

CIE Biology GCSE

7: Human nutrition

Notes

Humans need many different nutrients to survive. To receive these nutrients in the correct quantities, a **balanced diet** must be eaten. A balanced diet **includes all essential nutrients**, such as carbohydrates, fats and vitamins, in the **correct amounts** needed for growth and repair.

Balanced diets vary between people. The amounts of nutrients needed are different for people of different **ages and genders**. The amount of nutrients needed also varies depending on the **amount of physical activity** undertaken by individual people each day. In addition, pregnant and breastfeeding women need more nutrients as they must be able to feed their baby as well as themselves.

Nutrients and their importance:

- **Carbohydrates** - found in foods such as pasta, rice and potatoes; carbohydrates are used as a source of energy in respiration in cells.
- **Fats** - found in fatty meats, cheese and butter. Fats have a variety of roles in organisms including insulation, energy, waterproofing, structure and protection around delicate organs.
- **Protein** - found in meat, fish and eggs. Proteins are broken down into amino acids in digestion and absorbed into the blood. They are then used in cells to produce new proteins by protein synthesis, where they are used as enzymes in reactions and for structure. They can also be used for signalling as hormones, and carrying other molecules, for example haemoglobin which carries oxygen in the blood.
- **Vitamins (C and D)** - Vitamin C is found in citrus fruits and some other vegetables and is used in the synthesis of proteins which help make up the skin, ligaments and blood vessels. Vitamin C is also used in the repair of tissues. Vitamin D is found in dairy products, eggs and fish oil. It helps the uptake of calcium during digestion and is also a factor in maintaining healthy bones. Vitamin D deficiency leads to rickets, a condition that causes weak and soft bones, as well as deformities. It can also cause stunted growth in children as the bones cannot develop correctly.
- **Mineral salts (calcium and iron)** - Calcium is needed for healthy bones and teeth and is found in dairy products and fish. It also has a role in blood clotting. Iron is found in red meat and some green vegetables. Iron is present in haemoglobin and plays an important role in transporting oxygen around the body in the blood for cells to use in respiration. A lack of iron leads to anaemia and can cause tiredness, as enough energy will not be produced.

- **Fibre (roughage)** - Found in vegetables, fruit and whole grains. Fibre is not digested and thus helps food to move through the stomach and intestines, it also adds bulk.
- **Water** - Comes from both drinks (80%) and food (20%). Water moves into the blood via osmosis during digestion and then into cells. Here it acts as a solvent in which chemical reactions occur. It also helps to maintain a constant temperature in the body due to its high specific heat capacity and is a metabolite.

Malnutrition:

The lack of a balanced diet can lead to malnutrition which can have a variety of outcomes:

- **Starvation** - caused by eating too little food, leads to weight loss, organ damage, muscle atrophy and eventually death.
- **Constipation** - caused by a lack of fibre, leads to pain, stomach ache and inability to defecate.
- **Coronary heart disease** - caused by a build-up of cholesterol in the coronary artery which limits blood flow to the heart and can cause heart attacks. Cholesterol is a result of too much saturated fat in the diet, which comes from foods such as high fat dairy products and fatty meats.
- **Obesity** - caused by eating too much food, leads to a range of health issues including diabetes, high blood pressure, strokes and heart disease.
- **Scurvy** - caused by lack of vitamin C, leads to bleeding under the skin and around gums, premature stopping of bone growth in children leading to stunted growth, and very dry skin and hair.
- **Kwashiorkor and marasmus** - these are conditions caused by **protein-energy malnutrition**, which is a result of having a protein or calorie deficiency over a long period. Kwashiorkor occurs due to a severe protein deficiency and a carbohydrate-based diet and is often developed by older children. Whereas marasmus is more common with young children and babies.

Alimentary Canal

Once food is **ingested** (taken into the body), it undergoes both **mechanical and chemical digestion** as it is broken down. Mechanical digestion breaks down food into smaller molecules **without chemical change**. This occurs in the mouth due to chewing and in the stomach as food is churned. Chemical digestion is the breaking down of large, insoluble molecules into **smaller, soluble molecules** with the use of **enzymes**, so that the products can be **absorbed**. Absorption occurs as the smaller molecules and ions pass through the walls of the small intestine into the blood. These molecules then travel around the body, where they are **assimilated** into the cells and used in metabolic reactions. Food that is not digested and absorbed is **egested** as faeces.

