Chapter 4-7 Notes

Chapter 4: The Chemicals of Life

Water

Metabolic reactions are the chemical reactions that take place inside a living organism. They can only take place when the chemicals reacting together are dissolved in water. This makes water an important solvent.

Water is present in plasma, cytoplasm and spaces between cells:

- If cells dry out, chemical reactions stop, and the organism dies
- To be carried around the body, glucose is dissolved in water in the plasma
- Water dissolves enzymes and nutrients so that digestion can take place
- Urea (waste product from kidneys) is dissolved in water to exits the body

Almost 80% of the body is made up of water

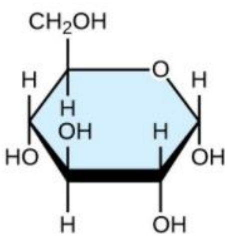
Carbohydrates

Carbohydrates are starches and sugars.

They are called carbohydrates because they are made up of carbon, hydrogen and oxygen. Hydrogen is present twice as much as carbon and oxygen

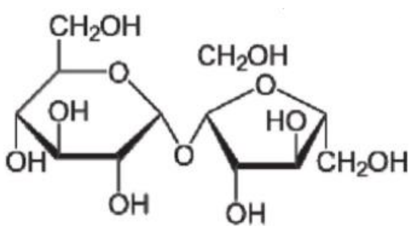
The carbohydrate usually used in respiration is glucose

1 gram of carbohydrates releases 17 kilojoules of energy



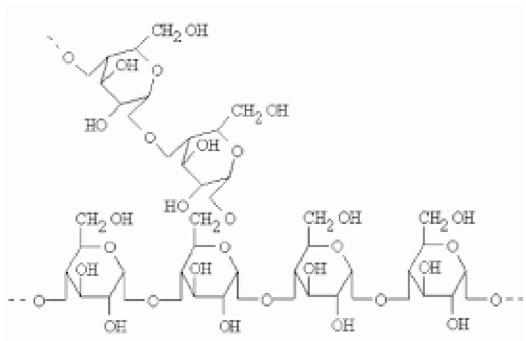
Simple sugars (ex. Glucose) are called **monosaccharides**. They are small, sweet, and soluble in water

Glucose formula: $C_6H_{12}O_6$



Two monosaccharides can join and form **disaccharides** (ex. Sucrose and maltose). They are also sweet and soluble in water

Multiple simple sugars can join and form **polysaccharides** (ex. Starch and glycogen). They don't taste sweet and are insoluble in water.



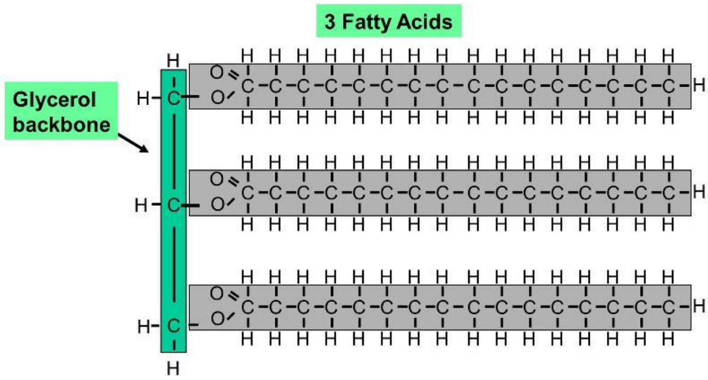
Plants store carbohydrates as **starch**, while animals store it as **glycogen**

Fats

Fats (or **lipids**) contain only carbon, hydrogen and oxygen. A fat molecule is made of four small molecules joined together – One glycerol molecule is attached to three long molecules called fatty acids.

Fats are insoluble in water, but dissolve in ethanol. Liquid fats at room temperature are called oil

1 gram of fat releases 39 kilojoules



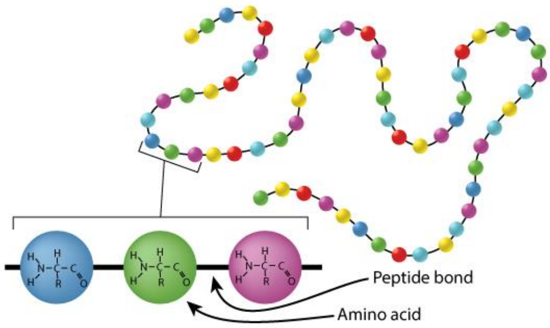
Fats are also used in releasing energy, but only when all carbohydrates have been used.

A layer of cells under the skin called **Adipose tissue** store droplets of fat under they are needed. Adipose tissue also helps keep the body warm as they insulate the body

Protein

Proteins are made of smaller molecules of **amino acids** joined together end to end by string like structures called **peptide bonds**. The molecules are made of hydrogen, oxygen, carbon and nitrogen atoms (some contain sulfur too).

There are about 20 types of amino acids. These can be arranged in any order to form a protein molecule, leaving millions of different types of protein



Some are soluble in water, others are not

Proteins are usually used to make new cells, antibodies and even enzymes. The proteins curl up in 3D shapes, and their shapes determine their functions

Testing for carbohydrates, proteins, fats and starch

Carbohydrates:

- To test the presence of carbohydrates, a **Benedict's test** is used.
- A **benedict's solution** is added to a food, which is blue in color, and then it is heated.
- If the food has carbohydrate, the color will change gradually from blue to green to yellow to orange and finally to brick red.
- No carbohydrate present will leave the Benedict's solution blue

The sugars (ex. Glucose and maltose) that make the Benedict's solution turn brick-red are called **reducing sugars**

Starch:

- Testing for starch is different. Iodine is placed on a food.
- If starch is present the iodine will turn blue-black.
- If it is not present, the iodine will turn orange brown. It is easier since no heating is required

Proteins

- A **biuret test** is used to test for protein.
- The food is mixed in water, then dilute copper sulfate solution is added.
- Then dilute solution of potassium hydroxide is added.
- If the mixture is purple, then protein is present.
- If the solution is blue, protein is not present.

