BL1131 Notes

Foundations in Biology I

Topics 1 to 7

This is a compilation of topics taught in BL1131 Semester 1 and Semester 2.
Made by LQ

...who hates bio.
Why does bio exist AHHHHHH

Links of All LQ Notes: LQ Notes Links Document

Topic	
Topic 1: Organisms and the Environment	
Topic 2: Biological Molecules (I) - Nutrients	
Topic 3: Cell Structure and Organisation	
Topic 4: Movement of Substances	
Topic 5: Biological Nutrients (II) - Enzymes	
Topic 6: Nutrition in Animals	
Topic 7: Nutrition in Plants	
Topic 8: Transport in Plants	(new in 2023, found in 2023 BL2131 Notes as Topic 1)

Year 2 Biology Notes can be found here: **BL2131 Notes**

Note

Topic 1 - Organisms and the Environment and *Topic 3 - Cell Structure and Organisation* are **NOT** tested for (2022) end-of-year exams.

Topic 1: Organisms and the Environment

1.1 Ecology

1.1.1 Abiotic and Biotic Factors in the Environment

Biotic (Living)	Abiotic (Non-living)
No. of Prey No. of Plants No. of Predators	pH level Temperature Light intensity Photosynthesis Water availability Salinity (Salt Content) Oxygen concentration

Note: Chemical Processes like photosynthesis are considered Abiotic.

1.1.2 Ecological Organisational Levels

Species ⟶ Population ⟶ Community ⟶ Ecosystem ⟶ Biosphere

1. **Species:** A species is a group of similar organisms. Organisms within a species can breed and produce healthy(viable) offspring that can grow, develop and reproduce normally.

2. **Population:** A population is a group of organisms of the same species that live together at a particular time and place.

3. **Community:** A community is two or more populations of different species that live together in a particular place and time and interact with each other.

4. **Ecosystem:** An ecosystem is a community together with the abiotic environment.

5. **Biosphere:** A biosphere is the sum of all ecosystems. It includes all the parts of the earth where life can be found.

1.1.3 Interactions Between Species

Mutualism	+	+
Commensalism	+	0
Predation (Parasitism)	+	-
Amensalism	-	0

Competition	-	-

1.1.4 Transfer of Energy

Through the food chain, energy is transferred from one trophic level to the next. However, through each trophic level, only about 10% of the energy is transferred, while the rest of the energy is lost through

1. Heat
2. Excretion (Sweat, Urination)
3. Egestion (Faeces)
4. Uneaten Parts

1.1.5 Assimilated Energy

Assimilated Energy is the total energy, including the energy that is lost through heat, excretion, egestion and uneaten parts.

It is the total efficiency of animals to convert ingested food into energy for

1. Growth
2. Reproduction
3. Movement

1.1.6 Bioaccumulation and Bioamplification

Harmful chemicals like DDT are not biodegradable and hence remain in the soil and water for many years.

They are not water-soluble and cannot be excreted, and hence are stored in the fatty tissues of the consumer when ingested, increasing in concentration as the consumer consumes prey.

This is known as bioaccumulation.

The chemicals increase in concentration as it moves up the food chain. This is known as bioamplification.

1.1.7 Ecological Pyramids

The ecological pyramids are

1. Pyramid of numbers (The number of each species)
2. Pyramid of biomass (The amount of biomass/dry mass of each species)
3. Pyramid of energy (The total energy of each species)

Topic 2: Biological Molecules (I) - Nutrients

2.1 Carbohydrates

Carbohydrates are made of **Carbon, Hydrogen and Oxygen**.
They are classified into three types: Monosaccharides, Disaccharides and Polysaccharides.

2.1.1 Monosaccharides

Monosaccharides have 1 carbon ring,
Three monosaccharides are **glucose**, **fructose** and **galactose**.
They are all **reducing sugars**. (See 2.1.6 - Benedict's solution test)

Glucose	
Fructose	
Galactose	

Table 2.1.1a

Note: These molecules are not actually coloured, colours just for better identification

2.1.2 Disaccharides

Disaccharides have 2 carbon rings.
Three disaccharides are **maltose**, **sucrose** and **lactose**.
Maltose and Lactose are **reducing sugars**, while Sucrose isn't. (See 2.1.6 - Benedict's solution test)

Maltose	
Sucrose	
Lactose	

Table 2.1.2a

Note: These molecules are not actually coloured, colours just for better identification

2.1.3 Polysaccharides

Polysaccharides have many carbon rings.
Three polysaccharides are starch, cellulose and glycogen.

Polysaccharides in Plants	Polysaccharides in Animals
Starch Cellulose	Glycogen

Table 2.1.3a

These polysaccharides are all **polymers** (Polymer: a molecule with repeating structures).

Review WS 4, Question 7 (a) (ii)

Cellulose is a component of plant cell walls, while chitin is a component of fungal cell walls. Suggest why chitin, like cellulose, is used to build cell walls. [1]

Answer

Chitin is rigid/tough/strong. [1]

Note: Cellulose and Chitin are both relatively strong.

2.1.4 Disaccharides Forming

Disaccharides are formed through a **condensation (or dehydration) reaction**.

FYI: The reaction is called condensation because water is one of its products.

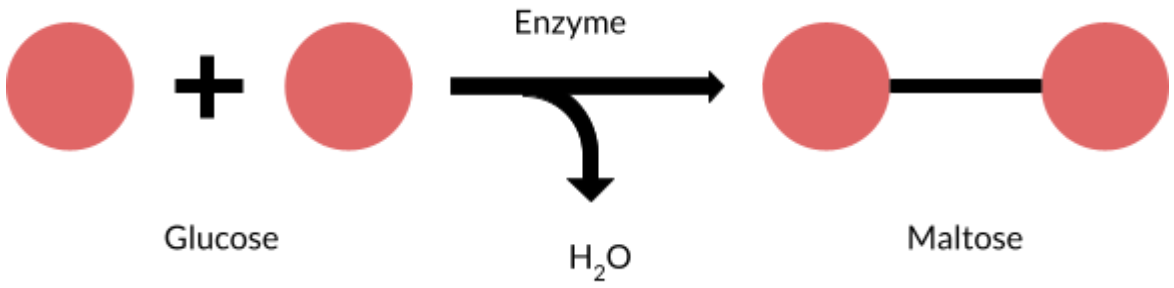


Diagram 2.1.4a

2.1.5 Breaking Down of Disaccharides

Disaccharides are broken down through a **hydrolysis** reaction.

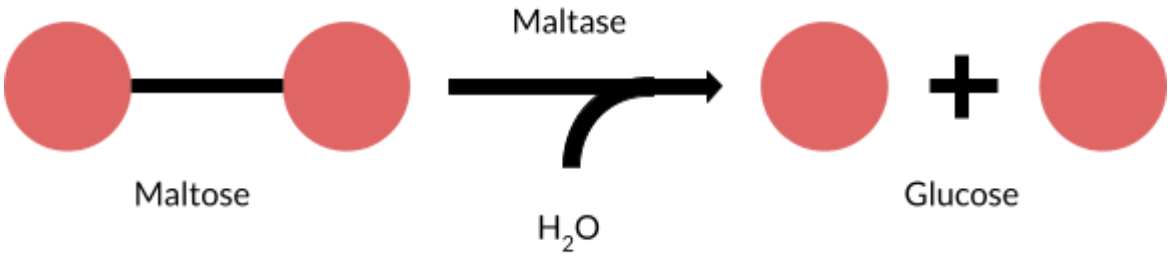


Diagram 2.1.5a

Note: Maltase is an **enzyme**, which is covered in Topic 6: Nutrition in Animals

2.1.6 Benedict's Solution Test

When Benedict's solution is added to a type of sugar, it can tell us whether the sugar is a reducing sugar, and a rough estimate of how much reducing sugar is present.

Blue	Green/Yellow	Orange	Brick-red
No Reducing Sugar	Traces of Reducing Sugar	Moderate amounts of Reducing Sugar	Large amounts of Reducing Sugar

Table 2.1.6a

Reducing Sugars	Non-reducing Sugars
Glucose, Fructose, Galactose (Monosaccharides) Maltose, Lactose (Disaccharides)	Sucrose (Disaccharide) **Note: Sucrose is the only non-reducing sugar.**

Table 2.1.6b

2.1.7 Iodine Starch Test

When Iodine (I_2) is added to a substance, it can tell us if starch is present.
Iodine is brown, but when it is added to a substance where starch is present, it turns blue-black.
This is the Iodine Test or Iodine Starch Test.

2.2 Fats

Fats are made of **Carbon, Hydrogen and Oxygen**. They are **Lipids**, which is a group of molecules that do not mix well with water.
Fats are also **triglycerides**.
This means that they are made of (1) glycerol and 3 fatty acids.

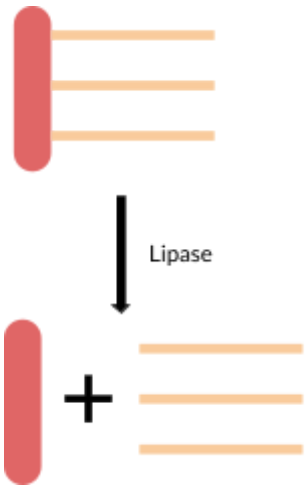


Diagram 2.1.7a

FYI: Lipase is the enzyme that breaks down lipids; This is covered in Topic 6: Nutrition in Animals.

2.2.1 Ethanol Emulsion Test

Lipids like fats react with ethanol, a colourless liquid, and will form a white emulsion (Emulsion: A "cloud" of chemicals). This is known as the Ethanol Emulsion Test.

2.3 Proteins

Proteins are made of **Carbon, Hydrogen, Oxygen and Nitrogen**.
The **monomer** (basic building blocks) of proteins is **amino acids**.
Proteins are a chain of amino acids joined together. They are joined by **peptide bonds**.

2.3.1 Structures of Amino Acids

Amino Acids have Primary, Secondary, Tertiary and Quaternary Structures.

2.3.1.1 Primary Structure

The Primary Structure of a protein is the basic string of amino acids.

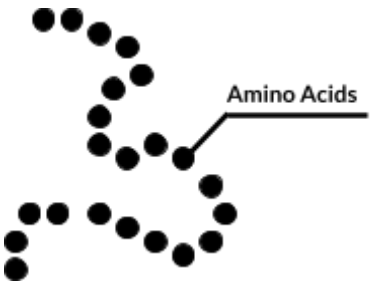


Diagram 2.3.1.1a

2.3.1.2 Secondary Structure

The Secondary Structure of a protein is usually **pleated sheets** or **alpha helixes**. This is as if specific parts of a string are folded.

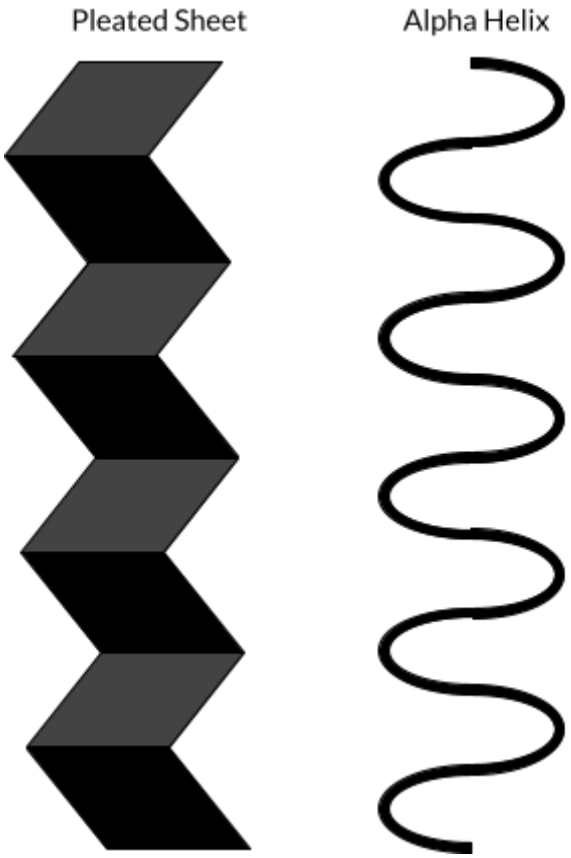


Diagram 2.3.1.2a

2.3.1.3 Tertiary Structure

The Tertiary Structure of a protein is usually obtained by folding the Secondary Structure many times, like coiling the whole string up.