Parts of the alimentary canal:

- **Mouth and salivary glands** - food is mechanically digested in the mouth by the teeth. The salivary glands release saliva which contains carbohydrase enzymes. These begin the chemical digestion of starch.
- **Oesophagus** - this allows food to pass from the mouth to the stomach by peristalsis.
- **Stomach** - Protease enzymes break down protein in chemical digestion. The food is also churned to break it up more by mechanical digestion. Hydrochloric acid is present to maintain an optimum pH for enzyme action and kills bacteria by creating extremely acidic conditions, which denatures the enzymes within them.
- **Small intestine** - the small intestine consists of the duodenum and ileum. In the duodenum, the acidity from the stomach is neutralised and protease, lipase and amylase enzymes are secreted to break down molecules. The ileum is the final part of the small intestine and is where the products of the digestion are absorbed into the blood.
- **Pancreas** - the pancreas secretes pancreatic juices into the small intestine. This contains lipase, protease and amylase enzymes to break down food so that it can be absorbed.
- **Liver** - The liver makes bile. Bile is also secreted into the small intestine and has two functions: firstly, it neutralises the acidic conditions from the stomach (bile is alkaline) to provide a suitable pH for enzymes to work at. It also emulsifies fats, increasing their surface area so enzymes can digest them more quickly.

- **Gall bladder** - Bile made in the liver is stored here before being secreted into the small intestine.
- **Large intestine** - indigestible food passes through the large intestine. The large intestine consists of the colon, rectum and anus. Remaining salts and water are absorbed here (most is absorbed in the small intestine).

Cholera:

Cholera is a disease caused by **bacteria** present in contaminated food and water. Although most bacteria are killed in the acidic conditions of the stomach, some pass through to the small intestine where they **stick to the intestinal walls**. Here they release **toxic proteins** that causes a **secretion of chloride ions** into the small intestine. This **lowers the water potential in the gut** thus water moves into the gut via osmosis, leading to diarrhoea, which is the loss of watery faeces. This can be avoided using **oral rehydration therapy**, where patients drink a mixture of **water, glucose and salts** to **rehydrate** themselves.

Mechanical Digestion

Mechanical digestion first occurs in the mouth. **Incisors and canines** at the front of the mouth are used to bite and tear food, before it is passed to the **premolars and molars** at the back of the mouth which are used for chewing and grinding food into smaller sections.

Tooth structure:

- **Enamel** - enamel is very hard. It covers the tooth and protects the tissue inside.
- **Dentine** - found underneath the enamel, dentine is less hard than enamel and thus decays more easily if the enamel is worn away.
- **Pulp** - central part of the tooth. The pulp is made of soft tissue which contains blood vessels and nerves.
- **Cement** - covers the root of the tooth and stabilises it

Dental decay:

Dental decay occurs due to **bacteria** coating the teeth. When the bacteria respire using sugars from food, they produce **acidic substances**. This acidity **dissolves the enamel** on the outer layer of the teeth and then the dentine on the inside, leading to tooth decay. To avoid tooth decay, teeth should be **regularly brushed to remove bacteria** and **sugary foods and drinks should be limited**.

Chemical digestion

Chemical digestion is important to allow food to be broken down into **small molecules** so that it can be **absorbed** and used in the body.

Enzymes:

- **Amylase** breaks down **starch** into **maltose**, and then **maltase** breaks down maltose into **glucose**. **Maltase** is a membrane-bound enzyme found in the membranes of epithelial cells in the small intestine. Amylase is found in **saliva** and is also present in the **small intestine**.
- **Protease** breaks down **protein** into **amino acids**. **Pepsin and trypsin** are proteases. Pepsin works in the **stomach**, whereas trypsin is present in the **small intestine**. These enzymes have **different optimum pH**, since in the stomach the conditions are very acidic (pH 1.5), whereas in the small intestine the pH is about 6-7. These enzymes will stop working in the wrong pH as they will become **denatured**.
- **Lipase** breaks down fats into **glycerol** and **fatty acids**. It is secreted into the **small intestine**.

Absorption

Digested food products are absorbed in the **small intestine**. Cells lining the small intestine are adapted for absorption by having hair-like projections called **villi and microvilli**, which **increase the surface area** in the small intestine. Each villus contains **capillaries**, which carry absorbed molecules away. This maintains a **high concentration gradient** which allows more molecules to diffuse into the capillaries. They also contain **lacteals**, which absorb fats.