The digestive system

Concept of nutrition

Nutrition is a series of processes that enable us to use and transform the substances we need to stay alive. It converts food molecules to a useful form.

Multicellular organisms have a number of organs, grouped into systems, which prepare nutrients, distribute them to all the cells and expel the waste products from cellular activity. This involves four systems:

Digestive system: prepares food so that the cells can use it.

Respiratory system: supplies oxygen to the blood and eliminates carbon dioxide released during cell metabolism.

Circulatory system: takes oxygen and nutrients to all the cells, and takes away waste products.

Excretory system: expels waste products released during cell metabolism and transported via the circulatory system.

How the digestive system works

Digestion is the breakdown of large, insoluble food molecules into small, soluble food molecules do that they can be absorbed into the blood stream.

The processes which convert these biomolecules into useful forms take place in the alimentary canal, gut or digestive system.

The digestive system is made up of the digestive tract and accessory glands.

- The **digestive tract** is about 9 meters long. It is narrow in some parts and quite wide in others. It starts at the mouth and ends at the anus. (oral cavity, pharynx, oesophagus, stomach, small intestine and large intestine)

- **Accessory glands** are organs that release secretions into the digestive tract. These include the salivary glands (in the mouth), the gastric glands (in the stomach) and the intestinal glands (in the intestine). The **liver** and the **pancreas** are lager glands which release digestive secretions into the digestive tract

There are several processes that make up digestion of food:

Ingestion: Food intake

Mechanical digestion: Chewing and grinding in the mouth, as well as movement of food by peristalsis along the digestive tract.

Chemical digestion: Enzymes breaking down large molecules.

Absorption: The entry of small food molecules from the gut to the blood.

Assimilation: The entry of those small food molecules from the blood into the cell. Now these nutrients can be used by cells for energy, growth and repair.

Egestion: Indigestible substances make their way to exit the body.

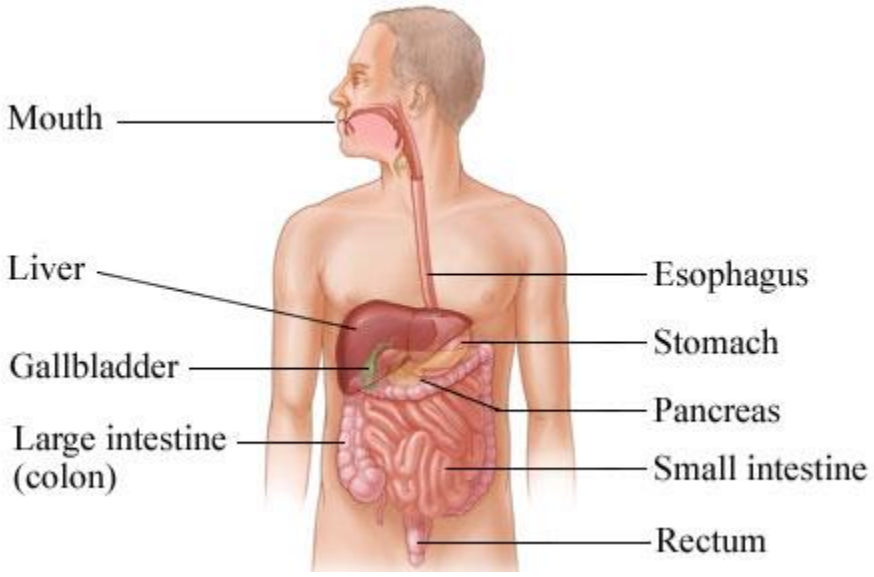
Defaecation: Indigestible substances are expelled from the body.

Enzymes

During digestion, food molecules are broken down by chemical reactions (hydrolysis). Our bodies need special and specific molecules for these reactions to happen. We call these molecules enzymes.

Enzymes are proteins that control and speed up biochemical reactions in living organisms. Enzymes are specific, for example, proteases break down proteins, but do not affect carbohydrates or lipids, and lipases break down lipids but do not affect proteins or carbohydrates and so on.

Anatomy of the system



As you can see, there are many parts to the digestive system, but each has its specific function.

Oral Cavity (mouth)

Teeth

Food enters the mouth and digestion begins with the teeth breaking down the food into smaller pieces. This serves 2 purposes:

1. Makes the food easier to swallow
2. Gives food a large surface area for enzymes to work on

Salivary glands

The salivary glands secrete saliva which mixes with the chewed food. Saliva has two functions:

1. Saliva contains the enzyme **amylase** which is a carbohydrase and breaks down starch into sugar.
2. Saliva also contains **mucus** which lubricates the food (forming into a ball called the bolus) and helps it pass down the oesophagus

Oesophagus and Pharynx **(Swallowing)**

Swallowing is a reflex reaction and happens without us thinking about it. Before swallowing the tongue rolls the food into the bolus and pushes it to the back of the mouth. The food pushes the soft palate upwards which blocks the upper pharynx and stops food going into the nasal cavity. Voluntary muscles in the face, neck and tongue push the food through the pharynx. As the food is swallowed it passes over the **epiglottis** which covers the opening of the respiratory system and prevents food entering it. Food passes the epiglottis and into the oesophagus which connects the pharynx to the stomach.

The oesophagus has circular muscles in the wall. These muscles contract behind the bolus to push it along and the muscles in front of the food relax. This way food passes along the oesophagus to the stomach. This movement is known as **peristalsis**.

Stomach

The bolus enters the stomach. The stomach cells (found in glands in its lining) make gastric juices which mix with the food.