Diagram 2.3.1.3a

2.3.1.4 Quaternary Structure

The Quaternary Structure of a protein is many Tertiary Structures of proteins together. An example of this would be haemoglobin, which is made up of 4 tertiary structures.

Note: not all proteins have a quaternary structure.

Note that the different tertiary structures are not chemically bonded, which means that they are not connected in any way.

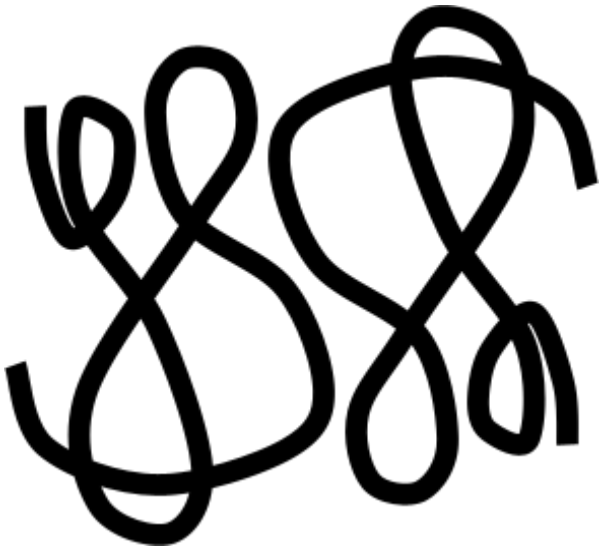


Diagram 2.3.1.4a

2.3.2 Biuret Test

The Biuret Test for protein is done by adding a few drops of sodium hydroxide to a substance, allowing the polypeptide to unfold into its primary structure.

Then, blue Copper (II) Sulfate solution is added.

If the substance **turns purple**, it contains protein. If it **remains blue**, it does not contain protein.

2.4 Summary of Food Tests

	Iodine Test	Biuret Test	Ethanol Emulsion Test	Benedict's Test
Negative	Brown	Blue	Clear	Blue
Positive	Blue-black	Violet	Cloudy suspension	Green/Orange/Red

2.4.1 Benedict's Test

For Benedict's Test, here is a more in-depth table of positive and negative results.

Colour	Conclusion
	No reducing sugars present.
	Small amount of reducing sugars present.
	Moderate amount of reducing sugars present.
	Large amounts of reducing sugars present.

Topic 3: Cell Structure and Organisation

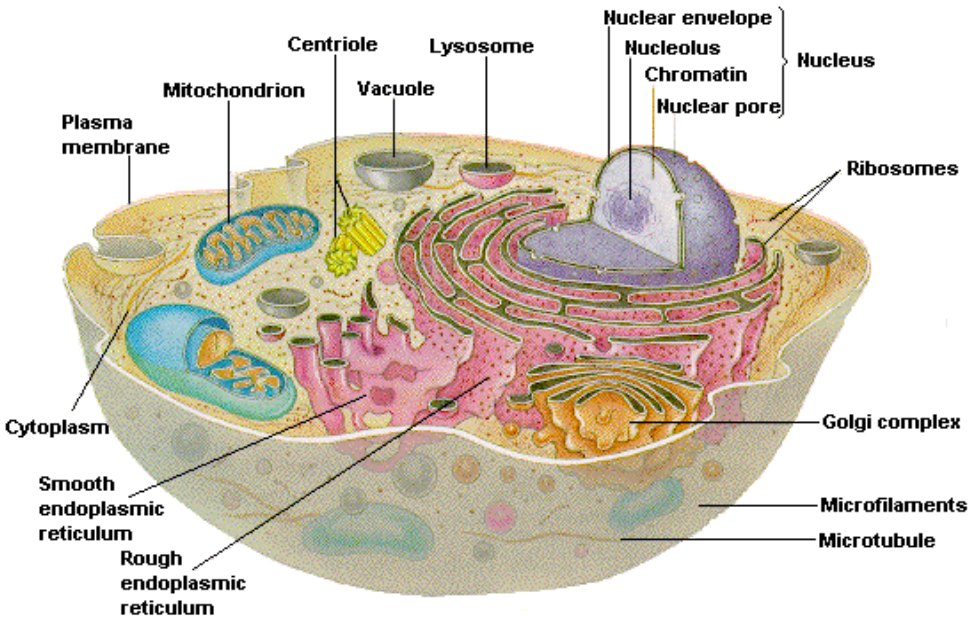


Image taken from https://www.haikudeck.com/cell-organelles-science-and-technology-presentation-a5cOqQC62d

3.1 What are Cells?

Cells are the **smallest unit of life that can replicate independently**.

3.2 Plasma Membrane

The **plasma membrane**, or **cell membrane**, is a **partially permeable** layer that forms a boundary around the cytoplasm.

It prevents the cell's contents from escaping and controls what substances **enter and leave** the cell.

3.3 Cell Wall

Cell walls in plants are made of **cellulose**.
It is (fully) **permeable**.

It prevents plant cells from bursting and gives cells their shape.

3.4 Vacuoles

Vacuoles are membrane-enclosed sacs.

There is a **large central vacuole** in plant cells and **numerous small vacuoles** in animal cells.

They **contain food and water**. The large central vacuole in plant cells also helps to support the plant.

3.5 Nucleus

The nucleus **controls the type and quantity of enzymes produced** by the cytoplasm. It **regulates the chemical changes** that will take place in the cell. Lastly, it controls cell division.

3.5.1 Nucleolus

The nucleolus **produces ribosomes**.

3.5.2 Chromatin

Chromatin condenses into chromosomes just before cell division. It consists of DNA.

3.5.3 Nuclear Membrane

The nucleus has a **double membrane** (See 3.13 - Single Membrane vs Double Membrane Organelles) known as the nuclear membrane.

3.6 Ribosome

Ribosomes are involved in **protein synthesis** (the manufacturing of proteins).

3.6.1 Free Ribosomes

Free ribosomes manufacture proteins that function and **remain in the cytoplasm.**

3.6.2 Bound ribosomes

Bound ribosomes are found on the Rough Endoplasmic Reticulum (rER) (See 3.7.1: Rough Endoplasmic Reticulum) and manufacture proteins that **make up membranes** or **are secreted from the cell**.

3.7 Endoplasmic Reticulum

The Endoplasmic Reticulum is highly folded and is made up of the Rough Endoplasmic Reticulum (rER) and Smooth Endoplasmic Reticulum (sER).

3.7.1 Rough Endoplasmic Reticulum

The rough endoplasmic reticulum **produces**, **transports** and **stores** proteins. It is attached to the nuclear membrane.

3.7.2 Smooth Endoplasmic Reticulum

The smooth endoplasmic reticulum **produces lipids and hormones**. Its enzymes also **help in detoxification**.

3.8 Golgi Apparatus

The Golgi Apparatus (or Golgi Body) is made of flattened sacs stacked on top of each other. The sacs are not connected in any way.

It **modifies, sorts** and **transports** proteins.

3.9 Mitochondria

Mitochondria (Singular: Mitochondrion) has a **double outer membrane** (See 3.13 - Single Membrane vs Double Membrane Organelles) and a **highly folded inner membrane**. It **releases energy from food substances**.

Note: Do NOT say "produce energy" as this violates the law of conservation of energy - energy cannot be created, or destroyed.

Review WS 5, Question 16 (b)

There are about 1700 mitochondria in the cell. Explain why there are a large number of mitochondria in the cell. [1]

Answer

Structure: Process + Explanation

Example: Protein synthesis [0.5 - Name process] requires energy/ATP [0.5 - Explanation] .

Review WS 5, Question 20 (c)

Describe how the structure of a mitochondrion enables it to carry out its function efficiently. [2]

Answer

Mitochondria have highly folded inner membranes [1].
This increases surface area [1] to volume ratio to increase the rate at which energy is released.

3.10 Chloroplasts

Chloroplasts contain **chlorophyll** and have a **double outer membrane** (See 3.13 - Single Membrane vs Double Membrane Organelles) and a **highly folded inner membrane**.

It **traps energy from sunlight** and **converts light energy to chemical energy** through **photosynthesis**.

3.11 Vesicles

Vesicles transport proteins around the cell and transport nutrients to be secreted.

3.12 Cytoplasm and Protoplasm

The Cytoplasm refers **to the organelles within** (but not including) **the cell membrane** together with the **cytosol**.
The Protoplasm refers to the living part of the cell (i.e. **The cytoplasm together with the cell membrane**)

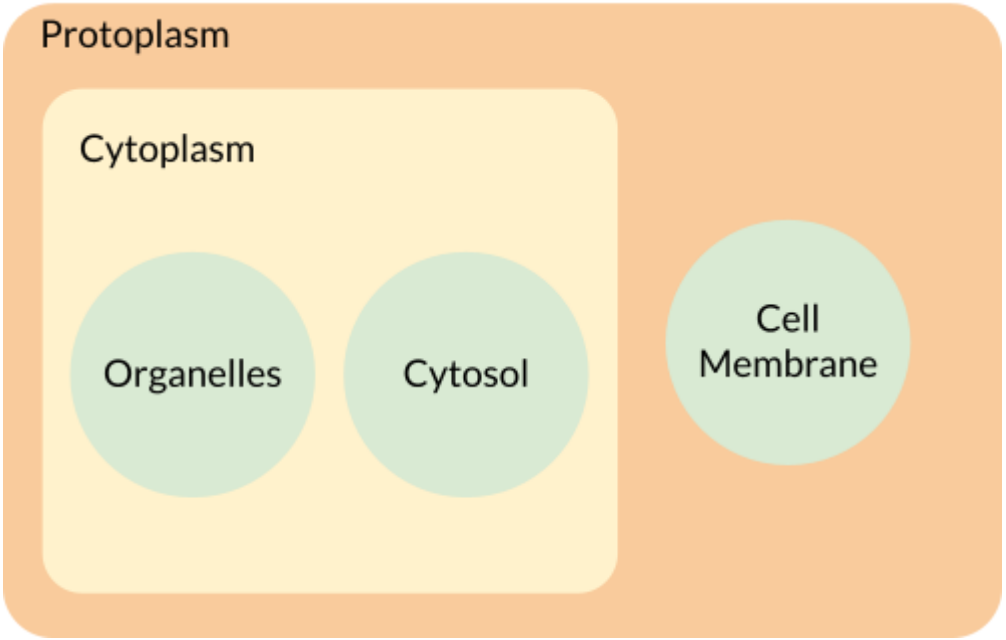


Diagram 3.11a

3.13 Single Membrane vs Double Membrane Organelles

Single Membrane Organelles	Double Membrane Organelles
Vesicles Food Vacuoles Transport Vacuoles Golgi Apparatus Endoplasmic Reticulum	Nucleus Chloroplasts Mitochondria

Table 3.12a

3.14 Organisation Levels in Cells

The Organisation Levels in Cells from the smallest to largest is:

Cell ⟶ Tissue ⟶ Organ ⟶ Organ System

Cells are the **smallest structural and functional unit of an organism**, which is typically microscopic and c**onsists of the cytoplasm and a nucleus enclosed in a membrane.**

Tissues are a group of cells with similar structures working together to **perform a shared function**.