Fats

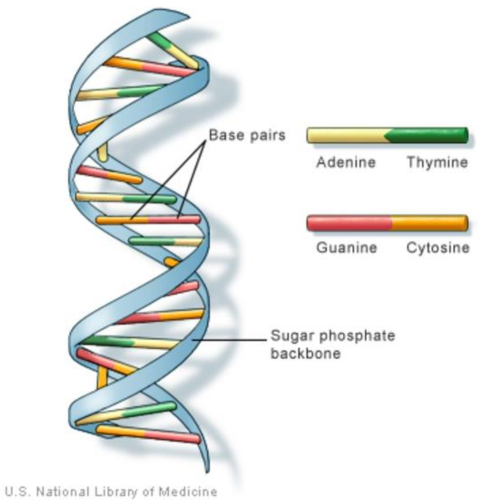
- The ethanol **emulsion test** is used to test for fats.
- Bits of food are chopped and shaken up in ethanol until they dissolve.
- The ethanol is then poured into water.
- If ethanol is present, **emulsion** will occur, the mixture will look white and opaque as the fat-ethanol mixture will break down into millions of tiny droplets when they mix the water.
- If no fat is present, the water and ethanol mixture will remain transparent.

DNA

DNA, short for **deoxyribonucleic acid**, is the chemical that makes up our **genes** and **chromosomes** and are inherited. The codes in the DNA determine everything- how proteins made in our cells and how the organs develop in our body

They are made of two long strands with bases like bonds forming between them and attaching them. The structure is twisted in a spiral shape called helix

There are four kinds of bases: A, T, C, G. A and T are always attached together, and C and G are always together in pairs.



Chapter 5: Enzymes

Enzymes

Enzymes (all made of proteins) are **biological catalysts** responsible for metabolic reactions in the body. They are found in plants and animals.

Catalysts are substances that increase the rate if a chemical reaction and is not changed by the reaction.

This means that enzymes can make multiple reactions and don't get damage after one or a few reactions

There are many different types of enzymes (more enzymes in digestion chapter), the main ones being:

Carbohydrates are enzymes that digest carbohydrates

Proteases are enzymes that digest proteins

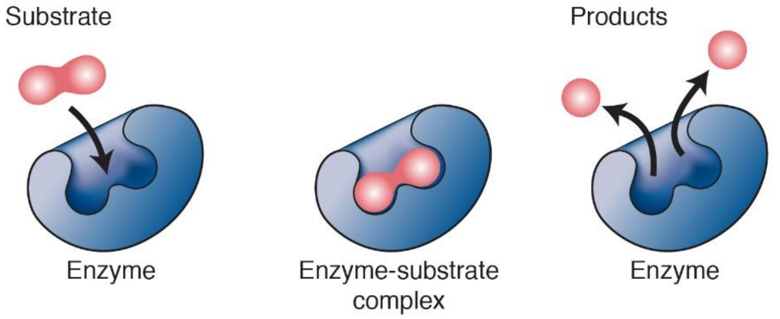
Lipases are enzymes that digest lipids (fats)

Amylases are enzymes that break down starch

Enzyme breaking down

The substance that the enzyme will break down at the beginning of the chemical reaction is called the **substrate**. The substance made at the end of the reaction is called the **product**

Each enzyme has a specific shape that allows it to break down only one type of substrate. Each enzyme has a dent on its surface where the chemical reaction occurs, called **active site**. This dent has a certain shape that is complimentary to the substance it breaks down, like a lock and key.



Ex. A starch molecules fits into the active site of an amylase. However, amylase cannot break down protein. Only protease enzymes can.

When the enzyme attaches to the substrate, it forms an enzyme-substrate complex. The enzyme breaks the substrate apart.

Temperature and pH

Enzymes work best at a specific temperature, or the **optimum temperature**. The closer the environment's temperature is to the optimum temperature, the faster the chemical reactions.

The optimum temperature of an enzyme in the human body 37*C. For plants, it is around 40*C. The temperature differs for organisms in different environments

This occurs because the higher the temperature, the more kinetic energy the molecules have, the faster they bump into the enzymes, and the faster the breaking down of the food occurs.

However, if temperatures are too high, proteins become **denatured** (damaged) and can no longer catalyze (even if the temperatures become optimum again).

Enzymes also work best at the **optimum pH**. This is because the pH affects the shape of an enzyme.

Most enzymes are at a perfect shape at neutral pH, or pH 7. If the pH is too acidic or alkaline, the enzymes can become denatured

Some enzymes don't have an optimum pH of 7.

Ex. The enzymes (pepsin) present in the stomach have an acidic optimum pH (2) because of the hydrochloric acid in the stomach. Protease must work well in the stomach, and so they have different optimum pH than most enzymes

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Chapter 6: Plant Nutrition

Nutrition

Nutrition is taking in materials that are required for energy, growth and development.

Substances made by living things are **organic** substances (ex. Glucose). Substances not made by living things but needed for growth are **inorganic** (ex. Carbon dioxide and water)

Photosynthesis

Green plants make the carbohydrate glucose in a reaction process called **photosynthesis**, which occurs in the leaves.

Photosynthesis is the process by which green plants manufacture the carbohydrate glucose from raw materials using energy form sunlight

The reaction can be represented with the equation:

$$6CO_2 + 6H_2O \xrightarrow[\text{chlorophyll}]{\text{Sunlight}} C_6H_{12}O_6 + 6O_2$$

Carbon Dioxide, Water → Glucose (Energy), Oxygen

Sunlight's energy is needed in the reaction to make carbon dioxide react with water. However, it needs to be trapped. A green pigment in plants, called **chlorophyll**, absorb the sun's energy and releases it during photosynthesis.