- The gastric juices contain a **protease** enzyme called **pepsin** which breaks down proteins into amino acids.
- The juices also contain **hydrochloric acid**, this is because pepsin works best in an acidic environment of pH 2.
- The acid in the juices also kills any germs.

The muscular walls of the stomach churn the food and mix it well with the secretions. After 2-3 hours of churning the food is a thick liquid called **chyme** that can be released in spurts into the duodenum, the first part of the small intestine.

Small Intestine

The small intestine is about 6 or 7 meters long. Chyme leaves the stomach via the pyloric sphincter and enters the small intestine. The small intestine consists of three parts, the **duodenum, jejunum** and **ileum**.

In the small intestine 3 important digestive juices are added to the food secreted by the liver and pancreas.

- **Bile:** The **liver produces bile** which is stored in the **gall bladder** and enters the small intestine via the **bile duct**. Bile has 2 important functions:
    1. Bile is alkaline and neutralises the acid which was added to the food in the stomach. This provides the best pH for the enzymes in the small intestine to work at.
    2. Bile **emulsifies** fats; it breaks large molecules of fat into smaller droplets which increases the surface area of fats for the enzyme lipase to work on.

- **Pancreatic juice:** The **pancreas** produces pancreatic juices which contain carbohydrases, proteases and lipases. These enzymes empty into the duodenum to further continue digesting the food.

- **Intestinal juices:** The glands in the wall of the small intestine produce intestinal juice. This also contains carbohydrases, proteases and lipases. These enzymes complete the digestion of the food.

In addition to digestion the small intestine has another important job and this is **ABSORPTION**. The small intestine is ideal for absorption because it has:

- A thin lining
- Plentiful blood supply
- Very large surface area

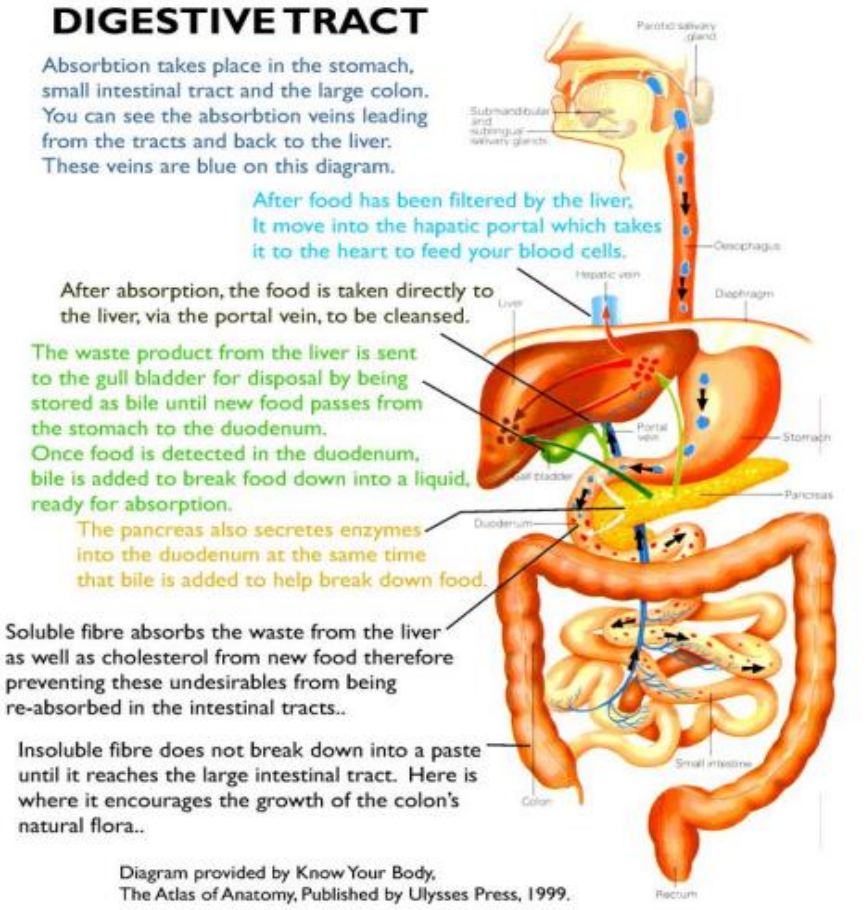
The surface area of the small intestine is around 9 square meters! This is possible because the small intestine is very long (around 6 or 7 meters) and it is lined with tiny finger like projections called **villi**. Each villus in turn is covered with even smaller **microvilli**. The villi have very thin walls and a good blood supply which means that the digested food can be easily absorbed from the gut into the blood. There are millions of villi which provide a massive surface area to maximise the rate of absorption.

Large Intestine

Any indigestible or non absorbed chyme passes into the large intestine. Excess water and salts are absorbed and the remaining chyme is converted into faeces. The faeces is stored in the rectum until it is excreted through the anal canal.

Intestinal bacteria

The intestines are home to more than 500 species of bacteria, which they need to function effectively. Some of these bacteria protect the intestines from disease. Certain bacteria in the large intestine make vitamin K, which the body needs for blood clotting.



MOUTH

The mouth is a cavity formed between the tongue at its base, cheeks at the side, hard and soft palate in its roof, and teeth at the front. The teeth tear and grind food, which is then churned through movements of the jaws and tongue. This is called mechanical digestion. Breaking the food into smaller pieces creates a larger surface area for the action of enzymes in saliva (Amylase); these begin to digest

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