Organs are **structures made of a group of tissues**, working together to **perform a specific function**.

Organ Systems are **groups of organs with related functions**, working together **to perform a body function**.

Topic 4: Movement of Substances

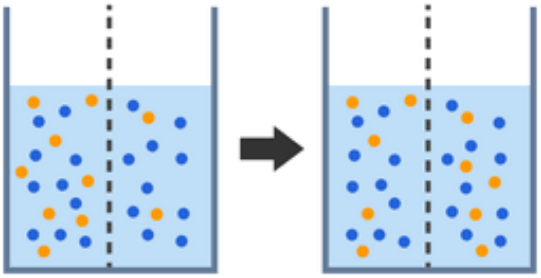
4.1 Diffusion

Let's talk about the most basic form of transport processes - diffusion.

4.1.1 What is Diffusion?

Diffusion is defined as the **net movement of molecules and ions from a region of their higher concentration to a region of their lower concentration down a concentration gradient**, as a result of their **constant random movement**.

4.1.2 How does Diffusion Look Like?



Refer to the diagram above. In the beaker on the left, there are less orange particles on the left side than the right side, so we say that the left side is a more **concentrated** solution of orange particles than the right.

Hence, by diffusion, as denoted by the arrow, the orange particles spread out to the other side, until there are about the same number of orange and blue particles on either side.

This is called **equilibrium**, and we say in the beaker on the right, **equilibrium has been reached**.

4.1.3 Factors Affecting Speed of Diffusion

Here are some factors affecting speed of diffusion

- Surface Area to Volume Ratio
- Temperature
- Concentration Gradient
- Diffusion Distance (i.e. distance molecules/ions have to diffuse over)
- Size of Molecules/Ions
- Diffusion Medium

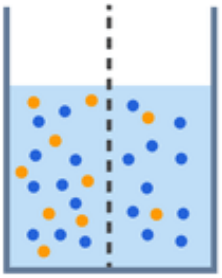
4.1.4 What Can, or Cannot Diffuse Across a Partially Permeable Membrane?

Smaller molecules, like Oxygen and Carbon Dioxide are able to diffuse across a membrane, while larger molecules, like proteins, fats, and carbohydrates, cannot.

4.2 Osmosis

Osmosis can be treated as a special case of diffusion.

4.2.1 Concentration, Tonicity and Water Potential



Refer to the beaker above. Let the left side of the beaker be A, and the right side be B. Let's focus on the orange particles.

Since there are more orange particles in A, we say A is more **concentrated** than B.

Similarly, we can say A is **hypertonic** to B, or that B is **hypotonic** to A.

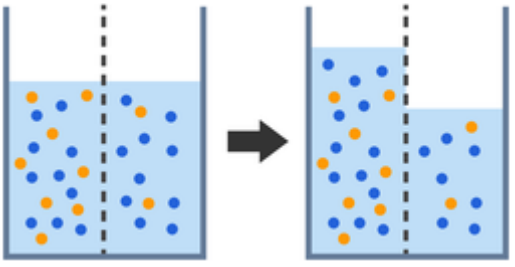
"hypertonic to" simply means "more concentrated than" and "hypotonic to" simply means "less concentrated than".

We can also say A has a **lower water potential** than B. If there are more orange particles in A, that means there must be less water in A than B. Hence, it has a **lower water potential**.

4.2.2 What is Osmosis?

Osmosis is the **net movement of water molecules** from a region of **higher water potential** to a region of **lower water potential**, through a **partially permeable membrane**, as a result of **its constant random movement.**

4.2.3 How does Osmosis Look Like?



Refer to the diagram above. Let the left side of the beaker be A and the right side be B. As discussed in 4.2.1 - Concentration, Tonicity and Water Potential, A has a lower water potential than B.

Hence, water is transported from B to A, through the **partially permeable membrane** (denoted by the dotted line), via osmosis.

Again, we can say **equilibrium** is reached.

4.2.4 Effects of Osmosis on Animal and Plant Cells

Here is what will happen to Animal and Plant Cells when osmosis causes too drastic of an effect.

Osmosis Function	Effect on Animal Cell	Effect on Plant Cell
Osmosis Draws Water Out	Crenated	Plasmolyse and turns flaccid
Osmosis Transports Water In	Burst	Expands and turns turgid

4.3 Active Transport

Active Transport is arguably the most different out of the 3 transport processes.

4.3.1 What is Active Transport?

Active Transport is the **movement of molecules or ions** through a **partially permeable membrane** from a region of its **lower concentration to higher concentration**, **up a concentration gradient**, using **energy obtained from cellular respiration**.

4.3.2 Common Uses of Active Transport

A common use of active transport is found in the roots of plants.

Nutrients from the soil are transported through a cell membrane **from a region of lower concentration (soil) to a region of higher concentration (cell)**, **using energy obtained from cellular respiration(ATP-**Adenosine triphosphate**)**.

Topic 5: Biological Nutrients (II) - Enzymes

5.1 What are Enzymes?

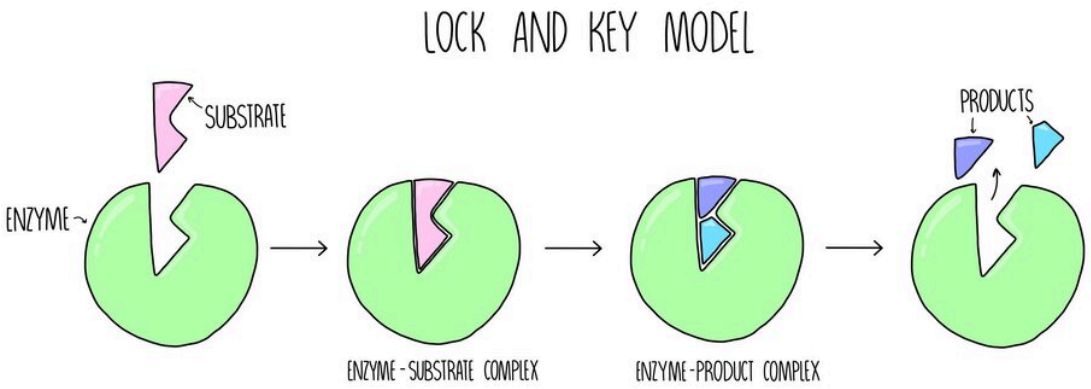
Enzymes are **biological catalysts**, which means they help to speed up reactions. They are **proteins** in nature.

There are two main models describing how enzymes work - the **Lock and Key Hypothesis** and the **Induced Fit Hypothesis**.

5.1.1 Substrate and Active Site

Enzymes have an **active site**, which is a **3-dimensional structure**. The active site can be thought of as the keyhole of your door's lock, and the **substrate** is simply the key in this case, which is what fits into the **active site.**

5.2 Lock and Key Hypothesis

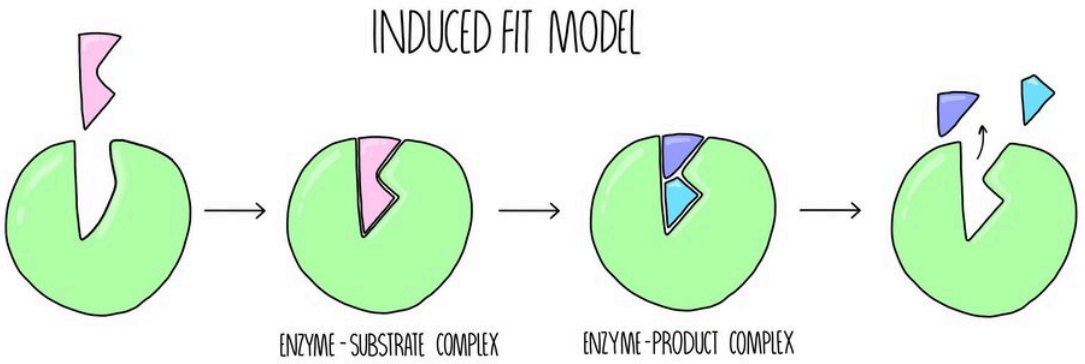


The **Lock and Key Hypothesis** asserts that enzymes have a **specific active site structure** that **will not change shape** throughout the reaction.

When the Substrate fits into the Enzyme, it forms an **Enzyme-Substrate Complex**.

The reaction then occurs, forming new **Products** from what was the **Substrate**. Then, these products are released, and the enzyme can then be re-used for the same reaction again.

5.3 Induced Fit Hypothesis



The **Induced Fit Hypothesis** asserts that enzymes have an **active site which changes shape slightly** to fit the **substrate**.

When the Substrate fits into the Enzyme, an **Enzyme-Substrate Complex** is formed.

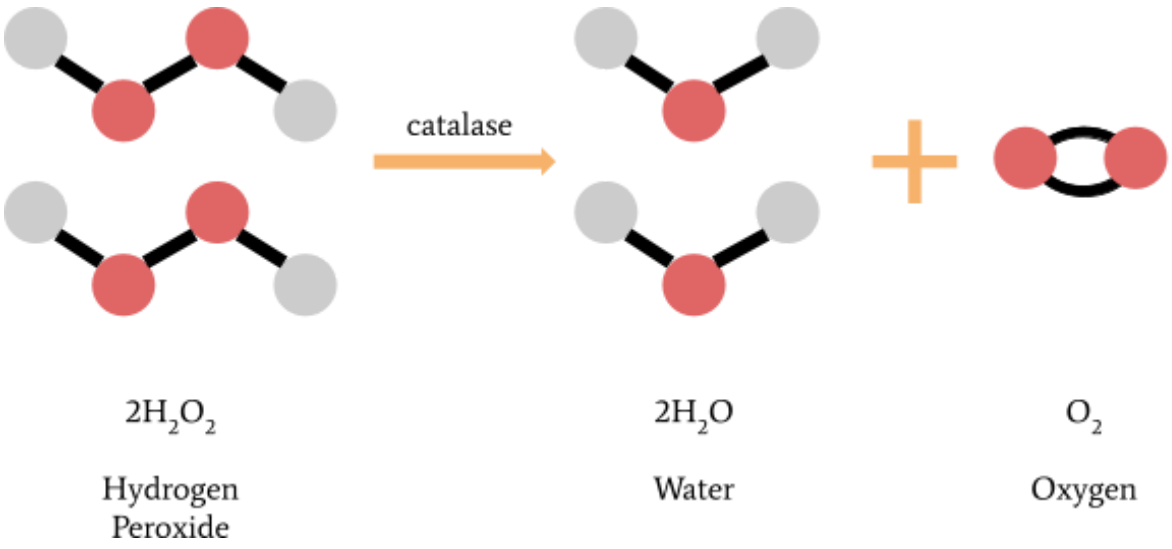
The reaction then occurs, forming new **Products** from what was the **Substrate**. Then, these products are released, and at the same time the shape of the active site changes back to before the reaction occurred.

Then the enzyme can be re-used for the same reaction again.

5.4 Catalase

Catalase is an enzyme found in our liver.

It detoxifies and breaks down harmful **Hydrogen Peroxide** into harmless **Oxygen** and **Water**.



5.5 Denaturation of Enzymes

Under certain **extreme conditions**, an enzyme will become **denatured**.

These conditions are:

1. **Heat** - When you heat an enzyme to a certain point, it becomes **denatured**.
2. **pH** - When you expose an enzyme to a strong acid or base, it becomes **denatured**.

Now, what is **denaturation**? An enzyme is denatured when it **loses its active site's shape**, as it unfolds into its **primary structure**.

When this happens, enzymatic reactions can **no longer** occur, since the **enzyme can no longer fit with the substrate**.