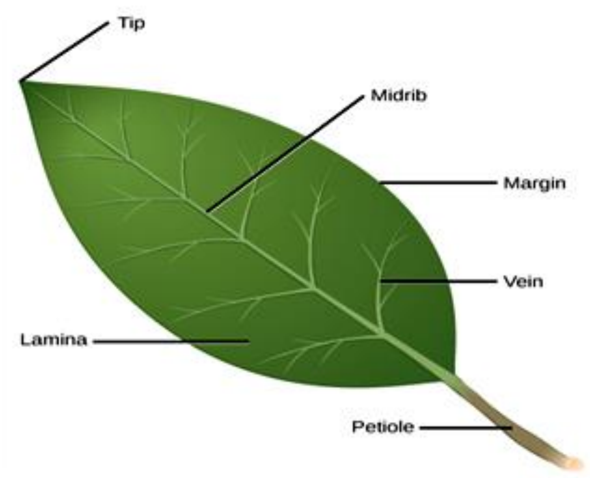
Chlorophylls are inside **chloroplasts**, which contain enzymes that are also needed for photosynthesis.

Photosynthesis is important because it is the basic reaction that brings the sun's energy into the ecosystem. Energy's flow goes one way, and there is a constant need for replenishment from the energy source, and therefore in constant need of photosynthesis

Photosynthesis is also essential for maintaining constant global level of oxygen and carbon dioxide

Leaf structure

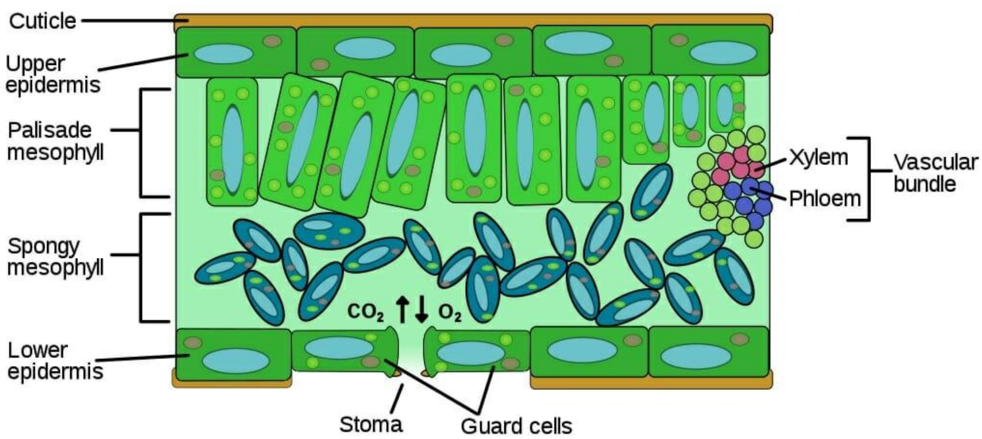
Leaves are adapted to allow photosynthesis to occur as efficiently as possible



The leaf consists of a broad, flat part called **lamina**, which is joined to the rest of the plant by a leaf stalk, or **petiole**. The veins in the leaf, in the form of **vascular bundles**, run from the plant branch out into the leaf.

The leaf consists of layers, where the top and bottom parts of the leaf are covered with a layer of closely-fitting cells called the **epidermis** (upper and lower epidermis), that do not contain chloroplasts and protect the inner layers of the leaf.

The upper (and sometimes lower) epidermis often secretes a waxy substance on the surface, called the **cuticle**, which limits water evaporation from inside the leaf.



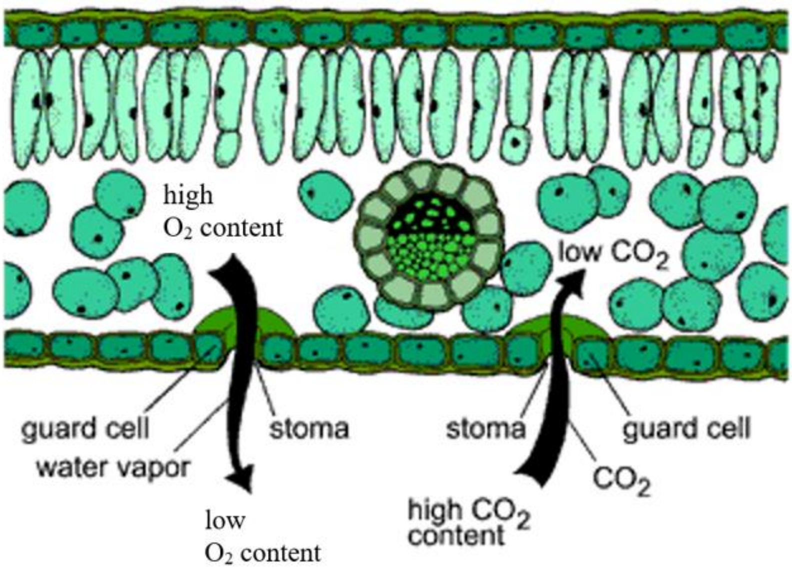
Stomata (singular: stoma) are small openings on the lower epidermis that allow gas exchange withing the leaf. The stomata are surrounded by two **guard cells** that are responsible for opening and closing the hole

The middle part of the leaf, the **mesophyll layer**, contains chloroplasts, and consists of two parts. The first, the **palisade mesophyll's** (on the top) cells are arranged in a fence-like structure and are tightly packed. The **spongy mesophyll's** (bottom layer) cells are round and have air spaces between them.

