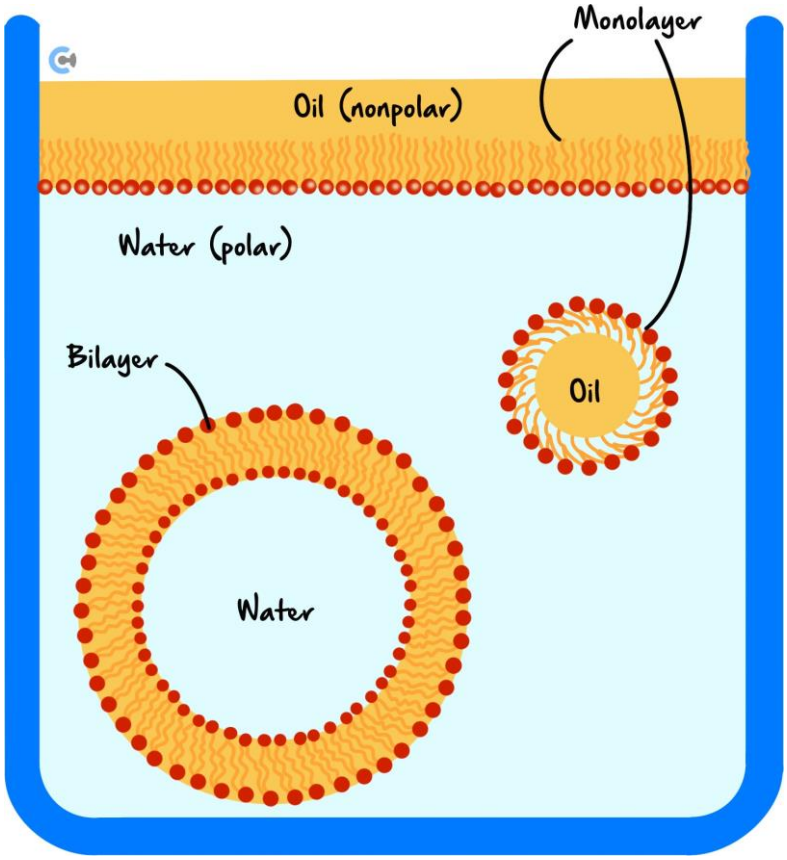
- Purpose: Key component of the plasma membrane, and contributes to selective permeability.
- Structure:



Component	Chemical Nature	Properties
phosphate	polar	hydrophilic
fatty acid tails	nonpolar	hydrophobic

- Arrangement:





- Naturally forms this orientation due to aqueous intracellular and extracellular environment; the tails will clump together to minimise contact with water.

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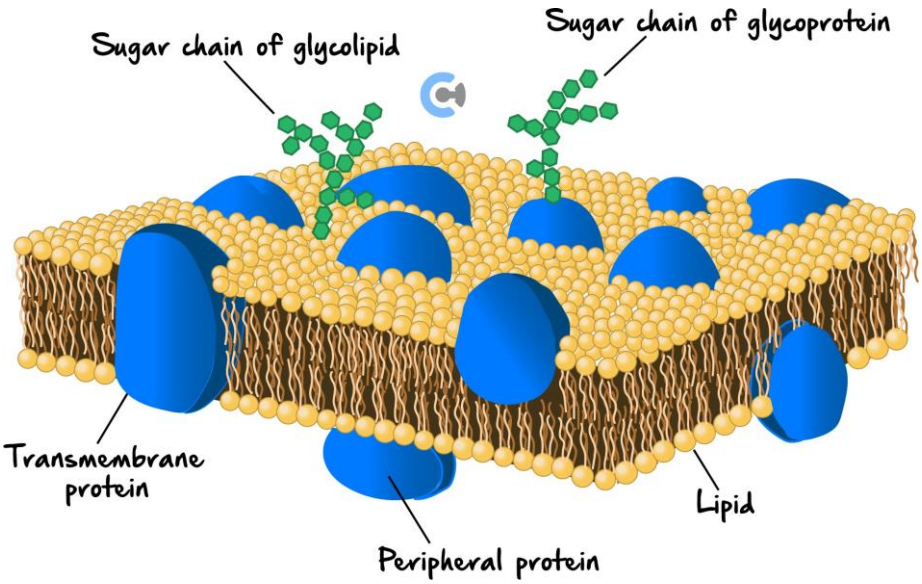
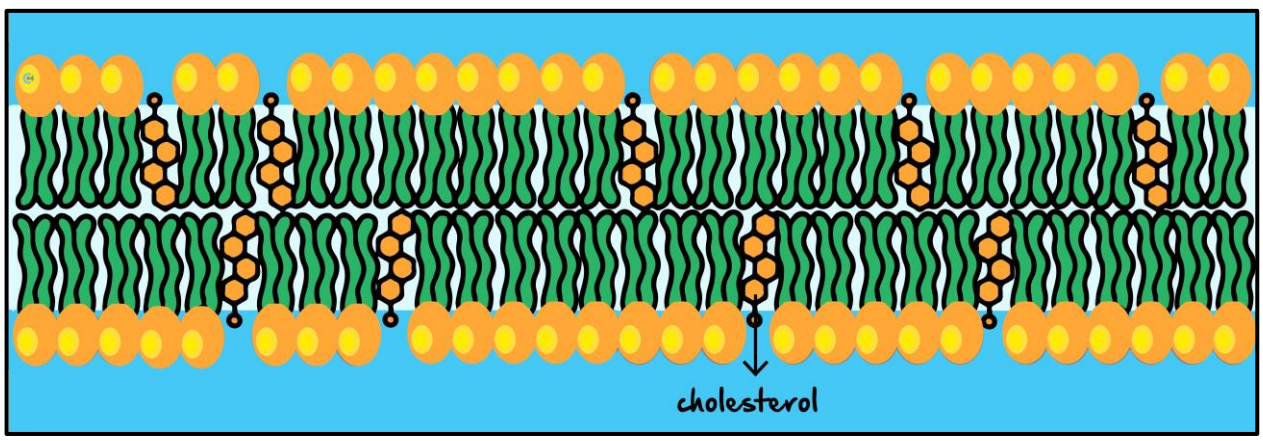
Everything Else

- **Proteins** – Provide alternative pathways for _____ hydrophilic _____ substances to cross the plasma membrane.
  - **Channel proteins:** Act as a tunnel through which substances can move.
  - **Carrier proteins:** Change shape to let a substance through.