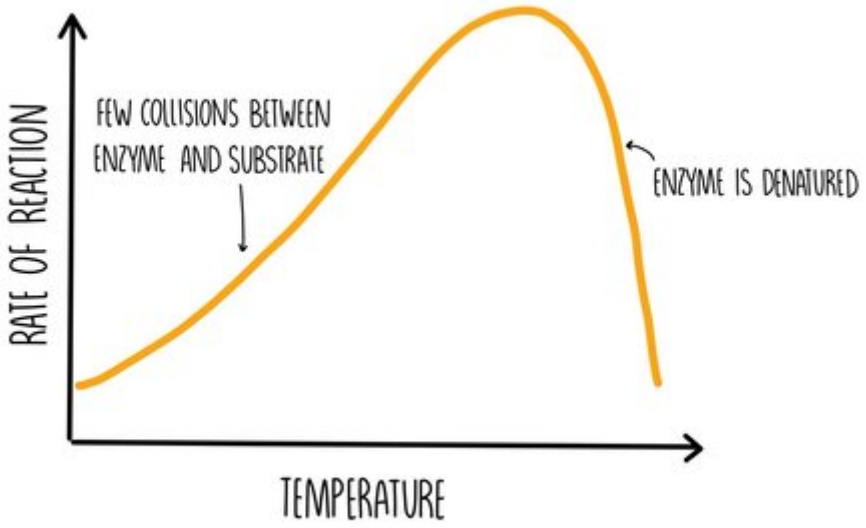
5.6 Anabolic and Catabolic Reactions

An **Anabolic Reaction** ("building up" reaction) is one where multiple substrates are combined together to form a larger product.
A **Catabolic Reaction** ("breaking down" reaction) is one where a single substrate is split into multiple smaller products.

5.7 Factors Affecting Rate of Enzymatic Reaction

There are two main factors affecting the rate of enzymatic reaction - Temperature and pH.

5.7.1 Temperature

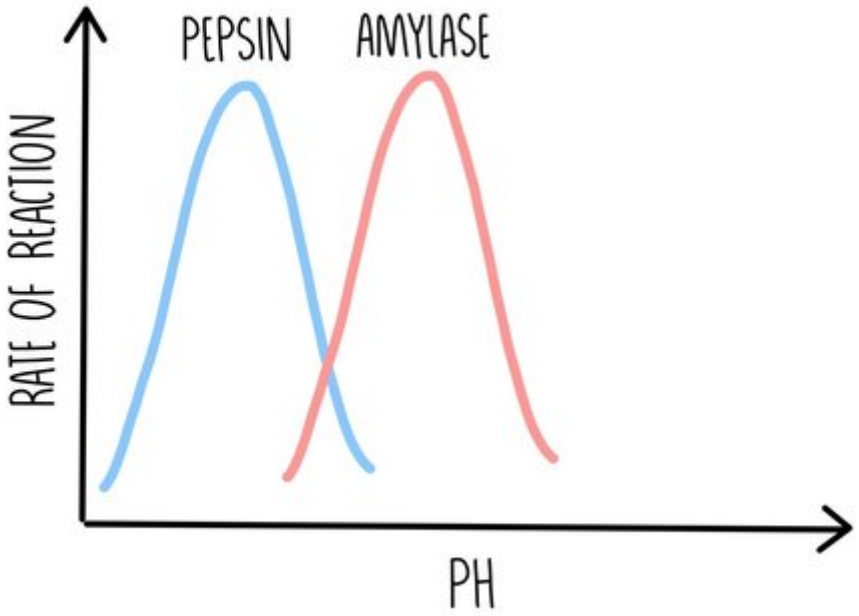


Refer to the diagram above. Most enzymes have a rate of reaction against a temperature graph that looks something like this.

As the temperature increases from the left-most point to the peak, since there is more energy in the environment, the **kinetic energy within the environment increases**, so the **number of collisions between enzymes and substrates increases**.

On the contrary, from the peak to the right-most point, **denaturation occurs**, so enzymes do not work well anymore.

5.7.2 pH

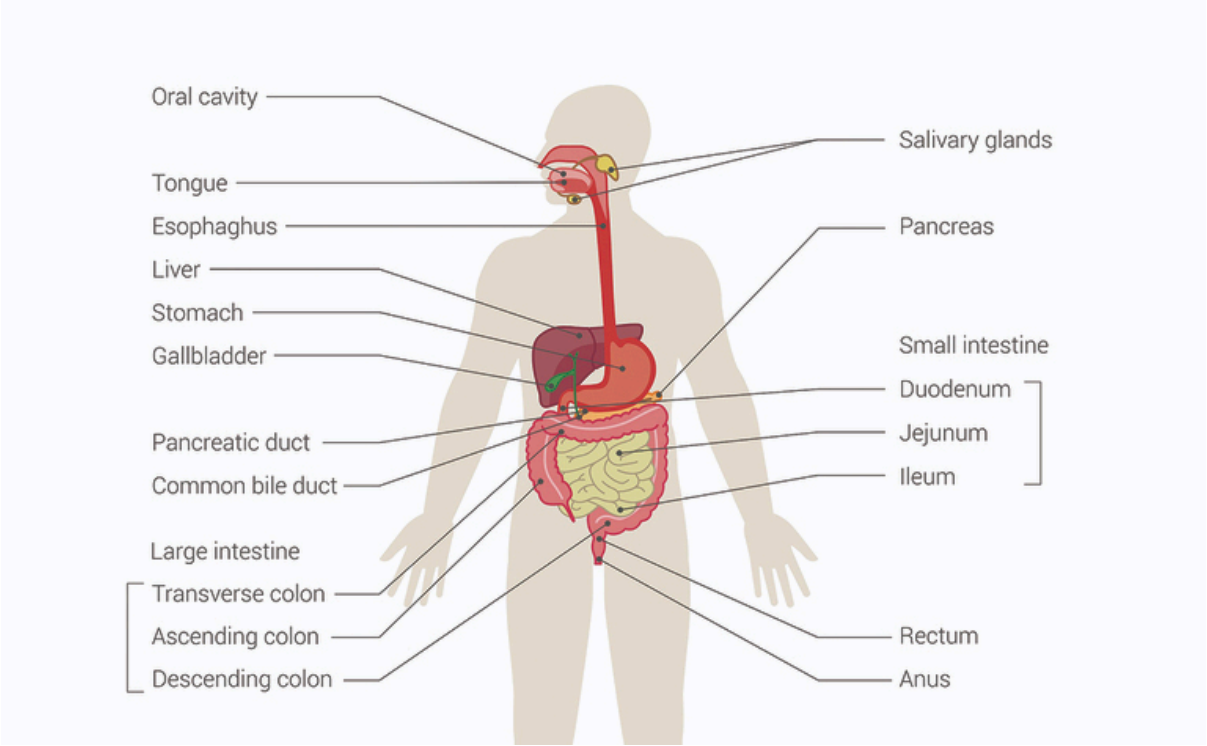


Pepsin and Amylase are the names of 2 enzymes, which will be covered under Topic 6: Nutrition in Animals.

However, as you can see, different enzymes have different peaks of rate of reaction, so this means that different enzymes work better at different pHs.

The pH where the peak is located is called the **optimum pH level** of the enzyme.

Topic 6: Nutrition in Animals



Note: Image not from syllabus, these are not the tested organs - some are not included, some are additional.

6.1 Chemical vs Physical Digestion

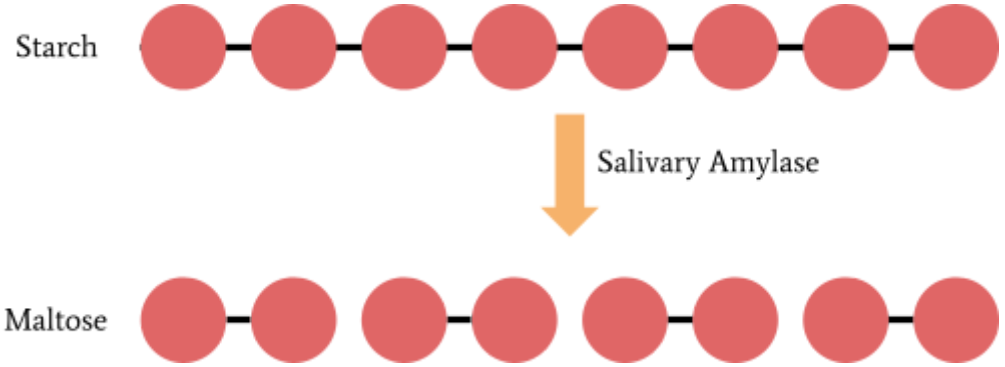
Chemical Digestion refers to **digestion using enzymatic reactions**.
Physical Digestion simply refers to **mechanically breaking down food**.

6.2 Carbohydrates and Enzymes

Recap: 2.1 Carbohydrates

6.2.1 Mouth

In the mouth, salivary amylase breaks down **Starch** into **Maltose**.

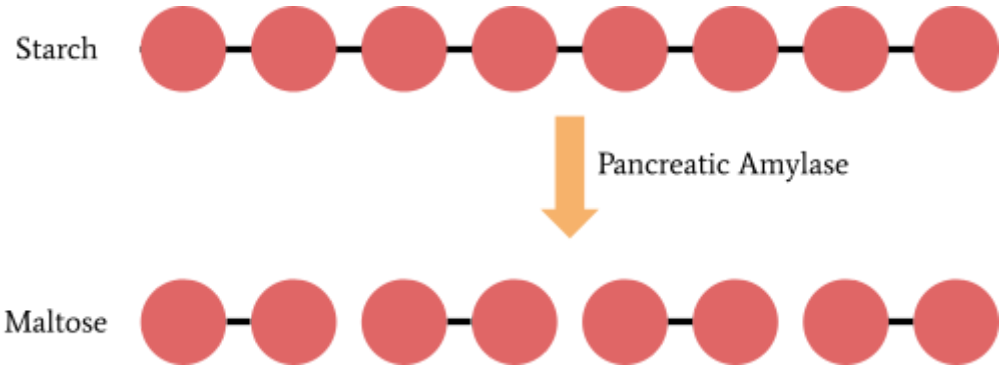


Do note that it is good practice to write “salivary amylase” to be more specific as to where the amylase is secreted from.

6.2.2 Small Intestine (Pancreatic Juices)

In the Pancreatic Juices, **pancreatic amylase** is present.

Hence the same reaction occurs, with pancreatic amylase breaking down **Starch** into **Maltose**.



6.2.3 Small Intestine (Intestinal Juices)

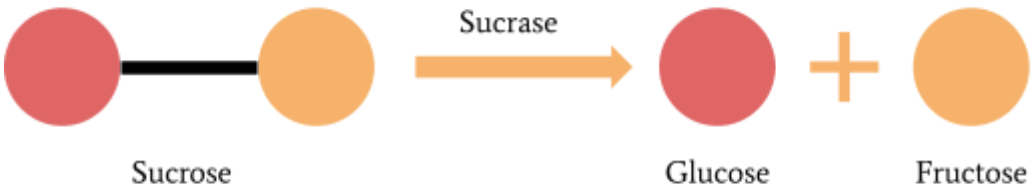
In Intestinal Juices, the enzymes **maltase, sucrase** and **lactase** are present.

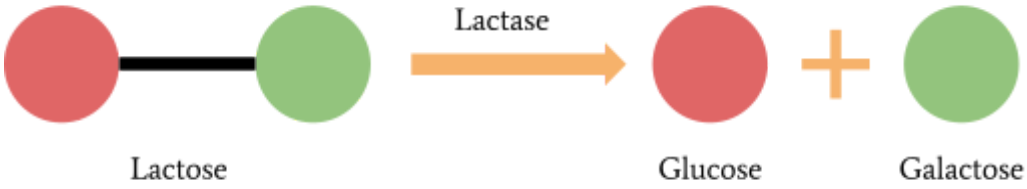
Tip: You may have noticed by now that many enzymes’ names end with -ase.