Running through the mesophyll layer are **vascular bundles**. Each bundle contains large, thick-walled **xylem vessels** (bring water to the leaf) and small, thinner **phloem tubes** (carry sucrose and substances made by the leaf to the rest of the plant)

Leaf Adaptations

The leaf has certain adaptations that allows it to make photosynthesis as fast as possible



Carbon Dioxide

- Only 0.04% of the atmosphere is carbon dioxide
- Carbon dioxide enters the leaf into the stomata through diffusion

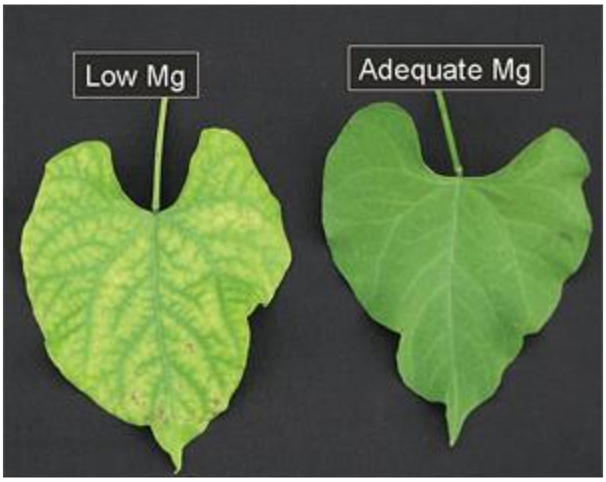
Water

- Is obtained from the soil and sucked in through root hairs
- Travels through xylem to the leaf by osmosis

Adaptation	Function
Supported by stem and petiole	Expose as much of the leaf to sunlight and air
Large surface area	Expose as much area as possible to sunlight and air
thin	-Allows sunlight to penetrate to all cells -Allows carbon dioxide and oxygen to diffuse as quickly as possible
Stomata in lower epidermis	Allows gas exchange
Air spaces in spongy mesophyll	Allows carbon dioxide and oxygen to diffuse to and from all cells
No chloroplasts in epidermis	To allow sunlight to penetrate the mesophyll layer
Chlorophyll in the mesophyll layer	To absorb energy from sunlight for the chemical reaction between carbon dioxide and water
Palisade calls are arranged end on	To keep as few cell walls as possible between sunlight and chloroplasts
Chlorophyll inside palisade cells are often arranged broadside on	To expose as much chlorophyll to sunlight as possible
Chlorophyll arranged on flat membranes inside the chloroplast	To expose as much chlorophyll to sunlight as possible
Xylem vessels close to every mesophyll cell	To supply water to the cells in the leaf
Phloem vessels close to every mesophyll cell	To take away sucrose and other organic products of photosynthesis

Uses for glucose

- For releasing energy by respiration
- Stored as starch
    - Storing glucose can be problematic as glucose is reactive and soluble in water
    - Glucose is converted to starch before storing, which is less reactive and soluble because it is a polysaccharide molecule
- Making proteins and chloroplasts
    - Plants use sugars from photosynthesis to make amino acids and attach them to proteins. To do this, they need a reactive form of nitrogen, or **nitrate** ions they absorb from the soil through root hairs. Nitrate is combined with glucose to form amino acids. Lack of nitrate can cause weak growth and yellow leaves
    - Plants take in magnesium ions from the soil through root hairs. The magnesium is combined with glucose to make chlorophyll. Lack of magnesium can cause yellowing between the veins of the leaf of the plant



To be transported from one point to another, glucose needs to be converted to **sucrose**. Glucose is soluble and small like sucrose, but too reactive to be transported. Sucrose have almost the same properties as glucose, but less reactive. It might be changed back to glucose or turned to starch or used for other substances

Testing Leaves for starch

It is not so simple to test leaves for starch

i. Starch is inside chloroplasts, and iodine cannot penetrate the cell membrane
ii. Green plant and the brown iodin can look black together

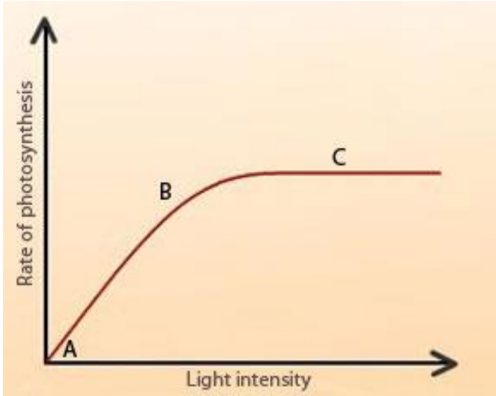
Before iodine is put

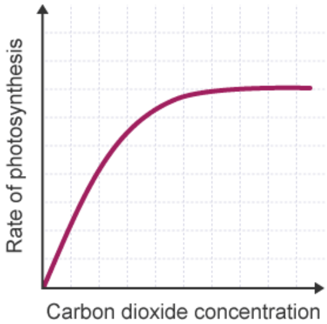
i. The cell membrane is broken by boiling the leaf
ii. The chlorophyll (green pigment) is removed by dissolving it in alcohol

Limiting Factors

A **limiting factor** is something present in the environment in such short supply that it restricts life process

Sunlight can be a limiting factor. In low light intensity, the plant will photosynthesize slowly. The greater the light intensity, the faster the plant photosynthesizes until the plant cannot photosynthesize any faster even if the light gets brighter. In part A on the graph, the light is a limiting factor. Point C, the plant cannot photosynthesize faster





Carbon dioxide can also be a limiting factor. Small amounts of carbon dioxide can slow photosynthesis, and the more carbon dioxide there is the faster photosynthesis occurs. It keeps increasing until the plant cannot photosynthesize any faster

The lower the temperature, the slower photosynthesis occurs. If the weather is too hot, the stomata close to prevent water from evaporating out of the plant. However, this also stops carbon dioxide from entering the plant, and photosynthesis will slow down.