- **Glycoproteins & Glycolipids** – _____ cell signalling _____
- _____ cholesterol _____ – Maintains cellular integrity by acting as a 'spacer' between phospholipids to control membrane fluidity.
  - At high temperatures, cholesterol _____ reduce _____ membrane fluidity.
  - At low temperatures, cholesterol _____ maintain _____ membrane fluidity.



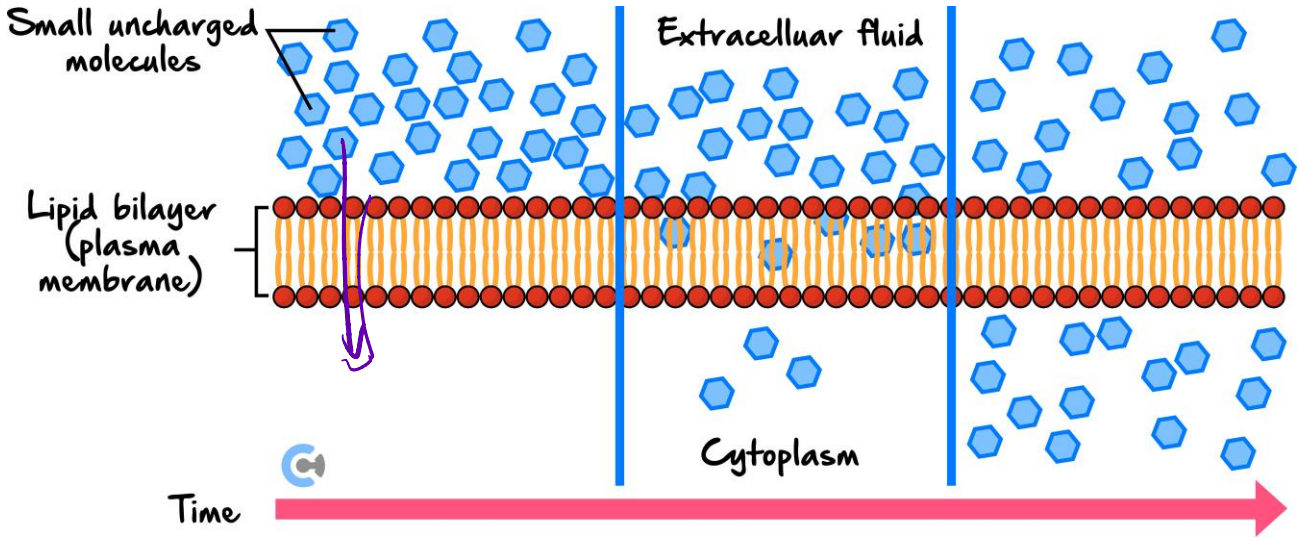
Sub-Section: Movement Across the Plasma Membrane

NOTE: 'Passive' transport means that this is an energy-requiring process!

NOT

Diffusion

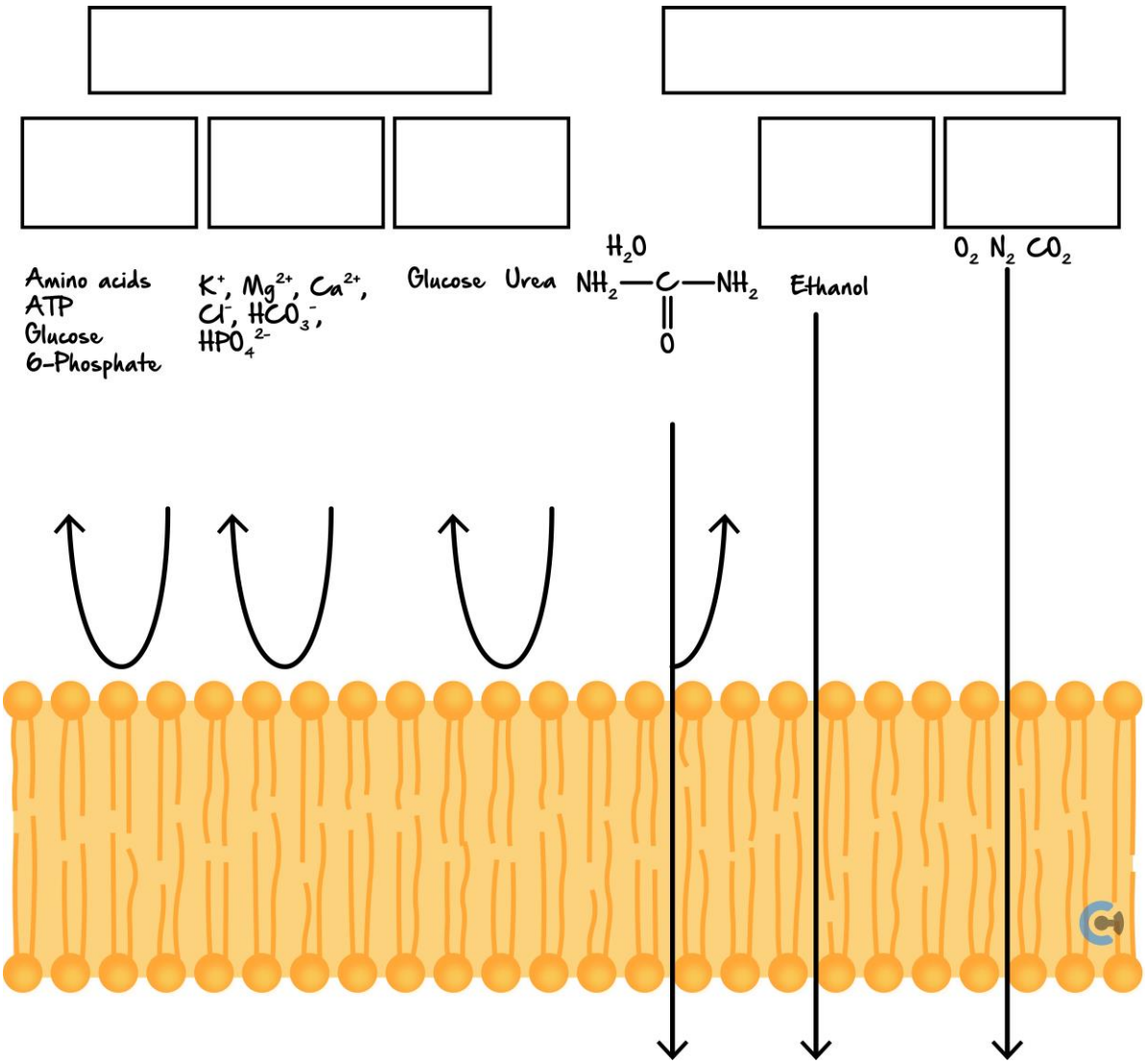
- This is the movement of solutes from an area of high concentration to an area of low concentration.
  - Substances will want to move across a membrane **DOWN** their concentration gradient.
- Simple diffusion is when a substance can directly move across the membrane unassisted.



