Nutrition - Digestive system
Digestion helps homeostasis

A digestive system involves various processes:

- Ingestion
- Mechanical digestion
- Chemical digestion
- Absorption
- Elimination
Chemical digestion involves specific enzymes in the macromolecule breakdown.
**Heterotrophs** are divided into four groups on the basis of their food strategy.

**Bulk feeders**
eat food in chunks or whole

**Filter feeders**
collect and eat small particles from water
Animal strategies

**Fluid feeders**
consume fluids as blood or lymph

**Substrate feeders**
live on or in the food they eat
Teeth are adapted to different strategies

**Heterotrophs** are divided into three groups on the basis of their food sources.

**Herbivores**: animals that eat plants exclusively; common examples include vertebrates such as cattle, horses and rabbits.

**Carnivores**: animals that eat other animals, such as crabs, squid, many insects and cats.

**Omnivores**: animals that eat both plants and other animals. Humans are omnivores, as are pigs and bears.

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<th>Herbivore</th>
<th>Carnivore</th>
<th>Omnivore</th>
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<td>Horse</td>
<td>Lion</td>
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Vertebrate digestive systems include highly specialized structures molded by diet.

The digestive system consists of a tubular gastrointestinal tract and accessory digestive organs. One-way movement through the digestive tract allows different regions of the digestive system to become specialized for different functions.
Carnivores have a short digestive tract, as they obtain nutrients from meat more easily. They also have a relatively small caecum.
Herbivores have a long digestive tract, as it takes a long time to digest cellulose from plants, and a large caecum which houses mutualistic aerobic bacteria which help animals digest the cellulose.
Some herbivores called **ruminants** (cows, sheep) have specialized stomachs divided into **rumen** (1), **reticulum** (2), **omasum** (3) and **abomasum** (4) hosting microbial flora.
Our digestive system is adapted to an omnivorous diet.

The breakdown of the nutrients requires the coordination of several digestive enzymes secreted from specialized cells.

The major organs or structures that coordinate digestion within the human body include:

- mouth
- esophagus
- stomach
- small and large intestine
- liver
The mouth

Both **first mechanical** (biting and chewing) and **chemical** digestion occur in the mouth.

Humans have four kinds of 32 teeth: **incisors** (for biting); **canines** (for tearing); **premolars** and **molars** (for crushing food).

**Three pairs of salivary glands** secrete saliva that contains an enzyme called **amylase**, which digests starch molecules into smaller disaccharides.

During chewing, the **tongue** moves food about and manipulates it into a mass called a bolus. The bolus is pushed down into the pharynx (throat).
The esophagus

The esophagus is a muscular tube that passes from the pharynx to the stomach.

During swallowing, the air passage is blocked by soft palate (1) and epiglottis (2), so the food bolus enters the esophagus (3).
After swallowing, **peristaltic movements** (a rhythmic series of muscular contractions) push the food bolus in the esophagus to the stomach.
The stomach

The **stomach** is a saclike organ. Its inner surface is highly convoluted, enabling it to fold up when empty and open out like an expanding balloon as it fills with food.

The human stomach has a volume of only about 50 mL when empty, but it may expand to contain 2 to 4 L of food when full.

Carnivores that engage in sporadic gorging as an important survival strategy possess stomachs that are able to distend even more.
The stomach

Layers of stomach muscle contract and attack the bolus of food with gastric juices to form a soupy liquid called chyme.

Where the esophagus joins the stomach, a valvelike muscle, the cardiac sphincter, relaxes as the bolus passes through and then quickly closes. A second sphincter, the pylorus, connects to the beginning of the intestines.
The stomach

1. stores food
2. prepares food for second chemical digestion.
3. plays a role in protein digestion. Gastric glands secrete an hormone that is converted to the enzyme pepsin which digests large proteins into smaller proteins (peptides)

The food is mixed with gastric acid juices containing pepsin. To protect the stomach wall from the acid, a third type of cell secretes mucus that lines the stomach cavity.
Gastric acids and the ulcer

The human stomach produces about 2 L of HCl every day, creating a very acidic solution (pH=2). The low pH in the stomach helps denature food proteins, making them easier to digest.

In adult humans, only proteins are partially digested in the stomach; no significant digestion of carbohydrates or fats occurs there. *The acidic solution within the stomach also kills most of the bacteria that are ingested with the food.*

Overproduction of gastric acids can occasionally eat a hole through the wall of the stomach, causing a **peptic ulcer**. Different reasons cause peptic ulcers such as the infection of the bacterium *Heliobacter pylori* and the consumption of some types of foods.
The intestine: Breakdown, Absorption, and Elimination
The small intestine

The chyme spurts from the stomach through a sphincter into the 5 to 9 meters long small intestine. Here **absorption of nutrients** takes place.

Small nutrient molecules are absorbed by the **villi** on the intestinal wall.
Accessory organs secrete enzymes into the small intestine

The main organs that aid digestion are the **pancreas**, **liver**, and **gallbladder**. They empty their secretions (pancreatic juice and bile), primarily composed of enzymes, through ducts directly into the small intestine.
Pancreas, Liver and Gallbladder

The **pancreas**, secretes **pancreatic fluid** into the duodenum through the pancreatic duct. This fluid contains a group of enzymes, including **trypsin**, which digest proteins; **amylase**, which digests starch; and **lipase**, which digests fat.

The **liver** is the largest internal organ of the body. The main secretion is **bile**, a fluid mixture consisting of:

1. **The bile pigments**: do not participate in digestion; they are waste products resulting from the liver’s destruction of old red blood cells and are ultimately eliminated with the feces
2. **The bile salts** play a very important role in preparing fats for subsequent enzymatic digestion

After bile is produced in the liver, it is stored and concentrated in the **gallbladder**. The arrival of fatty food in the duodenum stimulates the gallbladder to contract, causing bile to be transported through the common bile duct and injected into the duodenum.
The chemical digestion

- The enzymes digesting **carbohydrate** include **amylase** (for starch), **maltase** (for maltose), **sucrase** (for sucrose) and **lactase** (for lactose).

- For **fats**, the principal enzyme is **lipase**. Before this enzyme can act, the large globules of fat must be broken into smaller droplets by bile.

- **Protein** digestion is accomplished by several enzymes, including **trypsin**. Peptides are broken into smaller peptides, and **peptidase** reduces the peptides to amino acids.

- **Nuclease** digests **nucleic acids** into nucleotides.
The large intestine absorbs water, minerals and vitamins and prepare waste for elimination. It is divided into cecum, colon and rectum.

The cecum controls the flux of material through the intestine and the appendix protects from infections.
The large intestine

The **colon** is the last portion of the digestive tract and extracts the last water and minerals from waste before final elimination. Bacteria-aided fermentation occurs.

The **rectum** is the final part of the large intestine and terminates in the **anus**. Here feces are formed and expelled.
Nutrition disorders

Obesity is defined as weighing 30% more than ideal body weight. Obesity is often associated with Type 2 Diabetes and cardiovascular diseases.

Other common nutrition disorders are anorexia nervosa (distorted body image that leads to hypo-nutrition) and bulimia nervosa (binge-eating and purging).
Liver malfunctioning has effects on the whole organism.

Liver disorders include:

- *Hepatitis*: inflammation of the liver caused by viruses
- *Cirrhosis*: damage of tissues leading to loss of liver functions
- *Liver cancer*