Here is the equation for Maltase:

Note: This equation is not fully balanced. Refer to 2.1.5 Breaking Down of Disaccharides for the balanced equation, but you just need to know this simpler equation here.

Here are the other two equations for Sucrase and Lactase respectively.





We can also observe that **Malt<u>ose</u>** corresponds to **Malt<u>ase</u>**;
Sucr<u>ose</u> corresponds to **Sucr<u>ase</u>**; and
Lact<u>ose</u> corresponds to **Lact<u>ase</u>**.

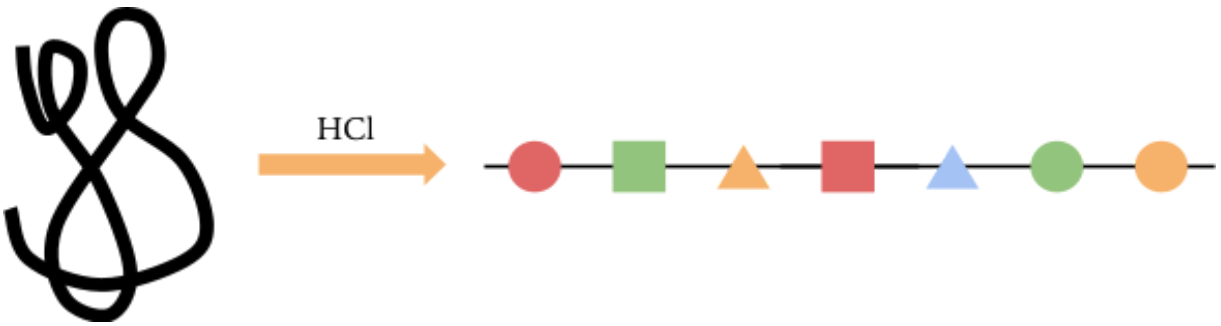
6.3 Proteins and Enzymes

Recap: 2.3 Proteins

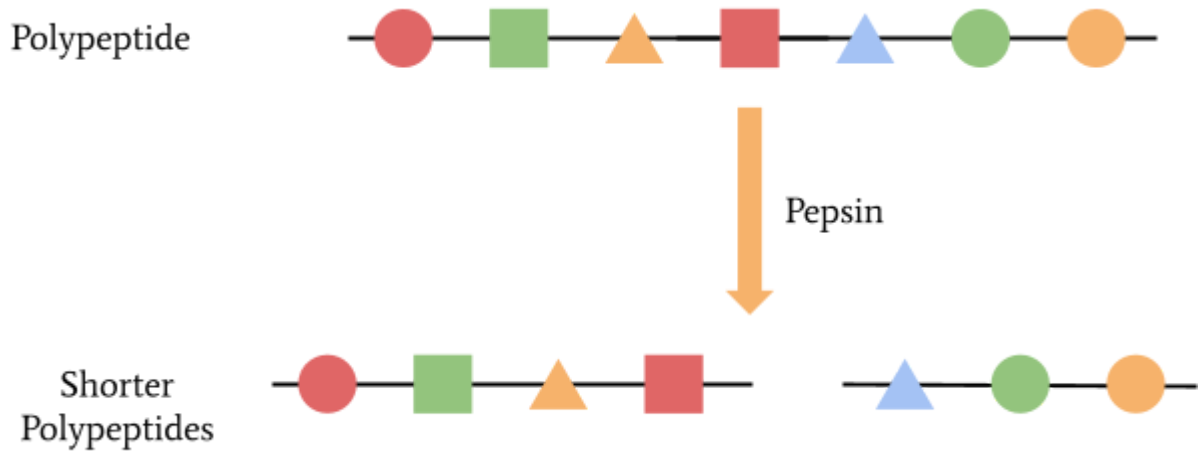
6.3.1 Stomach

First, in the stomach, inactive **Pepsinogen** is activated using **hydrochloric acid** into active **Pepsin**.

Then, we unfold a protein into its primary structure (i.e. polypeptide), also using **hydrochloric acid**.

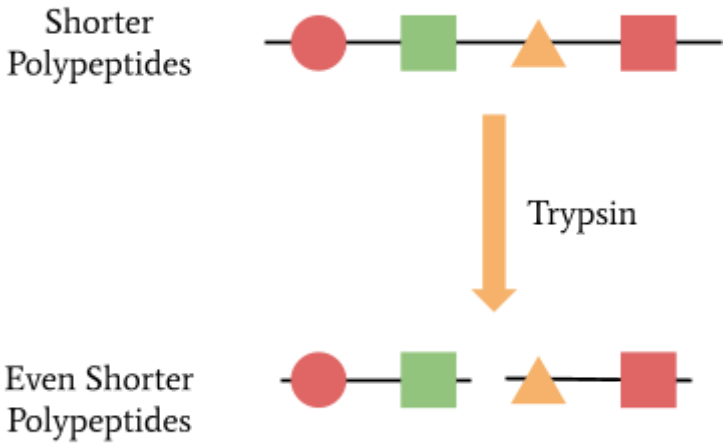


Then, **Pepsin** breaks the polypeptide down into **shorter polypeptides.** (There exists more specific names, but not tested)



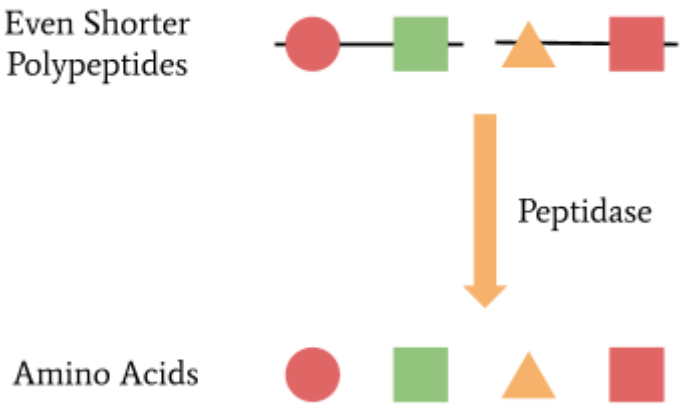
6.3.2 Small Intestine (Pancreatic Juice)

Trypsin is found in Pancreatic Juice, and it breaks down the shorter polypeptides down into **even shorter polypeptides**. (Again, a more specific name exists, but not tested)



6.3.3 Small Intestine (Intestinal Juice)

Peptidase is found in Intestinal Juice, and it breaks down the even shorter polypeptides down into **amino acids**.

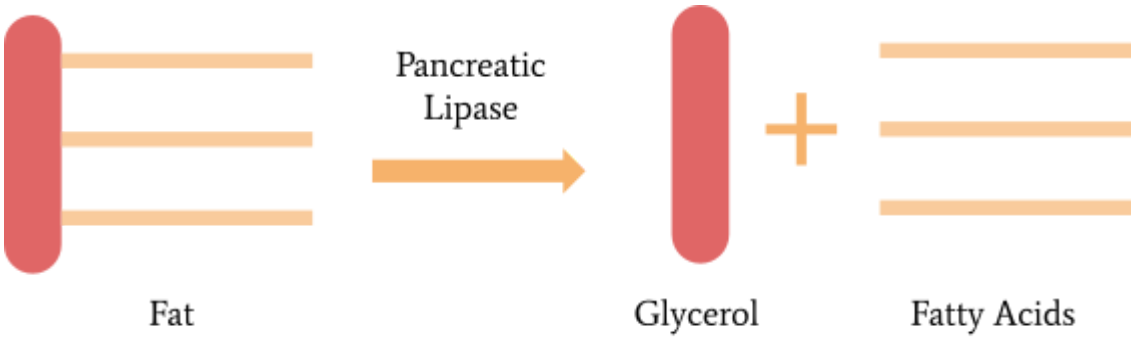


6.4 Fats and Enzymes

Recap: 2.2 Fats

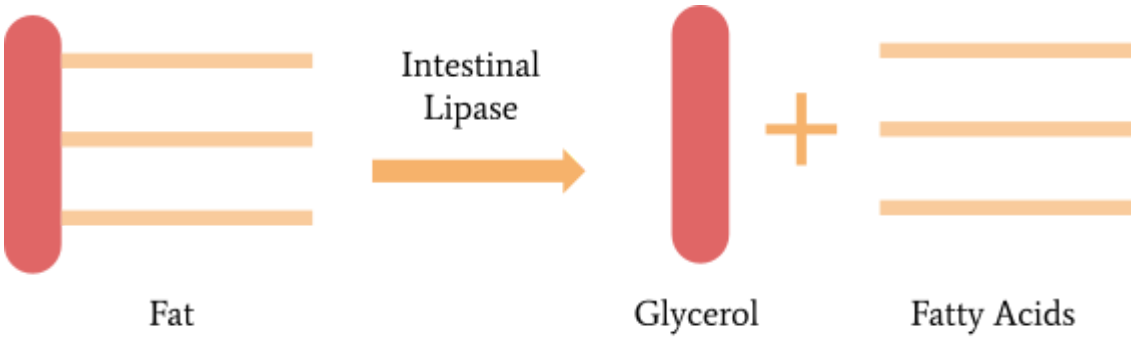
6.4.1 Small Intestine (Pancreatic Juice)

Pancreatic Lipase is present in the pancreatic juice, which breaks down fats into **glycerol** and 3 **fatty acids**.



6.4.2 Small Intestine (Intestinal Juice)

Similarly, **Intestinal Lipase** is present in the pancreatic juice, which breaks down fats into **glycerol** and 3 **fatty acids**.



6.5 Physical Digestion

6.5.1 In the Mouth

Teeth in the mouth **grind food** and **break them into smaller pieces** to increase **Surface Area to Volume Ratio** to speed up **Chemical Digestion** by enzymes.

Mucus in saliva **softens food** and **makes it easier to swallow** by providing lubrication.

Tongue rolls the food into a **round ball** called a **bolus** and **pushes the bolus to the back of the mouth**.

6.5.2 In the Stomach

Churning action by the **stomach muscles** further breaks food **into smaller pieces** to increase **Surface Area to Volume Ratio** to speed up **Chemical Digestion** by enzymes.

Gastric Juice (comprising HCl, water, pepsin) forms **Chyme** when mixed with **smaller food pieces**.

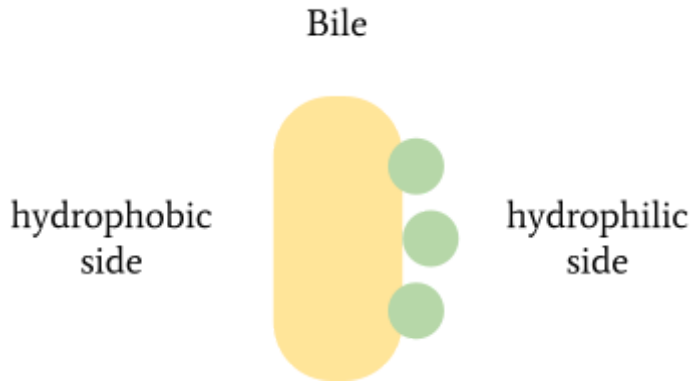
Mucus **contains bicarbonate ions** to **neutralise HCl** to prevent self-digestion of the stomach lining by HCl.