REMINDER: Mixture Terminology

- Solute = Substance that is dissolved.
- Solvent = Liquid in which a solute dissolves.
- Solution = Liquid mixture of the solute in the solvent.
- Net movement is the overall direction where movement has occurred. It should be noted that movement will occur in both directions across the membrane.

Exploration: What are the properties of substances that can move across the membrane?



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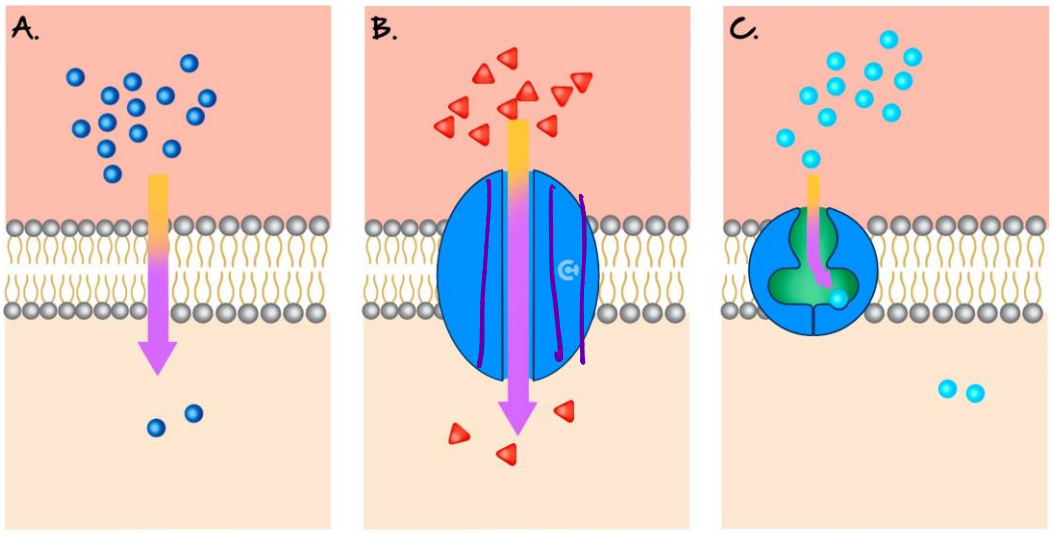
Facilitated Diffusion

- Substances are not able to directly move across the membrane, however, move across the membrane anyway due to the action of **carrier** and **channel** proteins.
  - Still moving from an area of high concentration to an area of low concentration (hence, going down their concentration gradient).
- Channel proteins have a water-filled pore for hydrophilic substances to move across.
- Carrier proteins are specific to a substance, and when it binds, this initiates a change in shape allowing the movement across the membrane.



hydrophobic hydrophilic hydrophilic

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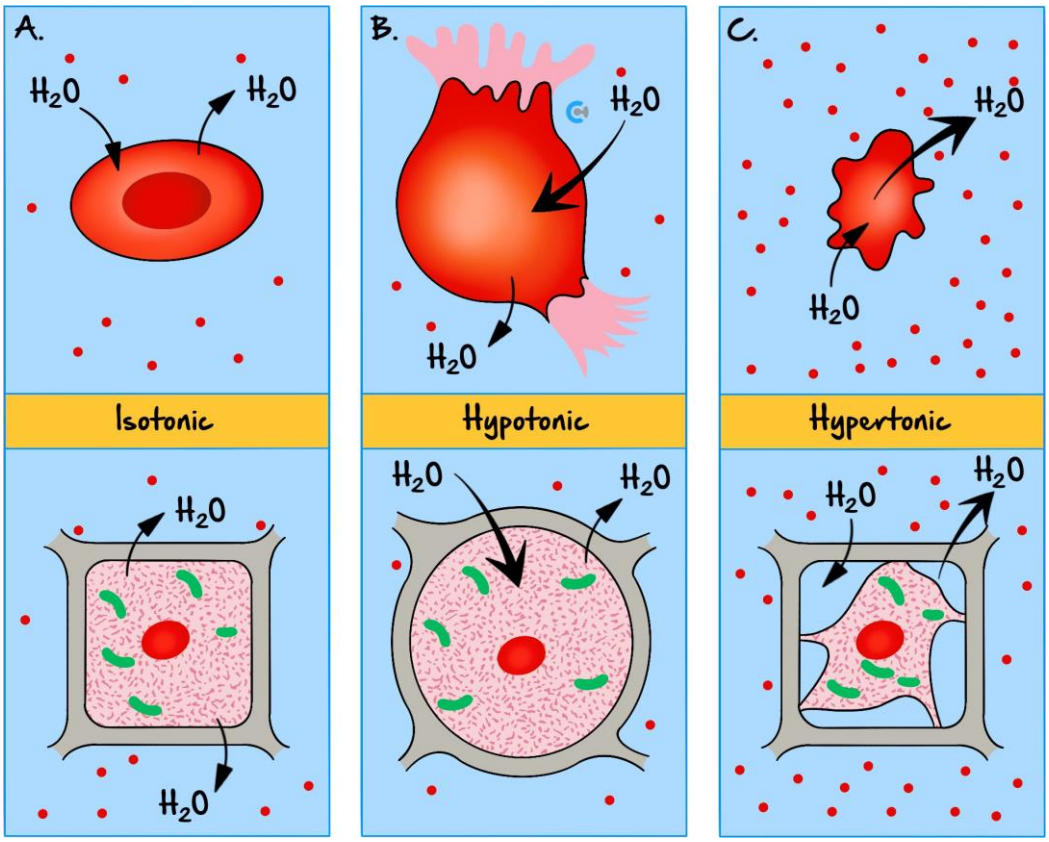
Osmosis