Plants are sometimes grown in greenhouses to avoid any limiting factors in the environment (ex. If it is cloudy, extra light can be provided, or light intensity is too much then shade can be provided) to allow plants to photosynthesize as fast as possible. Light, temperature, carbon dioxide concentration can be controlled

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Chapter 7: Animal Nutrition

Diet

Animals get their nutrition from other organisms. Seven types of essential types of nutrition are

i. Carbohydrates
ii. Proteins
iii. Fats
iv. Vitamins
v. Minerals
vi. Water
vii. Fibre

A **balanced diet** is a diet that contains all these types of nutrition in the correct amounts and proportions

Carbohydrates provide energy and gives brain high energy demand

Proteins help the body repair cells and make new ones

Fats give your body energy and support cell growth

Vitamins, minerals, fibre and water are called **nutrients**

Vitamins are organic substances needed by the body in small amounts. They help in functions such as healing wounds, boosting the immune system and repairing cellular damage. Lack of Vitamins can cause **deficiencies.**

Minerals are inorganic substances that are also needed in small amounts. They keep the heart, bones, muscles and brain working properly

Fibre is needed to help the alimentary canal working properly. The food moves through the alimentary canal by muscles contracting and relaxing in a movement called peristalsis. The peristalsis is stimulated to begin when food is present in the canal. Soft foods do not stimulate the muscles a lot, which can cause constipation. Fibre is hard and less digestible, and so keeps the digestive system working in order

Malnutrition

Malnutrition is caused by not eating a balanced diet. This can be caused by having too less or too much of something in the diet

Disease	Deficiency disease	Symptoms	Food that can prevent this	Why it is needed
Scurvy	Lack of Vitamin C	Pain in joints and muscles, bleeding from gums; common in sailors with no vegetables for long travels	Citrus fruits (lemons, oranges), raw vegetables	To make the stretchy protein collagen, found in skin and other tissues. They keep tissues in good repair
Rickets	Lack of Vitamin D	Bones become soft and deformed; common for children in industrial areas with not much sunshine	Butter, egg yolk, sunlight on skin	Helps calcium to be absorbed for bones and teeth
Brittle bones and teeth; poor blood clotting	Lack of Calcium, Ca	-	Dairy products, bread	For bones, teeth and blood clotting
Anaemia	Lack of Iron, Fe	Not enough red blood cells, and so the tissues do not get enough oxygen delivered	Liver, red meat, egg yolk, dark green vegetables	Making Haemoglobin, red pigment in red blood cells that carry oxygen
Kwashiorkor	Lack of Protein	Underweight, may look fat, swollen abdomen	Eggs, beef, seafood	help the body repair cells and make new ones
Marasmus	Lack of Protein and energy	Low body weight and look emaciated	Skimmed milk, fish, nuts	-

Constipation	Lack of Fibre	Hard stool	Fruits, berries, bread, oatmeal, black beans	Helps in peristalsis,
Obesity	Too much cholesterol- food with saturated fat	Higher risk of getting disease, heart disease, stroke, diabetes, and problems with joints	Less food with saturated fat	-
Coronary heart disease/heart attack	Too much cholesterol- food with saturated fat	fat can deposit on the side of an artery, making them stiffer and narrower, making it harder for blood to flow through. Complete blockage or artery can cause heart attack	Less food with saturated fat	-

Digestion (general)

Ingestion: The taking in of food (into the alimentary canal through the mouth

Alimentary Canal: long tube present in mammals that runs from one end of the body to the other

Absorption: the food movement from the alimentary canal into the bloodstream

Egestion: Food that the body is unable to digest is excreted from the body

Peristalsis: Is the rhythmic contraction and relaxation of stomach and oesophagus. It allows the food to move along the alimentary canal

Digestion is the process of breaking down of food molecules into molecules small enough to be absorbed into the bloodstream and used by cells

Mechanical digestion is when large pieces of food broken down physically by the body into smaller pieces (ex. teeth, alimentary canal movement)

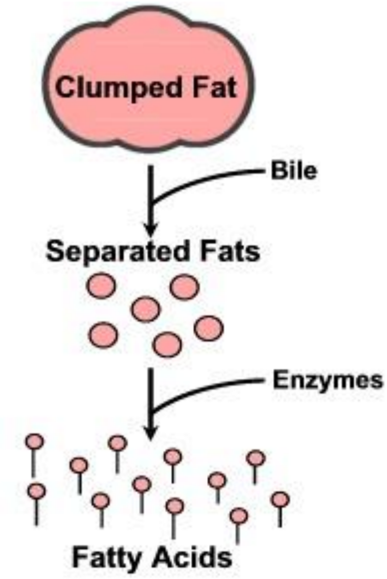
Chemical Digestion is when insoluble food molecules broken down chemically by the body into small soluble molecules. It involves enzymes (ex. Stomach, saliva [salivary amylase])

Simple sugars, water, vitamins and minerals are directly absorbed into the bloodstream as they do not need digestion

Digestion of fats, proteins and carbohydrates

Proteins are broken down to amino acids, Fats are broken down to fatty acids and glycerol molecules and carbohydrates are broken down to simple sugars, or monosaccharides