6.5.3 In the Small Intestine (Emulsification)

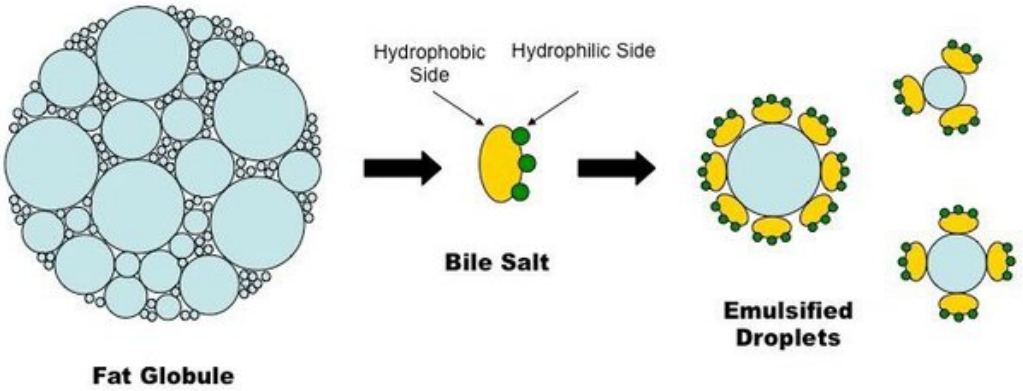
The **Liver** produces **bile**, a liquid stored in the **gall bladder**, which is then transported to the **Small Intestine** to be secreted.

Bile emulsifies fats, meaning it separates it into **smaller droplets**.

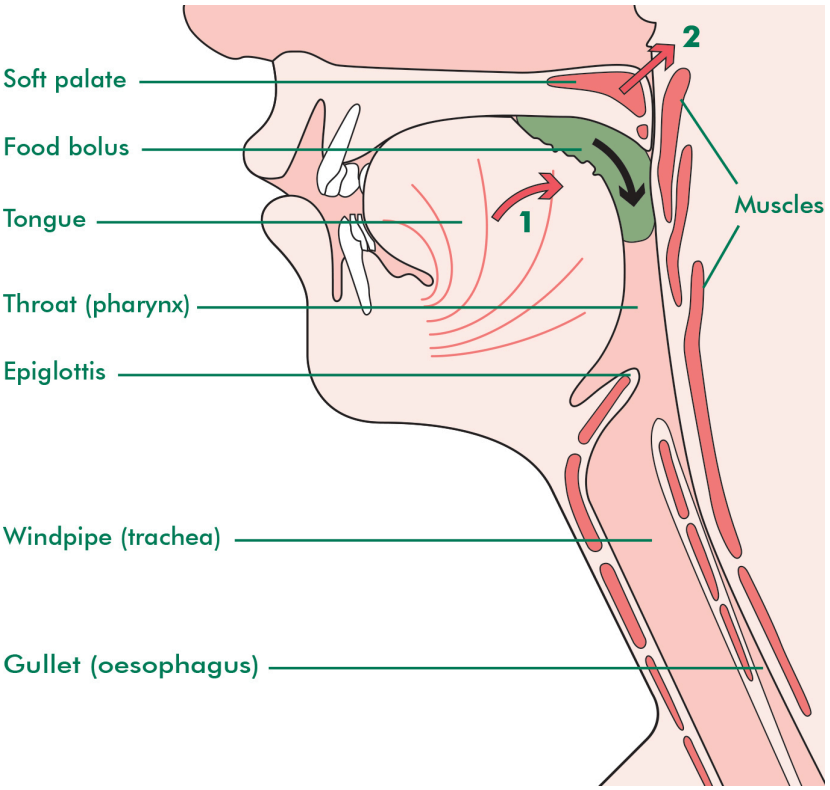
Bile comprises a **hydrophobic** (i.e. water-repelling) side and a **hydrophilic** (i.e. water-loving) side.



The bile then separates the larger fat droplets into smaller fat droplets.



6.6 Swallowing in the Mouth



Above is an image of a person swallowing a food bolus.

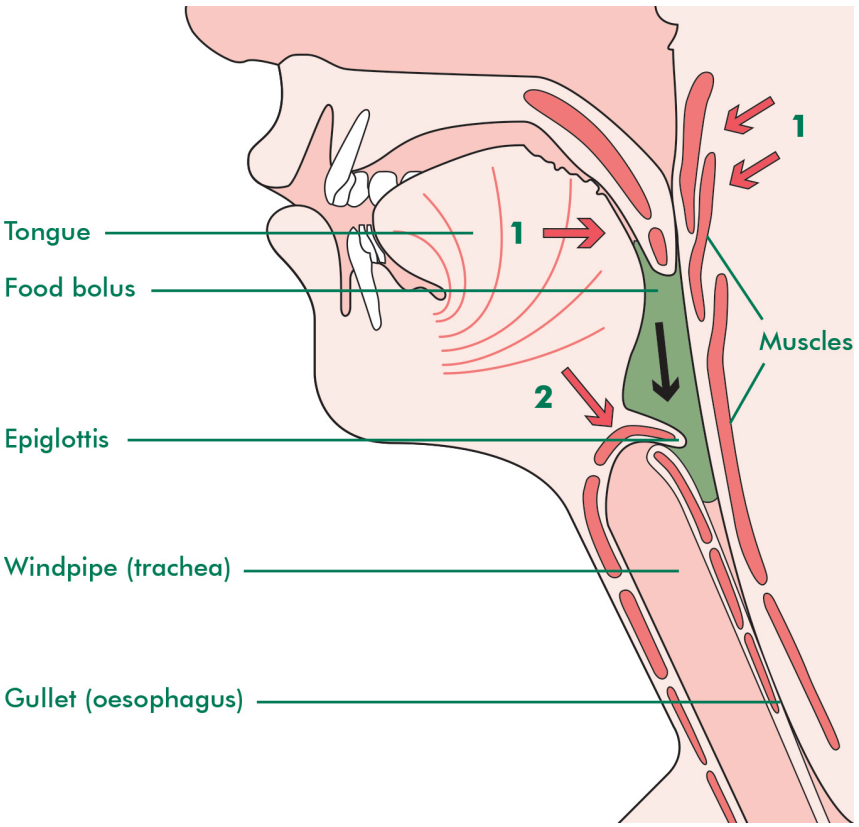
As you swallow, the **epiglottis** (which is like a "flap") **moves down** to block the trachea (i.e. windpipe).

This is to prevent food from entering the trachea and causing you to choke to death. (which is not good oh wait its exam season maybe it's not that bad after all FOR LEGAL REASONS THIS IS A JOKE)

This is also why we cannot breathe while swallowing at the same time.

While we swallow, the **larynx** ("voice box") **moves up, then down**.

Tip: If you can't remember whether the larynx goes up or down first, you can put your hand up to your larynx and swallow to see how it moves.



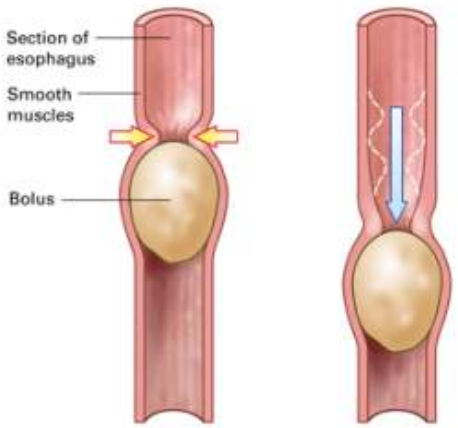
6.7 Peristalsis

Woah, fancy name!

Despite the seemingly complex name, peristalsis simply means "pushing food bolus down the gullet". It also occurs in the **Small Intestine** and **Large Intestine**, where similar functions are applied.

It also occurs in the **Stomach**, where it helps to churn the food, breaking it into smaller pieces and mixing the contents of the stomach.

The gullet (or oesophagus) consists of two layers of muscles, the **longitudinal muscles** on the outside and the **circular muscles** on the inside.



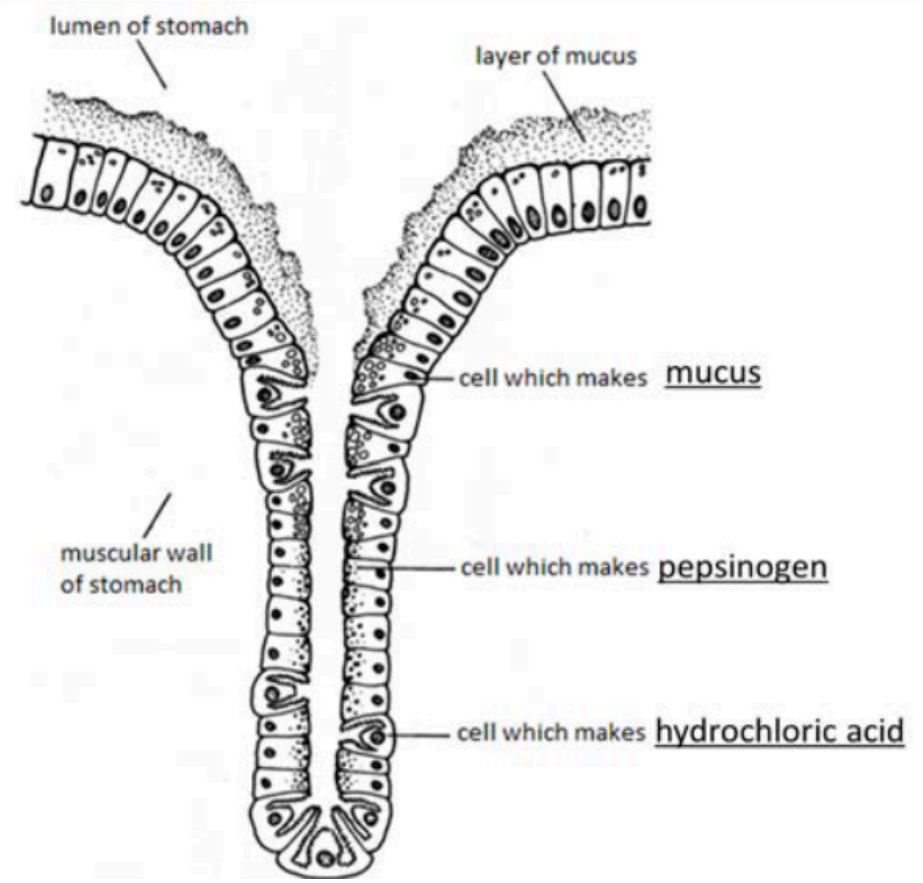
For Peristalsis to occur, the circular muscles behind the food bolus **contract**, while the longitudinal muscles behind the food bolus **relax**, making the **lumen** (you can think of as empty space) smaller.

Similarly, the circular muscles in front of the food bolus **relax**, while the longitudinal muscles in front of the food bolus **contract**, making the **lumen** larger.

This allows the food bolus to move down the gullet.

Tip: The longitudinal muscles and circular muscles always work in **opposite directions**.

6.8 Gastric Pit in the Stomach



Above is the structure of a Gastric Pit in the stomach, which is what contains the 3 types of cells that secrete **mucus, pepsinogen and hydrochloric acid**.

Topic 6.2 Oesophagus, Stomach Notes, 6.4.3 (i)

Why is pepsin first secreted in an inactive form, pepsinogen?

Answer:

So that the pepsin does not digest the proteins in the cells and thus damage the cells which secreted it.

6.9 Accessory Organs

Accessory Organs are organs that are **not on the main digestive track**, but **aid in digestion** in other ways.