- This is the net movement of water across a semi-permeable membrane from an area of low **solute** concentration to an area of **high** solute concentration.
  - So, instead of the solute moving - it's water!
  - I like to think of it like the "water concentration" - although this is a bit flawed in actual terms.
- Isotonic solutions - Equal solute concentration to the cell - where does the water move?
- Hypotonic solutions - Lower solute concentration to the cell - where does the water move?
- Hypertonic solutions - Higher solute concentration to the cell - where does the water move?
  - What happens here can differ for plant and animal cells, how?



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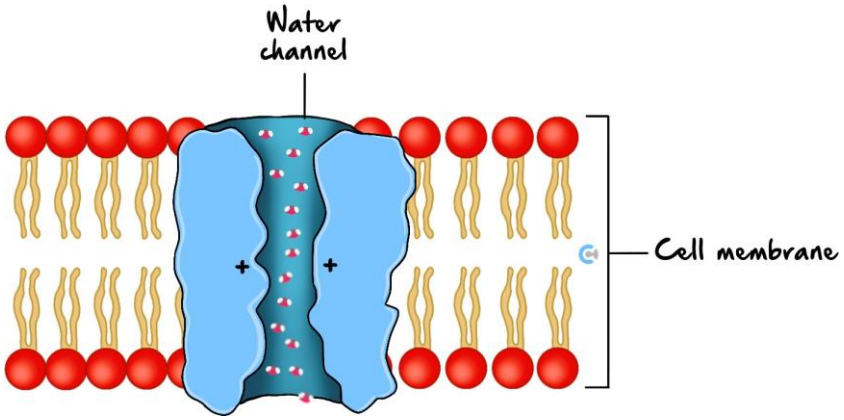
Exploration: Aquaporins

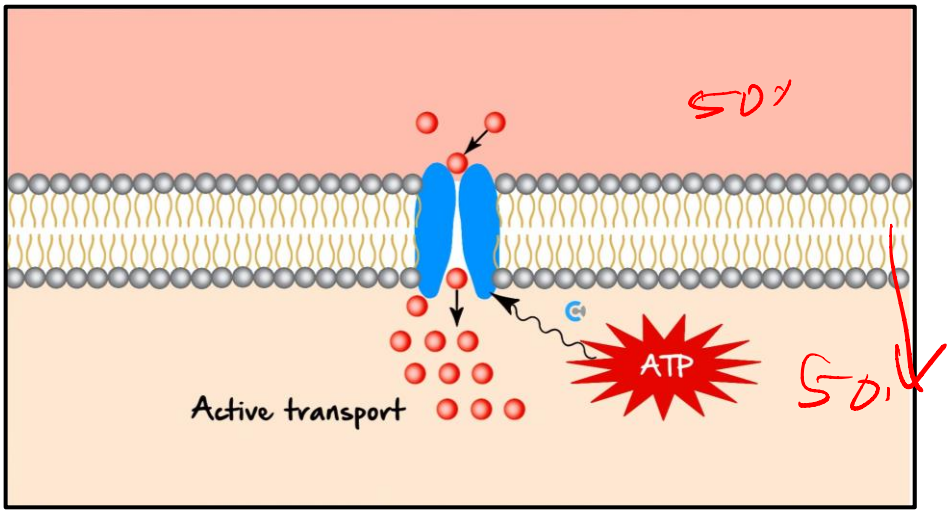
- Water moves through a mix of simple and facilitated diffusion – considering its properties why might this be the case?



NOTE: 'Active' transport means that this is an energy-requiring process!

Active Transport

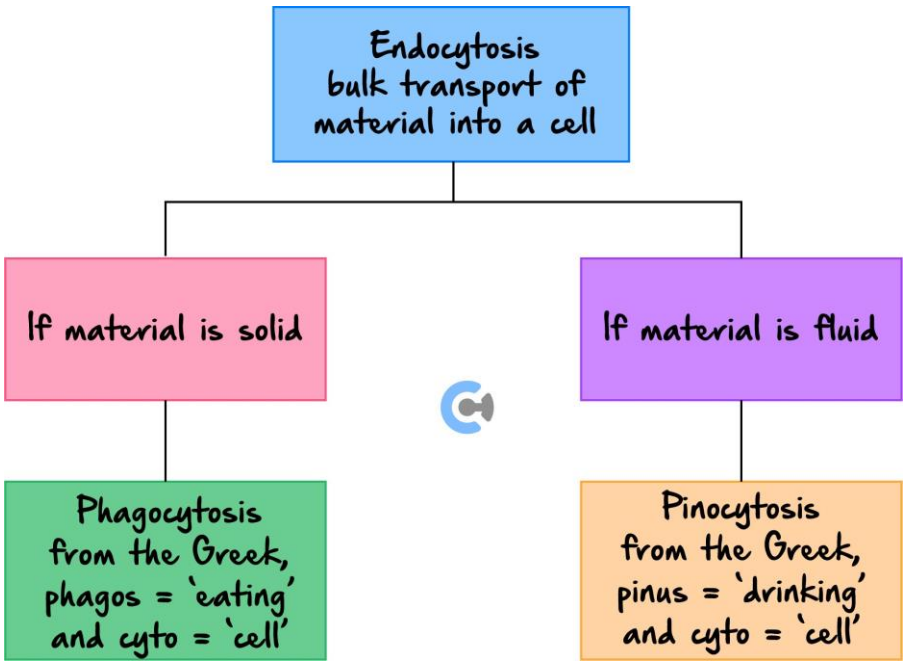
- A process that results in solutes moving AGAINST their concentration gradient.
  - Moving from an area of low concentration to high concentration.
  - Facilitated by "pumps" – carrier proteins that require the use of ATP.
- Why might this be useful?