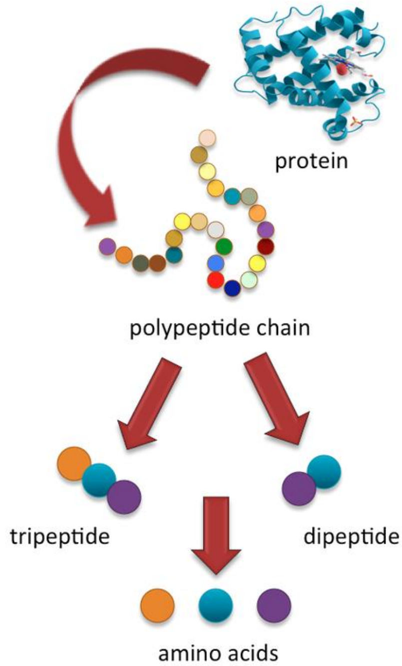
Digestion of fats:



i. The teeth chew the large bits of food to smaller ones.
ii. The saliva lubricates the food and makes it easier to swallow
iii. In the oesophagus, the muscle contraction movements (peristalsis) help digest the food mechanically
iv. The **bile salts** break down the large fat droplets to smaller ones, giving the enzymes a larger surface area to work on
v. **Lipase** (produced by pancreas, in small intestine) breaks down the fat molecules to fatty acids and glycerol molecules

Fats (lipids) → fatty acids and glycerol
lipase

Digestion of proteins



i. The teeth chew the large bits of food to smaller ones.
ii. The saliva lubricates the food and makes it easier to swallow
iii. The oesophagus, the muscle contraction movements (peristalsis) digests the food mechanically
iv. Water in digestive juices dissolves some food, turning it to a solution
v. **Pepsin** (stomach) breaks down the protein molecules to **peptones**
vi. **Trypsin** (produced by pancreas, in duodenum) breaks down the peptone molecules to **polypeptides**
vii. **Peptidases** (ileum) breaks down polypeptide molecules to amino acids

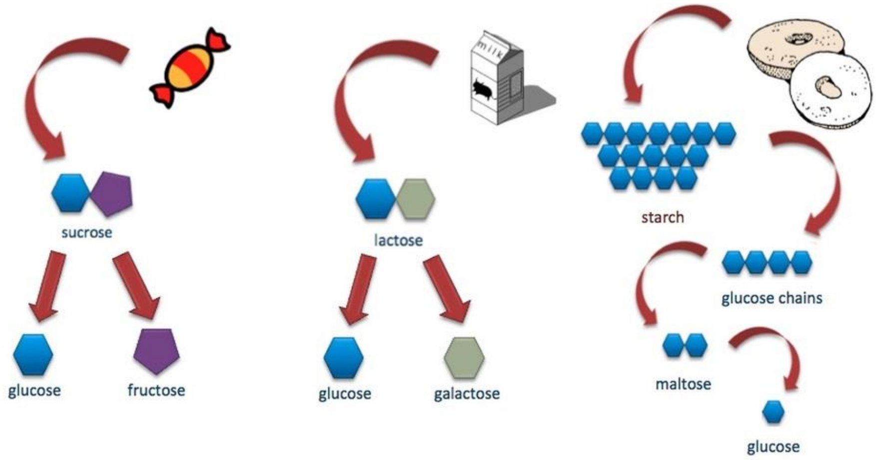
Proteins → Peptones → Polypeptides → amino acids
Pepsin Trypsin Peptidases

Digestion of Carbohydrates

i. The teeth chew the large bits of food to smaller ones.
ii. The saliva in the mouth lubricates the food and makes it easier to swallow; contains amylase that begins breaking down
iii. The oesophagus, the muscle contraction movements (peristalsis) digests the food mechanically
iv. Water in digestive juices dissolves some food, turning it to a solution

v. **Amylase** (produced by pancreas, in saliva and duodenum) breaks down starch molecules to **maltose** molecules
vi. **Maltase** (ileum) breaks down maltose to glucose

Starch → maltose → maltase
Amylase   Maltase



Disaccharidase are enzymes are secreted by the intestinal cells that line the villi. They are made to break down complex sugars: sucrase, maltase, and lactase.

Sucrase breaks down sucrose into glucose and fructose molecules.

Maltase breaks down maltose to glucose

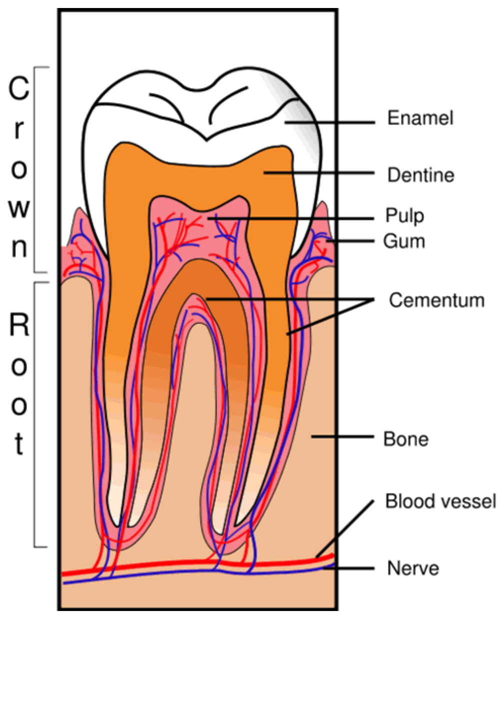
Lactase breaks the bond between galactose and glucose

Once carbohydrates are chemically broken down into single sugar units, they are then transported into the inside of intestinal cells

Teeth

Teeth are a part of ingestion and the mechanical digestive system. It makes it easier for the enzymes to break down the food.

Parts of a tooth



i. The part embedded in the gum is called the **root**
ii. The part we can see is the **crown**, which is covered by enamel
iii. **Enamel** is the hardest substance produced by animals, made mostly of calcium phosphate, but can be dissolved by acids
iv. A bone-like substance is present under the enamel, called the **dentine**, which is also a hard substance (but not as hard as enamel). It has channels containing living cytoplasm
v. Blood vessels and nerves are present at the centre of the tooth, called **pulp activity**, and supplies dentine cytoplasm with oxygen and food
vi. A layer of connective tissue binds the roots of the teeth to the jawbone with called **cementum**

Types of teeth

Most mammal usually four types of teeth- Incisors, Canines, Premolars and Molars

i. **Incisors** (8) are present at the font of the mouth, and are chisel shaped to bit off food
ii. **Canines** (4) are at the sides of incisors
iii. **Premolars** (8) are right after the canines and right before the molars and is used for chewing the food
iv. **Molars** (8) are at the back of the mouth and are flat and used to chew food
v. 4 Wisdom teeth (molars) grow around 18 years of age

Mammals usually have two sets of teeth, Milk and Deciduous.