The main accessory organs are:

1. Liver
2. Gall Bladder
3. Pancreas

6.10 Structure of Small Intestine

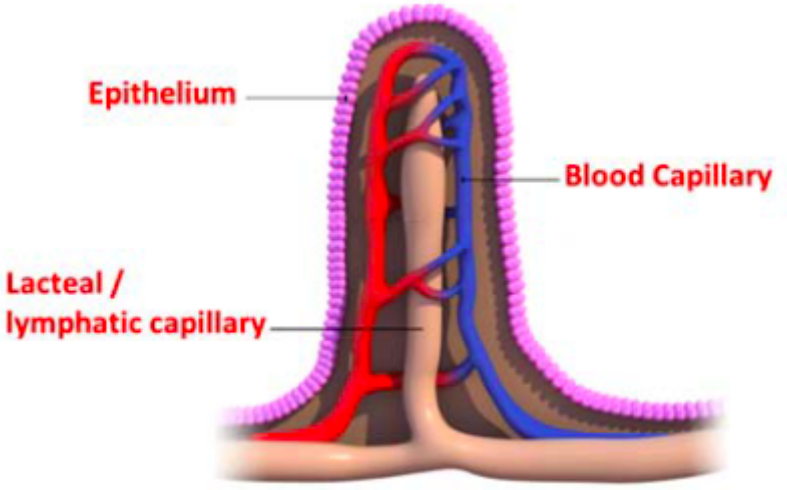
The small intestine has 3 main adaptations to increase **Surface Area to Volume Ratio**.

Firstly, the small intestine has **large circular folds**.
Secondly, the small intestine has **numerous villi**, which are like little brushes on its surface.
Lastly, the small intestine also has **numerous microvilli** located on the villi, which are like the brush hairs of the brushes on its surface.

These adaptations increase **Surface Area to Volume Ratio** to increase **rate of absorption of digested food**.

6.10.1 Inside the Villus

Note: Villus is the singular form of Villi.



After digestion as covered in 6.2 Carbohydrates and Enzymes and 6.3 Proteins and Enzymes, Simple Sugars (glucose, fructose, galactose) and Amino Acids are absorbed into the small intestine's blood capillaries by diffusion.

Topic 6.13 Absorption and Assimilation Notes, Section 3b, 1(a)

Examine the structure of a villus in the small intestine. How is the epithelium adapted for the absorption of food substances?

Answer

The epithelium is one cell thick which allows for a short **diffusion distance** to increase the rate of diffusion.

Topic 6.3 Absorption and Assimilation Notes, Section 3b, 1(b)

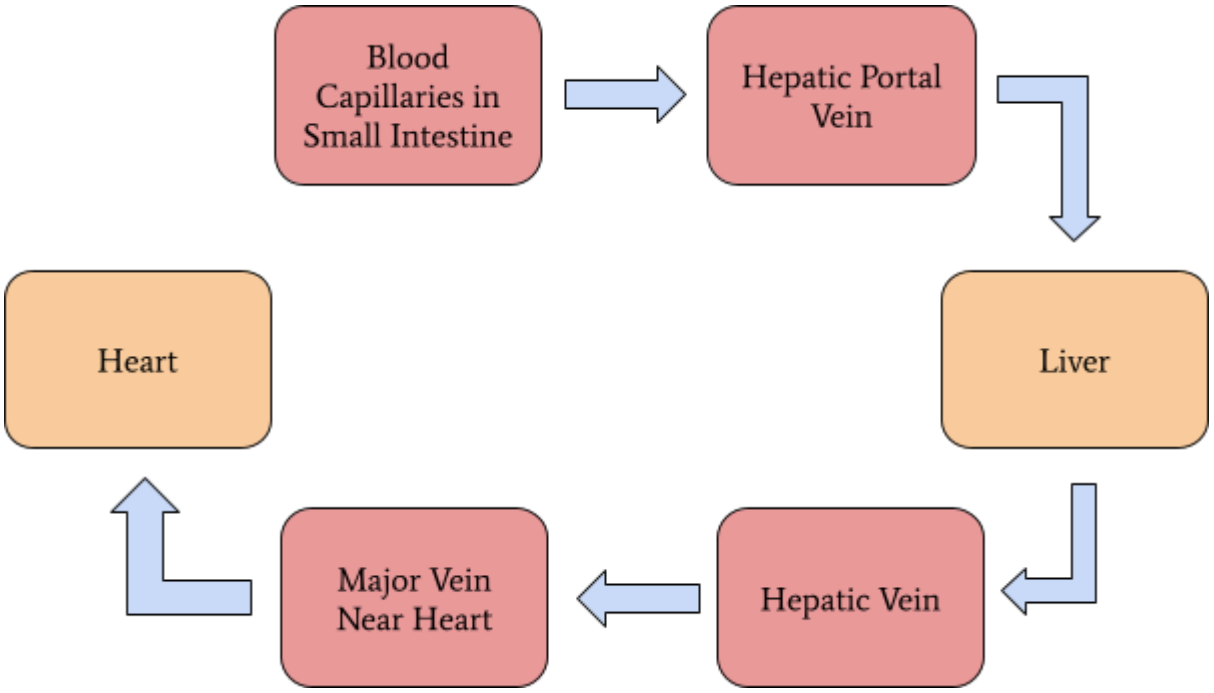
The villus is richly supplied with blood capillaries. How does this help to maintain a concentration gradient for the absorption of digested food substances?

Answer

The continuous flow of blood through the capillaries transports the absorbed food substances away from the villi quickly. This maintains the diffusion gradient.

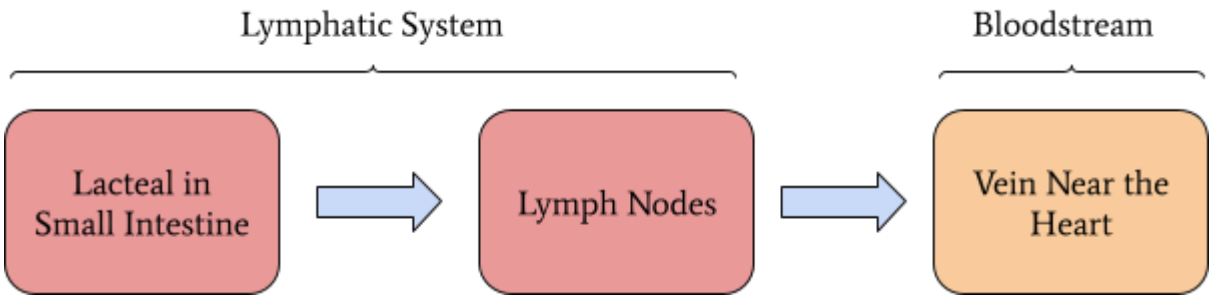
Fats, on the other hand, are absorbed into the **lacteal** (also known as lymphatic capillary) instead of the blood capillaries.

6.11 Journey of Amino Acids and Simple Sugars



6.12 Journey of Fats

Fats start in the lymphatic system after absorption, and then they eventually enter the bloodstream.



After going through a series of blood vessels, the fats eventually end up in the liver through the **hepatic artery**.

6.13 Assimilation

Assimilation is the process where absorbed food substances are used to build new protoplasm or to provide energy.

Different Substances are used for different things:

- Glucose is used as a **source of energy**;

- Fats are converted to **cholesterol** in the liver;
- Fats and amino acids are used to **build protoplasm;**
- Excess glucose is stored as **glycogen** in the liver;
- Excess amino acids are **deaminated** in the liver; and
- Excess fats are **stored**

6.14 Functions of the Liver

The liver has many functions.

6.14.1 Regulation of Blood Glucose Levels

When blood glucose levels are too high, a hormone, **insulin**, is secreted, which stimulates the liver into storing the **excess** glucose as **glycogen**, reducing the blood glucose levels.

When blood glucose levels are too low, a hormone, **glucagon**, is secreted, which stimulates the liver into converting the stored **glycogen** back into **glucose**, increasing the blood glucose levels.

6.14.2 Production of Bile

The liver produces bile, which is stored in the **gall bladder**, and secreted in the **small intestine** to emulsify **fats**.

6.14.3 Protein Synthesis

Protein Synthesis is the manufacturing of **proteins** and is what allows blood clotting to occur to stop bleeding when you injure yourself.

6.14.4 Iron Storage

Iron found in Haemoglobin, which is broken down in the liver, will be stored in the liver.

6.14.5 Detoxification

The liver converts harmful substances like **alcohol** into non-harmful substances.

6.14.6 Deamination

The **amino groups** of **excess amino acids** are converted into **ammonia**, then **urea**, and excreted from the body as **urine**.

6.14.7 Storage of Cholesterol

The liver stores **excess fat** as **cholesterol.**

6.15 The Large Intestine, Rectum, Anus

The **Large Intestine** further absorbs **water** and **mineral salts**.
The **Rectum** stores **faeces**.
The **Anus** egests **faeces**.

Topic 7: Nutrition in Plants

7.1 Conditions for Photosynthesis

Familiar, right? Sounds like PSLE trauma? Me too.

The conditions for photosynthesis to occur are:

- Light
- Chlorophyll
- Carbon DIoxide
- Water
- Sustainable Temperature

7.2 Light and Dark Stages of Photosynthesis

Hmm… not so familiar anymore…

Photosynthesis is a **two-part** process, consisting of:

1. Light Stage (Light-dependent)
2. Dark Stage (Light-independent)

7.2.1 The Light Stage

As we know, chlorophyll absorbs light energy.

The light energy is then used to split water into **oxygen gas** and **hydrogen atoms**, which is called **photolysis**. *[FYI: Photo - Light; lysis - Break down]*

The light energy is also **stored as chemical potential energy**.

7.2.2 The Dark Stage

The dark stage is where the **hydrogen** atoms produced by the **photolysis of water**, with **carbon dioxide,** is used to form **glucose** and **water**, through **enzyme-controlled reactions** and using the **chemical potential energy**.

7.3 Wavelengths of Light and Photosynthesis

As you *(hopefully)* know from PC1131, leaves appear green because they **reflect green light**.

By coincidence, green light also **induces the lowest rate of photosynthesis**.
On the contrary, **violet-blue** and **red** lights induce the **highest rate of photosynthesis**.

7.4 Fate of Glucose

Glucose can be:

1. Used for **respiration** to **release energy;**
2. Converted to **sucrose** to be **transported** to other parts of the plant;
3. Converted into **cellulose** to form cellulose cell walls; or
4. Converted into **fats or proteins**.

Excess glucose can also be **stored as starch**.

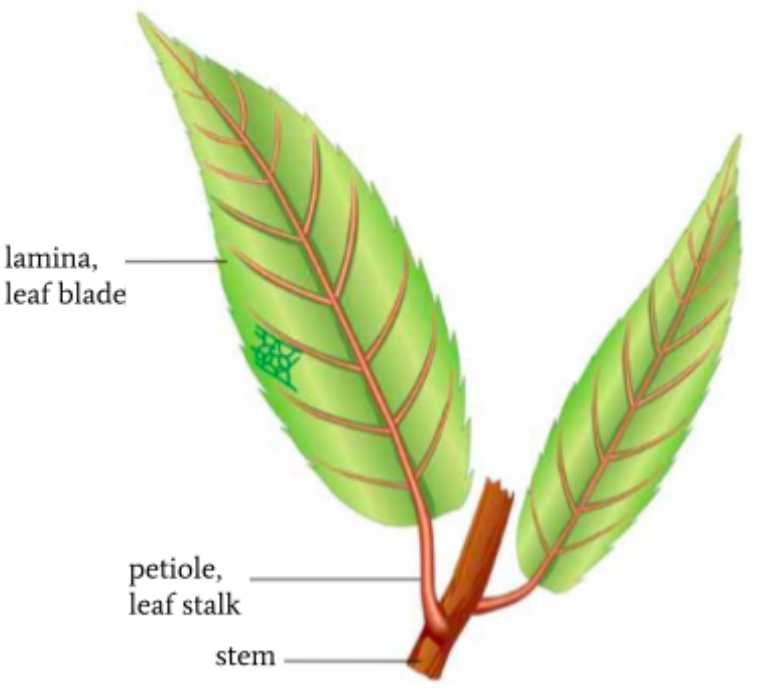
7.5 Additional Minerals Required by the Plant

The plant also requires **nitrate** and **magnesium** to survive, which can be obtained from the soil.