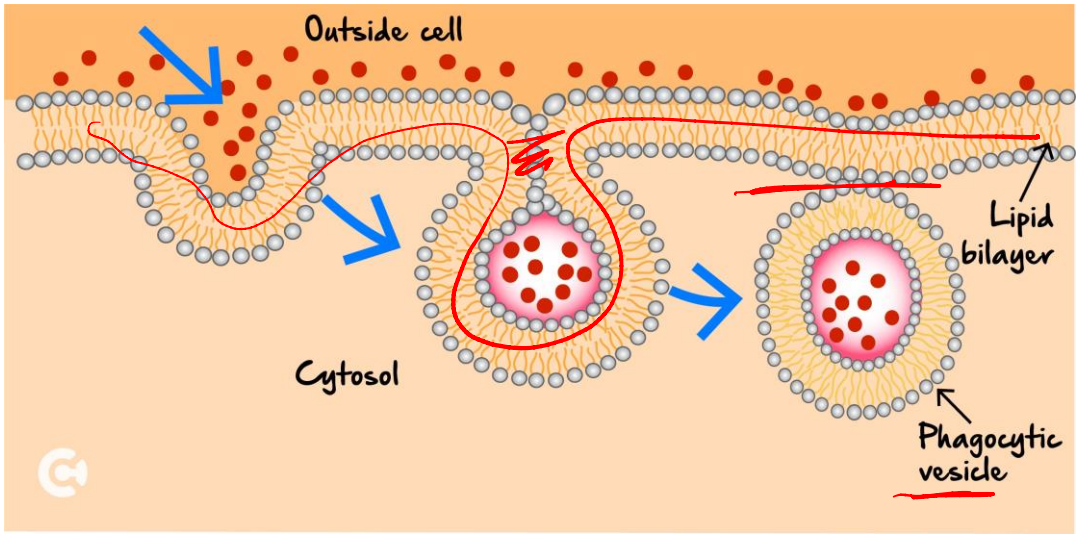


Sub-Section: Bulk Transport

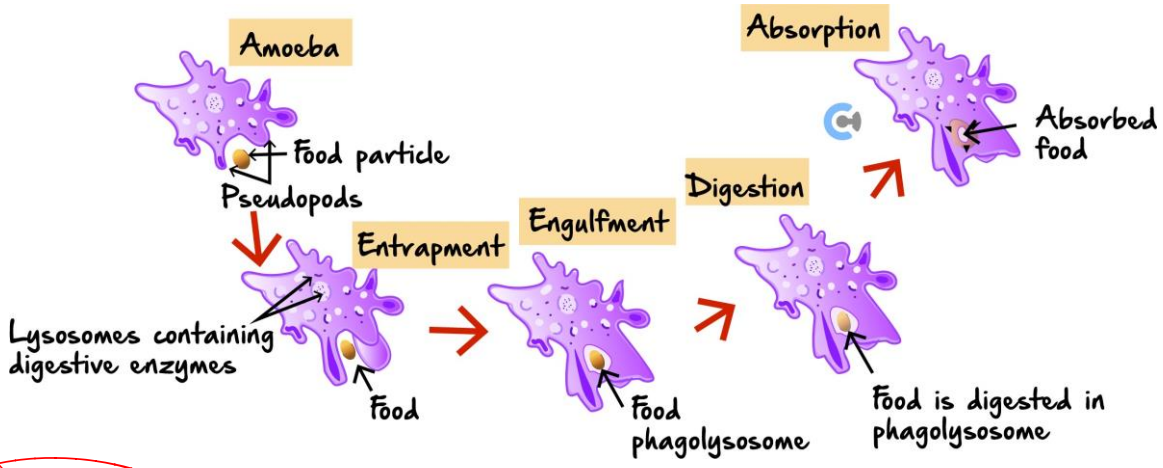
Bulk Transport

- Endocytosis - Involves the bulk movement of large materials into the cell.