- The **Milk set** of 20 teeth starts growing at an age of around 5 months to seven years

- The **Deciduous** or the permanent set of teeth grows after the first set falls out. The 20 teeth are replaced, and 12 new ones grow, to make the 32 teeth altogether

  - Present underneath each tooth from the milk set, is an already growing and developing deciduous tooth
  - When it is time for the deciduous tooth to emerge, the milk tooth becomes loose and eventually falls out, leaving place for the new and permanent tooth to settle

Dental decay is caused by bacteria.

Bacteria feed on sweet food on the teeth for respiration, which release acids. The acids break down and destroy the enamel and the dentine

Some bacteria form a sticky layer over the teeth and between the gums, called **plaque**. Plaque is easy to remove unless it is left for a long time, when it hardens to form tartar which cannot be removed by simple brushing

Plaque left unremoved can infect gums, making them swell and bleed. It might be painful if it reaches the root, and will loosen the tooth until it will have to be removed

Bacteria will feed on sugar and gradually dissolve the enamel. However, the dentine dissolves faster than enamel and reaches the root faster, forming holes in the teeth as the bacteria form more and more acids. A tooth left untreated will have to be taken out

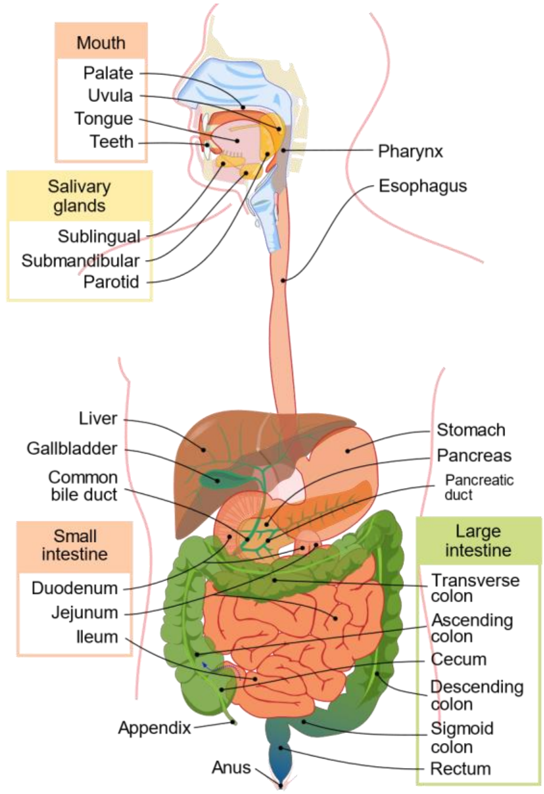
Ways to avoid tooth decay

i. Not eating too much sugar to avoid tooth decay

ii. Using fluoride toothpaste or drinking water with fluoride regularly will make the teeth more resistant to tooth decay
iii. Making regular visits to a dentist to stop a tooth decay before it becomes severe
iv. Taking in food rich in calcium to strengthen the enamel on the teeth
v. Flossing between teeth can remove plaques between the teeth that cannot be removes by brushing

The alimentary canal (mouth, oesophagus and Stomach)

The **alimentary canal** is a long tube that passes from one part of the body to the other. It is a part of the digestive system, along with the liver and the pancreas



The movement of the canal is peristalsis. When the food needs to be kept in one part of the alimentary canal for a while. The **sphincter muscles** close the canal completely to trap food for the needed time.

Along the alimentary canal, **goblet cells** produce mucus to help the food slide easily through the canal.

Mouth

- Food is ingested using teeth, lips and tongue. The teeth chew the food to increase its surface area.
- The food is mixed with saliva, made in **salivary glands**, which is a mixture of mucus, water, and the enzyme amylase
- Water lubricates the food; mucus lubricates and sticks them together to form bolus and make it easier to slide down the oesophagus
- **Amylase** begins digesting starch

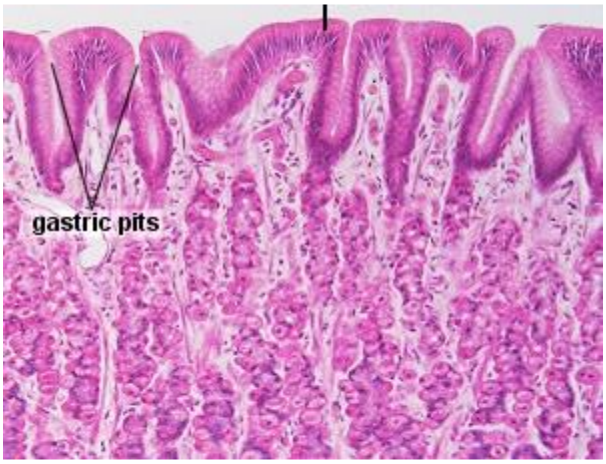
The oesophagus

- The tube behind the mouth splits two ways, the **trachea** (windpipe to lungs) and the **oesophagus** (takes food to stomach)
- When swallowing, a piece of cartilage covers the entrance of the trachea, so the food does not go to the lungs
- A **sphincter muscles** covers the entrance to the stomach, which relaxes to allow the food pass through

The stomach

- The walls of the stomach are made of muscles, which contract and relax to churn the food and mix it with enzymes and mucus
- The mixture is called **chyme**
- The mucus is secreted by goblet cells covering the walls of the stomach