Nitrate is used to make **amino acids**, which are eventually used to **build proteins**.

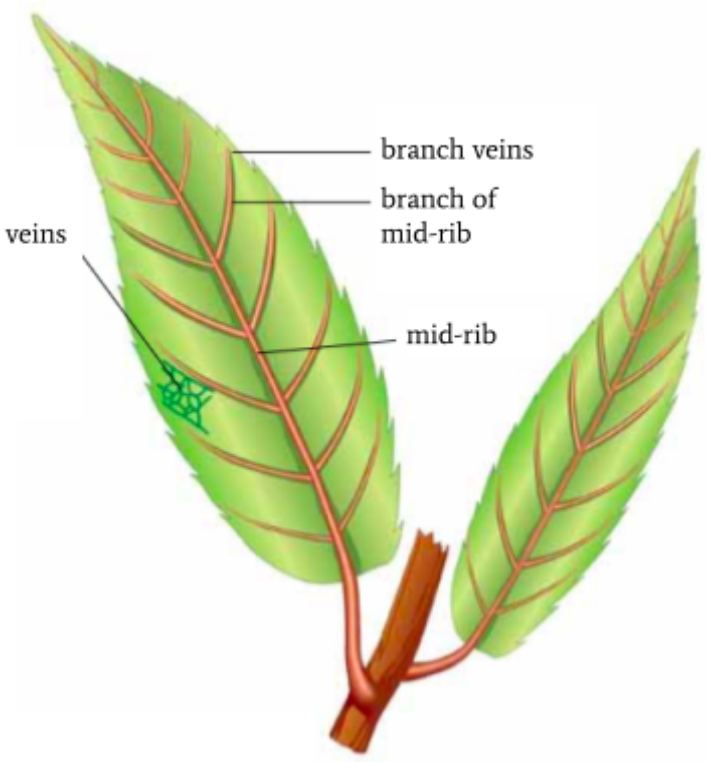
Both Nitrate and Magnesium are also involved in the composition of **chlorophyll**.

7.6 Non-aquatic Leaf Structure and Function



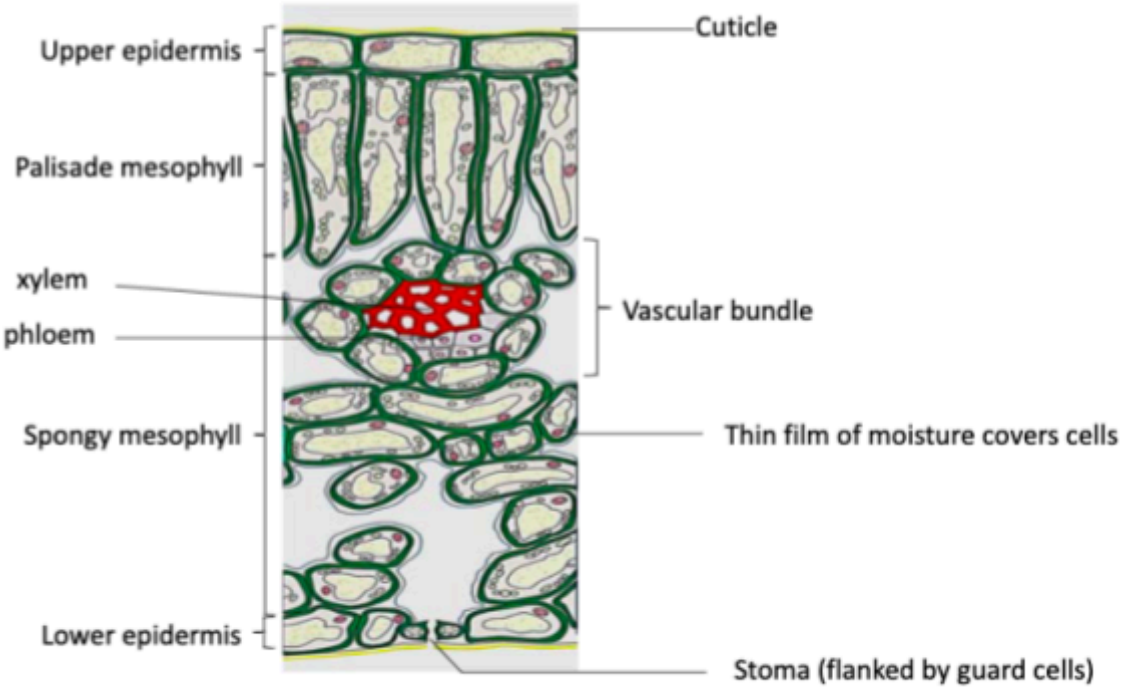
The **Lamina** (or leaf blade) has a large **Surface Area to Volume Ratio** to maximise the **absorption of sunlight** and to allow **rapid diffusion of carbon dioxide** to reach the inner cells of the leaf.

The **Petiole** (or leaf stalk) positions the **lamina** in a way to **optimise the lamina's function.** (maximum absorption of sunlight, maximum gaseous exchange rate)



The **Veins** (including mid-rib, branch veins, etc.) transport **water and mineral salts** to the cells in the lamina, which originate from the roots.

Similarly, they also transport **manufactured food** from the leaves back to other parts of the plant.



Above is an image of the transverse section of a leaf.

On the **Upper Epidermis**, there is a **waxy layer**, known as the **cuticle**.
The **cuticle prevents excessive water loss**, and **is transparent to allow sunlight to reach the mesophyll**.

The **palisade mesophyll** and **spongy mesophyll** have chloroplasts in them, which allows **photosynthesis** to occur.

7.7 Palisade vs Spongy Mesophyll

Palisade Mesophyll	Spongy Mesophyll
Long	Irregular
Closely Packed	Loosely Packed
More Chloroplasts	Fewer Chloroplasts
Allow Maximum Absorption of Light	Create Intercellular Air Spaces for Rapid Diffusion of Gases inside the Leaf
Carry Out Photosynthesis	

7.8 Stomata and Guard Cells

During the day, K^+ (potassium) concentration increases, **lowering the water potential** of the cell sap, so water enters the guard cells by **osmosis**.

This causes the guard cells to **swell and become turgid**.

The uneven cell wall of the guard cells causes them to **become curved on expansion**, **pulling open** the stoma.

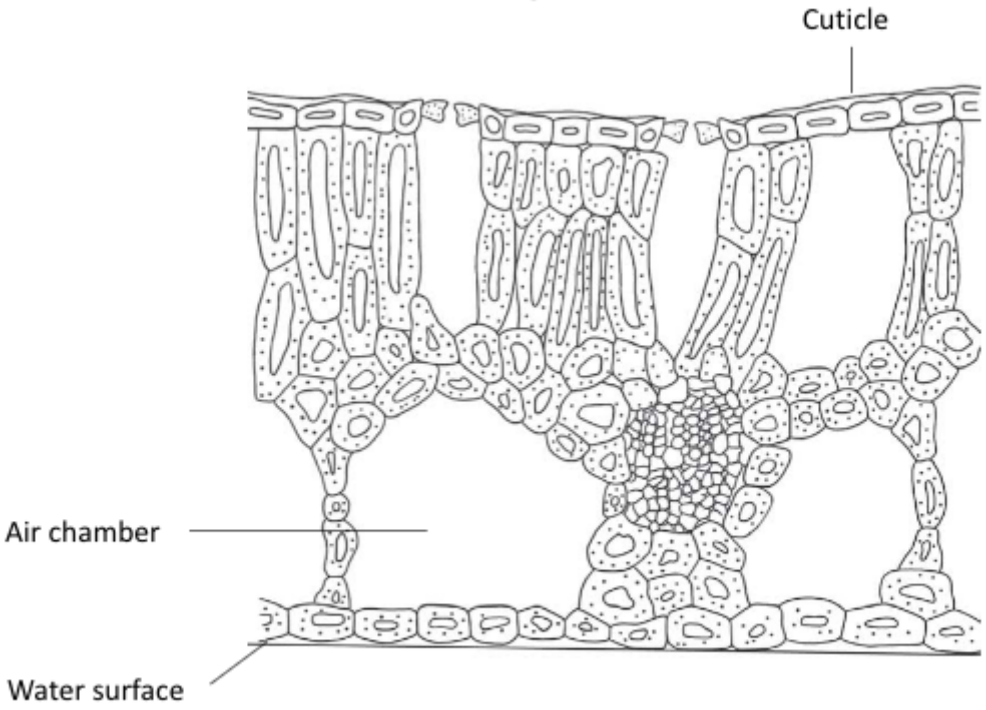
At night, K^+ concentration decreases, **increasing the water potential** of the cell sap, so water leaves the guard cells by **osmosis**.

This causes the guard cells to **become flaccid**, **closing the stoma**.

7.8.1 Substances Entering and Leaving the Stomata

	In the day	At night
Entering	CO_2	Stomata Closes
Leaving	O_2 and water vapour	

7.9 Aquatic Leaf Structure



7.9.1 Differences Between Aquatic and Typical Leaf

BL1131 Topic 7, Task 3 Comparison of Land and Aquatic Internal Leaf Cells, Q1

Name 2 ways in which the leaf structure differs from that of a typical leaf.

Answer

There are air chambers in the aquatic cell even amongst the palisade mesophyll cells.

The stomata of an aquatic leaf is on the upper epidermis instead of the lower epidermis.

7.9.2 Function of Air Chambers

BL1131 Topic 7, Task 3 Comparison of Land and Aquatic Internal Leaf Cells, Q3, Q4

Name two functions of the air chambers.

Answer

Air chambers provide **buoyancy** for the leaves to **float** in water, which enables the leaves to **obtain sufficient sunlight** and **carbon dioxide** for **photosynthesis**.

Air chambers **store carbon dioxide produced at night during respiration for photosynthesis** in the daytime. They also **store oxygen produced during photosynthesis in the daytime to be used for respiration** at night.

7.10 Entry of Carbon Dioxide into the Leaf

During the day, Carbon Dioxide is rapidly used up in the leaf, so the concentration of Carbon Dioxide inside the leaf is lower than that outside the leaf.

By **diffusion**, Carbon Dioxide diffuses into the leaf via the **stomata**.

The Carbon Dioxide dissolves in the **thin film of water** present on the **surface of the mesophyll cells** and diffuses into the cells.

The Carbon Dioxide can then diffuse between cells inside the leaf.

7.11 Entry of Water into the Leaf

The xylem transports water from the roots of the plant into the **leaf**. Water then leaves the xylem and moves from cell to cell by **osmosis**.

7.12 Limiting Factors and Factors Affecting Photosynthesis

A **limiting factor** is defined as any factor that **directly affects a process** if its **quantity is changed**.

The main factors affecting Rate of Photosynthesis are:

1. Carbon Dioxide Concentration
2. Light Intensity
3. Temperature
4. Amount of chlorophyll

Credits

https://theory.labster.com/hs_diffusion_and_osmosis/
https://www.thesciencehive.co.uk/enzymes-alevel
https://www.ibdrelief.com/learn/what-is-ibd/how-the-digestive-system-works
https://www.quora.com/How-do-bile-salts-stimulate-and-what-is-its-function-in-the-emulsification-of-lipids
https://www.macmillan.org.uk/cancer-information-and-support/head-and-neck-cancer/what-happens-when-you-chew-and-swallow

BL1131 Foundations in Biology I Semester 1 Module Notes Topic 4
BL1131 Foundations in Biology I Lesson Slides Topic 4 - 7

102 ALL-IN-ONE REVISION PACKAGE

Thank you for reading this set of notes!
Congratulations on making it to the end without dying :P

Each page you read is ~15 minutes of my time,
so I really hope you liked this set of notes :)

Very tired.
All the best for exams ❤️

~LQ, 18 Oct (Tue), 10:47pm