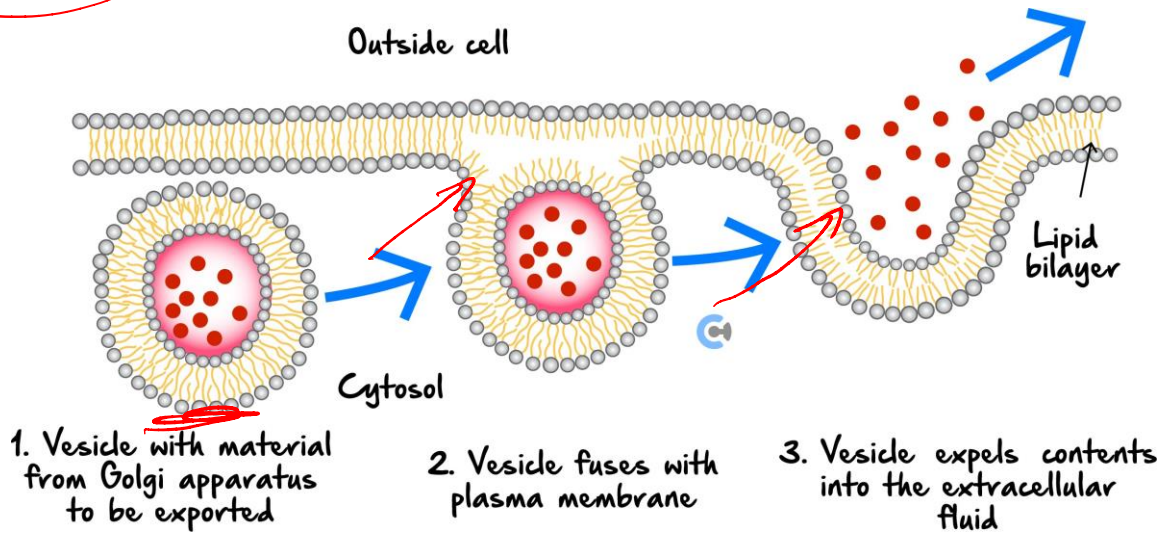




ENDOCYTOSIS



Exocytosis - Bulk release of material from a cell - commonly proteins and other biomolecules.



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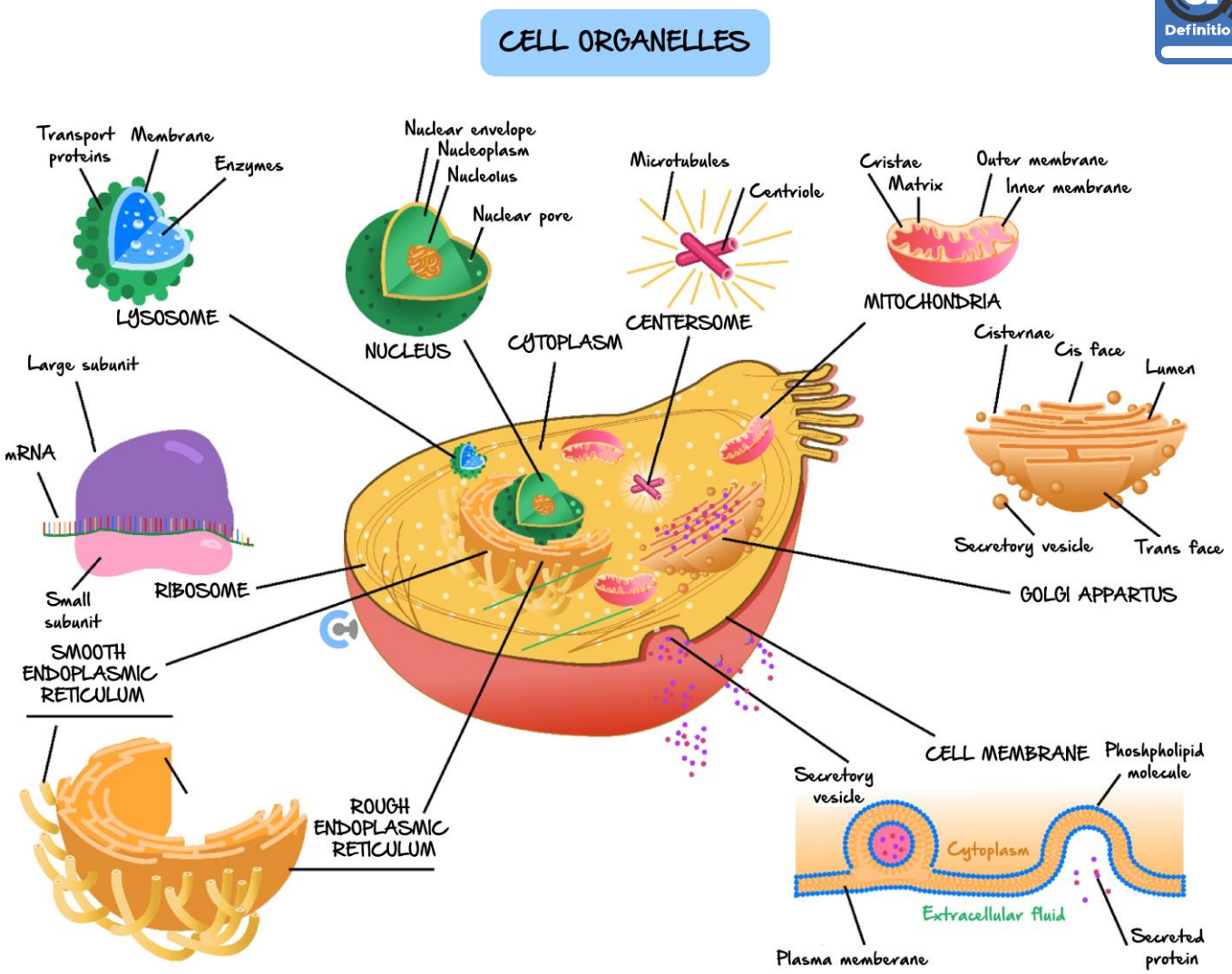
Sub-Section: Organelles

Organelles

- These are present in eukaryotic cells and are membrane-bound to create a separate environment so that they can perform a specific function.
- These are the important ones to know about for VCE Biology:
  - Nucleus
  - Ribosome (technically not an organelle)
  - Mitochondria
  - Chloroplast (only plant cells)
  - Endoplasmic Reticulum
  - Golgi Apparatus

Organelle	Function
1.2 Nucleus	stores DNA – genetic information
1.3 Ribosome	site of protein synthesis
2.2 Mitochondria	provides energy by performing respiration
2.1 Chloroplast	photosynthesis
1.4 Endoplasmic Reticulum	packages proteins and modifies TRANSPORT
1.4 Golgi Apparatus	packages proteins for export



