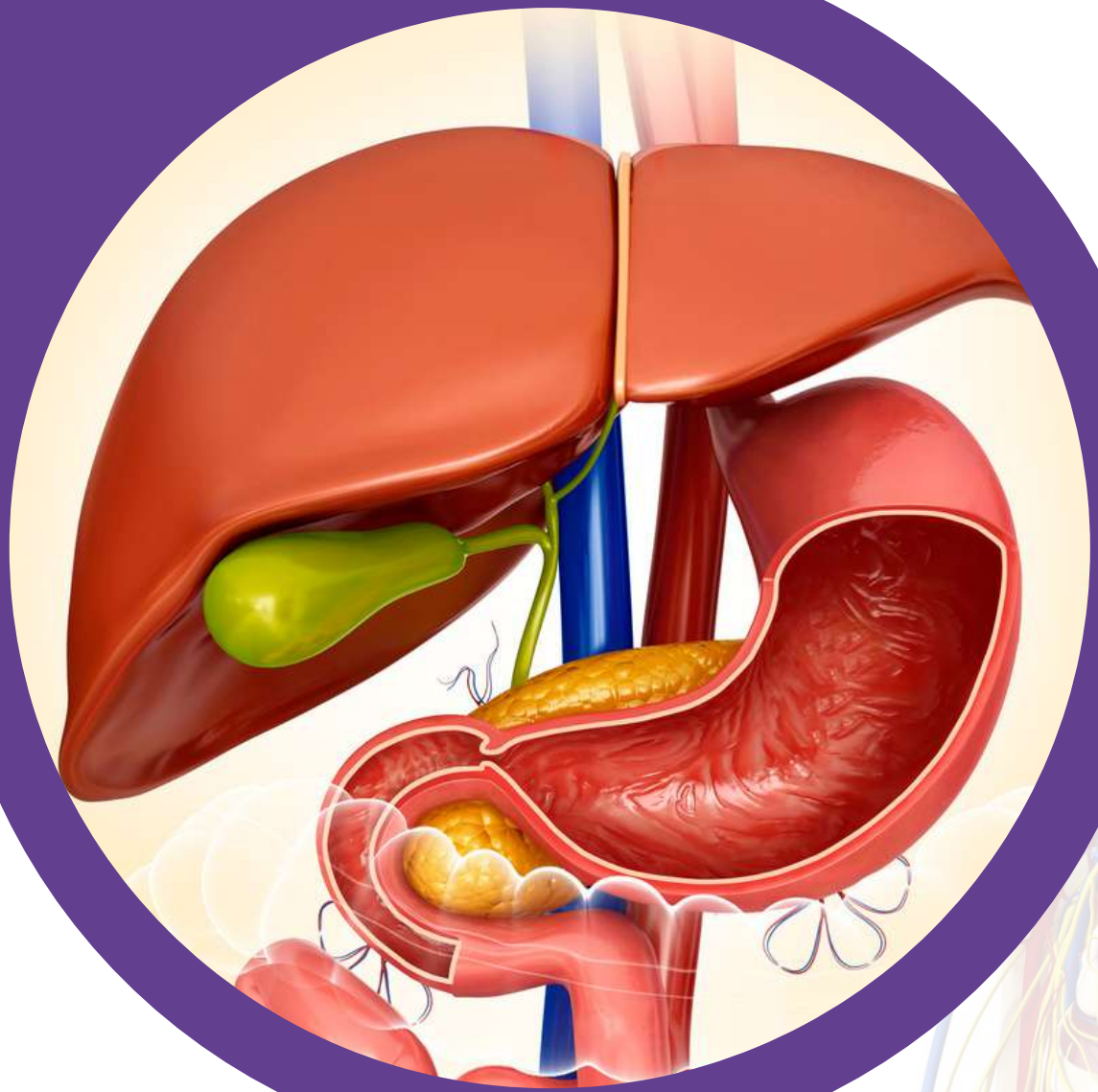
