Human Nutrition

Diet and deficiency diseases, the human digestive system, teeth, enzymes and digestion, bile, peristalsis, and absorption and assimilation in the small intestine.

7.1 Diet

A **balanced diet** contains all the nutrients in the correct amounts for energy and health: carbohydrates, lipids, proteins, vitamins, minerals, fibre and water. How much is needed depends on age, sex, activity level and whether a woman is pregnant or breast-feeding.

Nutrient	Main sources	Importance
carbohydrates	bread, rice, potatoes, pasta, sugar	the main source of **energy**
lipids (fats and oils)	butter, oil, nuts, meat, fish	a store of energy, insulation, and part of cell membranes
proteins	meat, fish, eggs, beans, milk	**growth and repair** of tissues; make enzymes and hormones
vitamin C	citrus fruits, tomatoes, green vegetables	keeps skin and gums healthy; helps wounds heal
vitamin D	oily fish, eggs, milk; made in the skin in sunlight	helps the body absorb **calcium**, for strong bones and teeth
calcium	milk, cheese, green vegetables	strong bones and teeth
iron	red meat, liver, spinach	makes **haemoglobin** in red blood cells
fibre (roughage)	vegetables, fruit, whole grains	gives bulk to the food so that **peristalsis** can push it along, preventing constipation
water	drinks and food	a solvent; makes up blood plasma, cytoplasm and urine; needed for all chemical reactions

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Deficiency diseases

Missing nutrient	Disease	Symptoms
vitamin C	**scurvy**	bleeding gums, slow healing of wounds, loose teeth
vitamin D	**rickets**	soft, weak bones that bend (bow legs) in children
calcium	**rickets**	soft, weak bones, and weak teeth
iron	**anaemia**	not enough haemoglobin, so tiredness, weakness and pale skin

NOTE

A **balanced diet** is not the same as a large diet. Eating too much energy food leads to being overweight and a higher risk of heart disease.

7.2 Human digestive system

Why food must be digested

Most food molecules are **large and insoluble**, so they cannot pass through the wall of the gut into the blood. They must be **digested** into small, soluble molecules that can be absorbed.

- **Physical digestion** is the breakdown of food into **smaller pieces without chemical change** to the food molecules (chewing and the churning of the stomach). It increases the **surface area** of the food for enzymes to act on.
- **Chemical digestion** is the breakdown of **large molecules into small molecules** by **enzymes**.

Teeth

Type	Function in physical digestion
incisors	cutting and biting food
canines	tearing and piercing food
premolars	crushing and grinding food
molars	crushing and grinding food

Parts of a tooth: **enamel** (the hard outer covering of the crown), **dentine** (a bone-like layer beneath it), **pulp** (the soft centre with nerves and blood vessels), and **cement** (which fixes the root into the jaw). Teeth are embedded in the **gum**.

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The regions of the digestive system

Region	Function
mouth	ingestion; physical digestion by teeth; chemical digestion of **starch** by **amylase** in saliva
salivary glands	secrete **saliva** containing amylase
oesophagus	carries food to the stomach by peristalsis
stomach	physical digestion (churning); chemical digestion of **protein** by **protease** (pepsin); secretes **hydrochloric acid**
small intestine (duodenum and ileum)	chemical digestion of starch by amylase, maltose by maltase, protein by protease and lipids by lipase; **absorption** of nutrients in the ileum
liver	makes **bile**; stores **glycogen**
gall bladder	stores bile
pancreas	secretes an **alkaline** juice containing **amylase, protease and lipase** into the duodenum
large intestine (colon)	absorbs water (and some ions)
rectum and anus	the rectum stores faeces and the anus **egests** them

The digestive enzymes

Enzyme	Substrate	Products	Where
amylase	starch	**maltose**	mouth (saliva) and small intestine (from the pancreas)
maltase	maltose	**glucose**	small intestine
protease (pepsin and trypsin)	protein	**amino acids**	pepsin in the stomach; trypsin in the small intestine
lipase	lipids (fats and oils)	**fatty acids and glycerol**	small intestine (from the pancreas)

- **Hydrochloric acid** in the stomach **kills bacteria** that are eaten with the food, and provides the **acid conditions** (about pH 2) in which pepsin works best.
- The proteases in the stomach and the duodenum work best at **different pH values**: pepsin in acid and trypsin in the alkaline conditions of the small intestine (the pancreatic juice and bile neutralise the acid

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from the stomach).

Bile

Bile is made in the liver and stored in the gall bladder. It emulsifies fats: it breaks large fat droplets into many smaller droplets, which increases the surface area for the enzyme lipase to digest the fat to fatty acids and glycerol. It also neutralises the stomach acid, giving the alkaline conditions that the enzymes need.

Bile does not contain enzymes, and it does not chemically digest fat.

Peristalsis

Peristalsis is waves of contraction of the longitudinal and circular muscles in the wall of the gut, which squeeze the food along the digestive system.

The circular muscles contract behind the food, narrowing the gut, while the longitudinal muscles contract to shorten that section; the muscles ahead of the food relax, so the food moves forwards.

TRY IT

Name the enzyme and the products when starch is digested in the mouth, and the enzyme that finishes the digestion.

Amylase breaks starch down to **maltose**. **Maltase**, in the small intestine, breaks maltose down to **glucose**.

7.5 Absorption and assimilation

Absorption is the movement of nutrients from the intestines into the cells that line the digestive system and then into the blood. Assimilation is the uptake and use of nutrients by cells from the blood.

The **small intestine** (mainly the **ileum**) is where most nutrients are absorbed. Absorption happens by **diffusion**, **osmosis** and **active transport**. **Water** is absorbed in the small intestine and the colon, but **most** of the water is absorbed in the **small intestine**.

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Villi

The inner wall of the ileum is covered in many tiny finger-like projections called **villi**. The cells on their surface have even smaller projections called **microvilli**.

Feature of a villus	Function
villi and microvilli	a very **large internal surface area** for absorption
a wall one cell thick	a short diffusion distance
a network of capillaries	a good blood supply that takes away glucose and amino acids, keeping a steep concentration gradient
a lacteal (a lymph vessel)	absorbs **fatty acids and glycerol**

The hepatic portal vein

> **The hepatic portal vein carries most of the molecules and ions absorbed from the ileum to the liver.**

The liver then regulates what reaches the rest of the body: it stores glucose as glycogen, turns excess amino acids into urea, and removes toxins.

Assimilation

The nutrients that are carried in the blood are used by the cells: glucose in respiration, amino acids to build proteins, and fatty acids and glycerol to make cell membranes and for energy storage.

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