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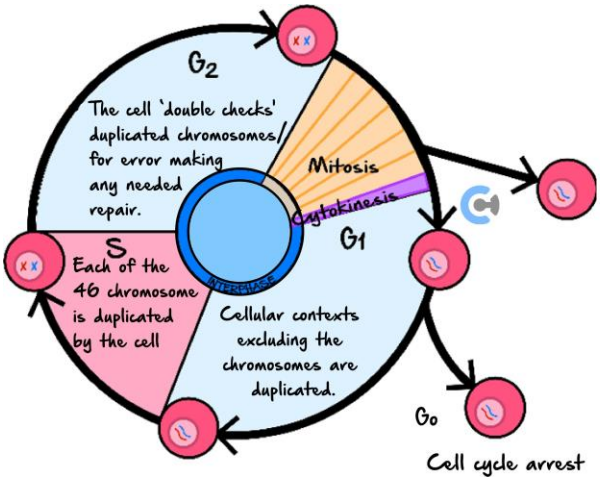
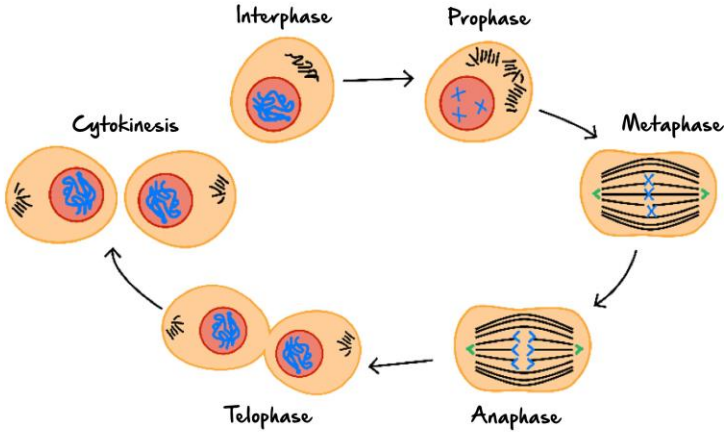
Sub-Section: Cell Division

The Cell Reproductive Cycle

- Prokaryotic cells will replicate themselves via "binary fission".
- Eukaryotic cells undergo the process of mitosis:
  - Interphase
  - Prophase
  - Metaphase
  - Anaphase
  - Telophase





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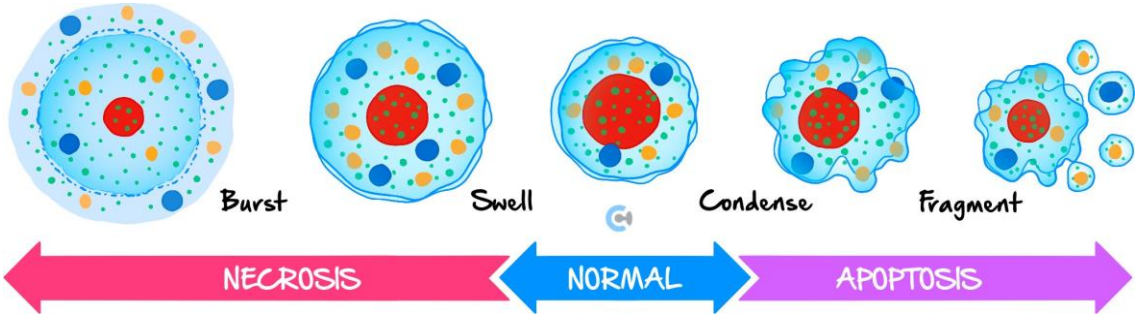
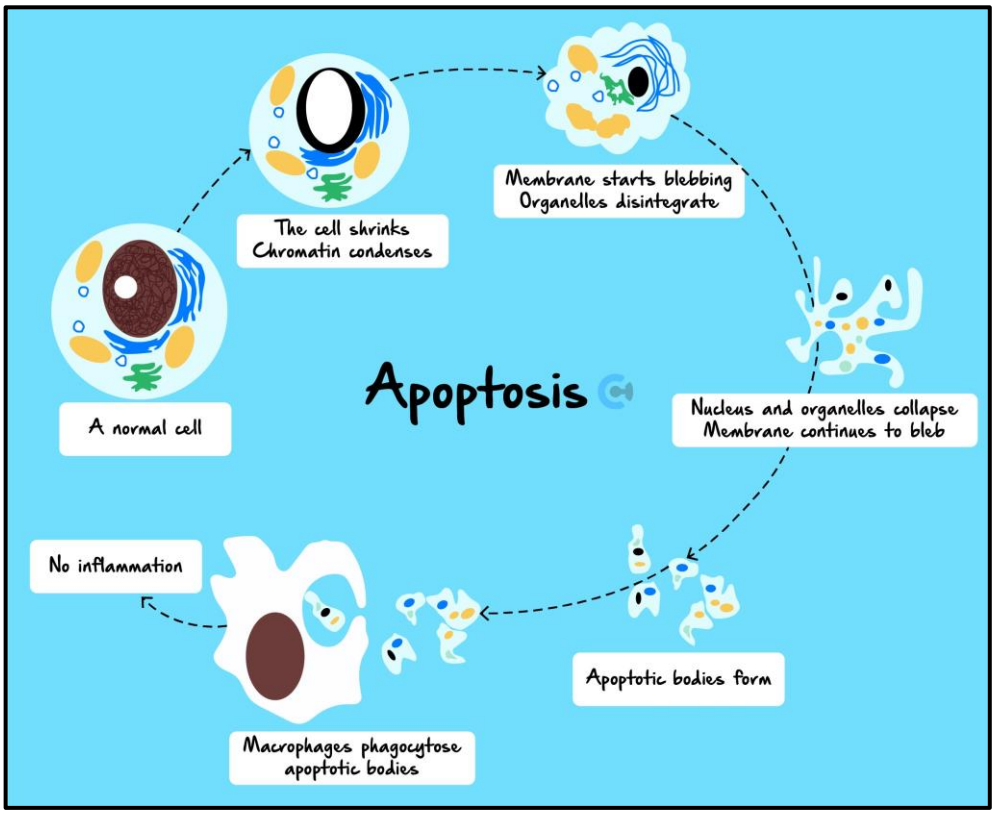
Sub-Section: Apoptosis

Apoptosis

- Apoptosis - programmed cell death
  - The cell (for whatever reason) decides to kill itself (or is ordered to).
  - The cytoskeleton breaks down causing the cell to shrink.
  - The cell's contents are packed into little blebs.
  - These are then cleaned up.