- The stomach wall is covered with cells that produce enzymes and hydrochloric acid. These cells are situated in **gastric pits**, or areas deeper than the rest of the stomach
- **Pepsin**, which works best in acidic conditions, is the main enzyme in the stomach and turns proteins to polypeptides
- The acid also helps kill bacteria
- **Rennin** (only present in young mammals) causes the milk from their mothers to clot, and then get broken down by pepsin



- A sphincter at the end of the stomach prevents the food from entering the intestine for one or two hours, until it relaxes to allow the chyme to enter the duodenum

The small intestine

The first part of the small intestine is called the **duodenum**. The part nearest to the colon is call **ileum.**

Villi

- Some of the enzymes in the small intestine are from the **pancreas**, others are made in the intestine itself
- The inner walls of the small intestine are made of millions of tiny projections called **villi** (singular villus) around 1 mm long each. The cells that cover the villi produce enzymes
- The villi themselves are covered with even smaller villi, called **microvilli**
- The enzymes produced by these cells always stay close to the cell that made them
- These enzymes complete the digestion of the food
- Villi have **lacteals** that absorb fats

Pancreas

- Just under the stomach, the cream-colored gland, **pancreas**, is attached to the duodenum by the **pancreatic duct**. **Pancreatic juices**, which contain enzymes, flow through the tube from the pancreas to the duodenum
- Enzymes in the pancreatic juices include **amylase, protease, lipase** and **trypsin**
- The chyme coming from the stomach is still acidic, and these enzymes don't work well in acidic environments. Pancreatic juices contain sodium hydrogen carbonate that partially neutralizes the acid

Bile

- **Bile** is a substance produced in the liver and stored in the **gallbladder**, which enters the duodenum through the bile duct.
- Bile is a yellowish green alkaline that help neutralize the stomach acids.
- Bile starts the breaking down of fat and gives lipase a larger surface area to work on. This is called **emulsification**

- A yellowish-green pigment in the bile, made from haemoglobin, breaks down old red blood cells

Assimilation

Assimilation is the movement of digested foods molecules into the cells of the body where they are used, becoming part of the cells

After being absorbed into the blood, the nutrients are taken to the liver through the hepatic portal vein. The liver breaks down some of the nutrients, converts some of them to other substance, stores some and leaves the rest unchanged

If there is too much glucose in the blood, the liver converts some of it to the polysaccharide glycogen and stores it

The nutrients are dissolved in the plasma and distributed to the cells, or assimilated

The small intestine has some adaptations for absorbing nutrients

i. It is long (5m in adult) to leave enough time digestion to be completed and the food absorbed
ii. Villi covering the walls give the inner surface of the small intestine a large surface. The greater the surface area the faster the absorption
iii. The villi's walls are only one cell thick, which allows nutrients to easily cross the wall to reach the capillaries and lacteals

Water, mineral salts and vitamins are also absorbed in the small intestine

Large Intestine

Some food that is eaten cannot be digested by the body and must be excreted

The food travels through the caecum, appendix (have no function) and into the colon, where more water and salts are absorbed.

When the food reaches the rectum, most foods that can be absorbed were taken in in the small intestine, leaving indigestible foods (fibre or roughage), bacteria and dead cells behind. The mixture form faeces and exit the body through the anus in the process of **egestion**

Summary

Part of the canal	Juices secreted	Where the juice is made	Enzymes in juice	Substrate	Product	Other juices and their function
mouth	saliva	Salivary glands	amylase	starch	maltose	-
stomach	Gastric juices	Gastric pits	pepsin	Protein	polypeptide	Hydrochloric acid – Acid

			rennin	Milk protein	Curdled milk protein	environment for pepsin; kills bacteria in food
Duodenum	Pancreatic juices	Pancreas	Amylase – trypsin – Starch	Starch – protein – fats	Maltose – polypeptide – fatty acids and glycerol	Sodium hydrogen carbonate – reduce acidity of chyme
	bile	Liver	-	-	-	
Ileum	Enzymes covering villi	By cells covering villi	Maltase – Sucrase – lactase – peptidase – lipase	Maltose – sucrose – lactose – polypeptide – fats	Glucose – glucose and fructose – glucose and fructose – amino acids – fatty acids and glycerol	-

Diarrhoea

Diarrhoea is the loss of watery faeces, which occurs when not enough water is absorbed.

It is caused by the bacterium **cholera**, which spreads rapidly through water and food contaminated by faeces from an infected person. It spreads mostly in areas living in unhygienic conditions

The bacteria releases **toxins** that stimulate the cells coving the intestine to secrete chloride ions, which accumulate and increase the concentration of the fluid in the lumen of the small intestine.

The water potential in the intestine becomes higher than the water potential in the blood vessels, and the water moves by osmosis from the blood stream to the small intestine

Severe diarrhoea can be a dangerous illness, as a person can lose dangerous amounts of waters and salts from the body and can cause organs and tissues to stop working

Cholera is cured by simply replacing the water lost in the faeces. This can be done using oral rehydration therapy, where cholera infected people are given water with small amounts of salt and minerals dissolved in it to replace the water lost

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Investigations

Carrying out an investigation for the starch in a leaf-

i. In an investigation, two leaves are used one plant is given everything it needs (the control), the other is given everything but one substance (ex. Less light intensity or less Carbon dioxide)
ii. Then, both plants are treated the same way. This way, any difference at the end of the investigation is caused by the substance the leaf lacks
iii. Then, compare the control leaf and the other leaf
iv. To make sure the investigation is fair, the plant must have no starch at the beginning of the investigation, so the two plants start with equal amounts of starch. Removing the starch is called destarching
v. To destarch a plant, the easiest way is to leave it in a dark area for 24 hours. Plants cannot photosynthesize in the dark and use up all the stored starch for respiration instead

After the experiment, check for starch using iodine