Discussion: Why would a cell want to undergo apoptosis?

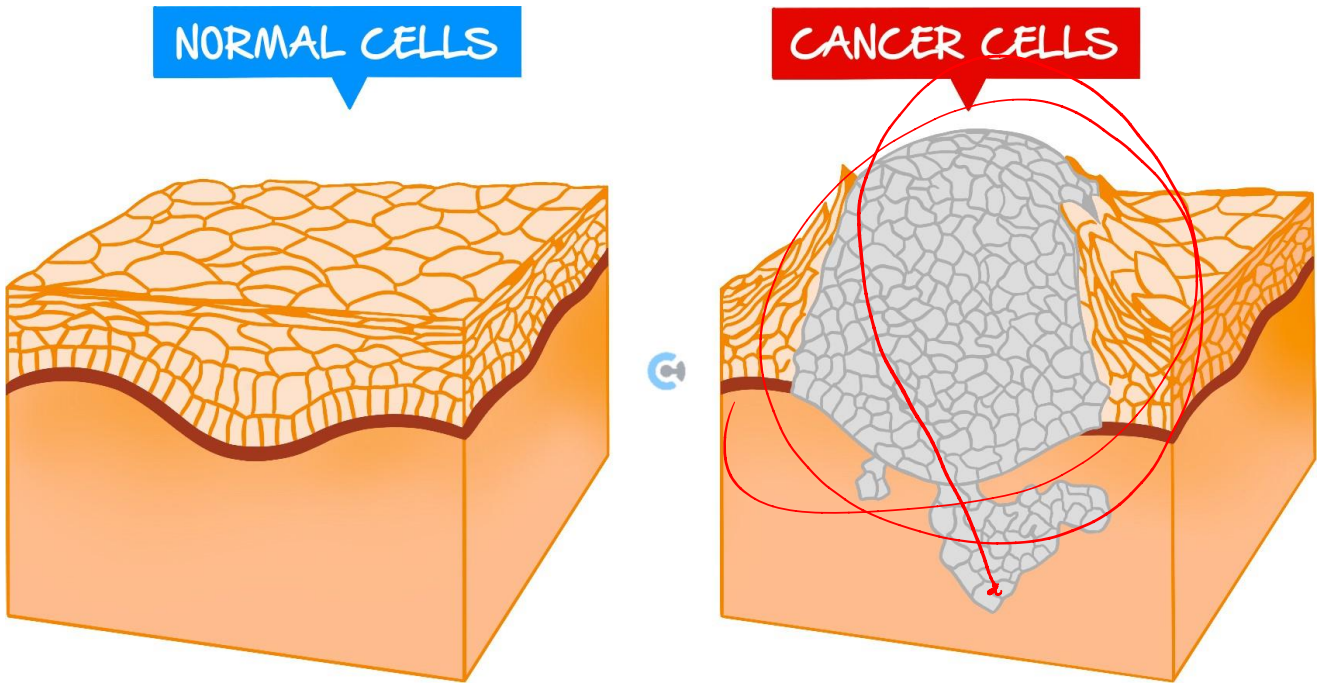
diseased
damaged
unnecessary

Discussion: What might happen when these processes go wrong?

CANCER

Cancer Cells

- uncontrolled cell replication



- This can occur due to an error in the cell cycle, causing the regulation of division to break down.
- Failed apoptosis - The body may try to kill the cell, but it no longer responds to such signals.

Normal Cells	Cancerous Cells
The rate of cell division is regulated so that, in a mature organism, cell production matches cell loss.	Mutations in genes that control the cell cycle occur, causing the cell cycle to continue in an unregulated manner.
Checkpoints exist in normal cells to ensure that the DNA that is to be transmitted to daughter cells is complete and error-free.	Checkpoints are overridden or fail.
Chemical signals convey information to cells about when to divide faster and when to slow down or stop dividing. Two kinds of genes are involved in this signalling: proto-oncogenes that signal cells to continue dividing, and tumour-suppressor genes that signal cells to stop dividing.	Mutations in the proto-oncogenes and tumour-suppressor genes disrupt the control of the cell cycle. Mutated proto-oncogenes that lead to cancer are known as oncogenes.
Contact inhibition occurs, which stops cell division if overcrowding occurs.	Contact inhibition does not occur - the cells continue to grow and masses of cells form.

Exploration: How do we treat cancer?

chemotherapy
radiation
removing tumour

NOTE: Cancer as a specific concept and its treatment is not explored in full depth – however you need to know it when discussing immunotherapy later, so it is really helpful to know HOW cancer kills so that you can better understand how we can HEAL.

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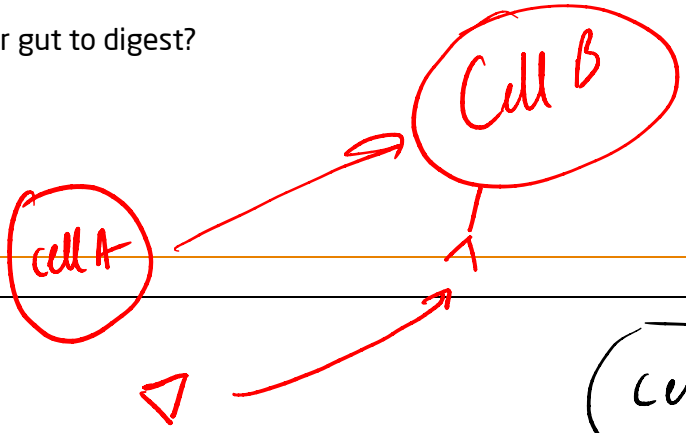
Sub-Section: Biology and Shapes

Exploration: How do cells and molecules "know" what to do?

- Everything in biology ultimately comes down to shape – things with certain shapes will interact with other things with matching shapes.
- A key idea in biology is that shapes determine function!
- For example, let's discuss cellular signalling – i.e. how do cells communicate?
- How does a cell in the neck tell your gut to digest?



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