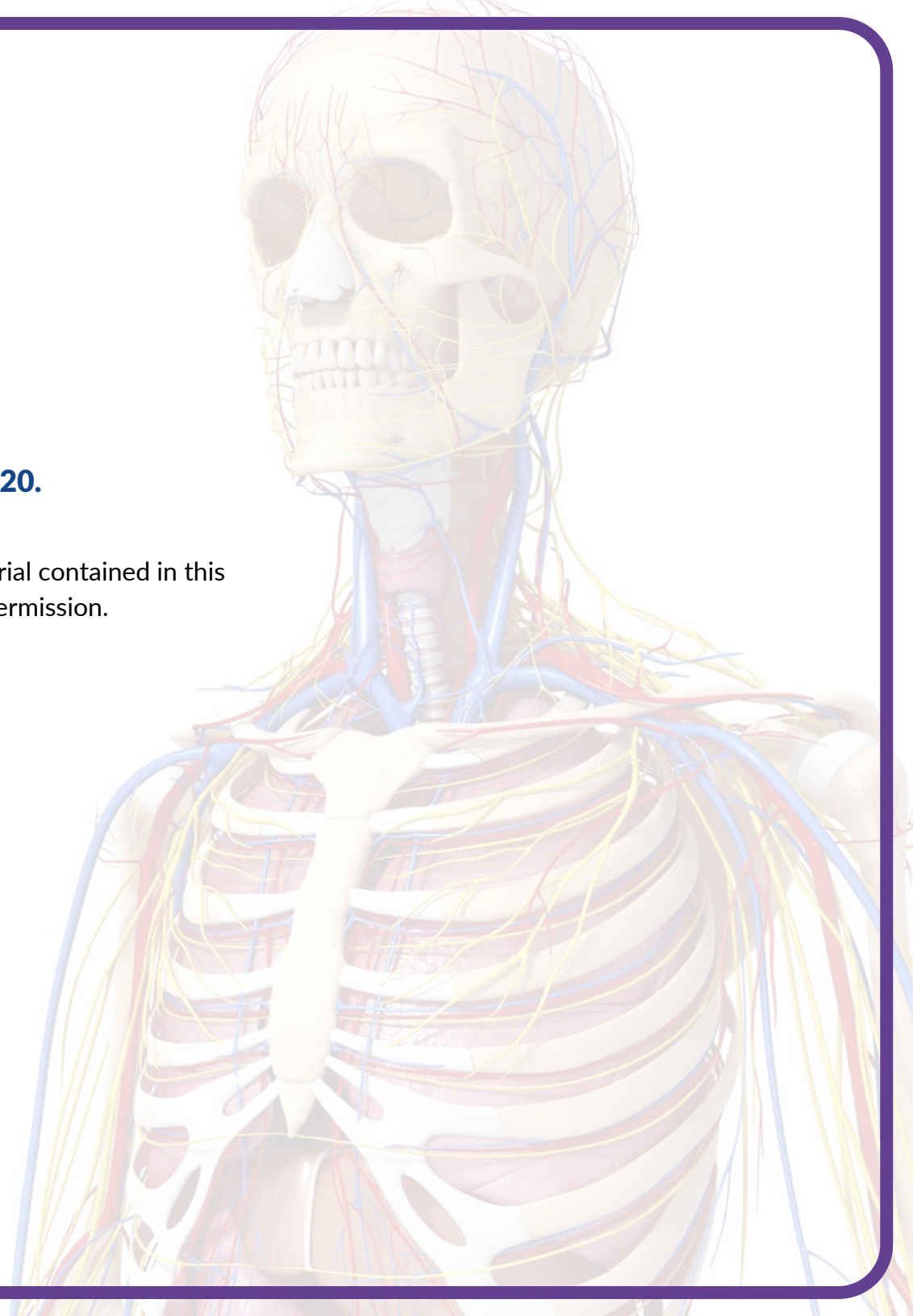


Digestive System Workbook



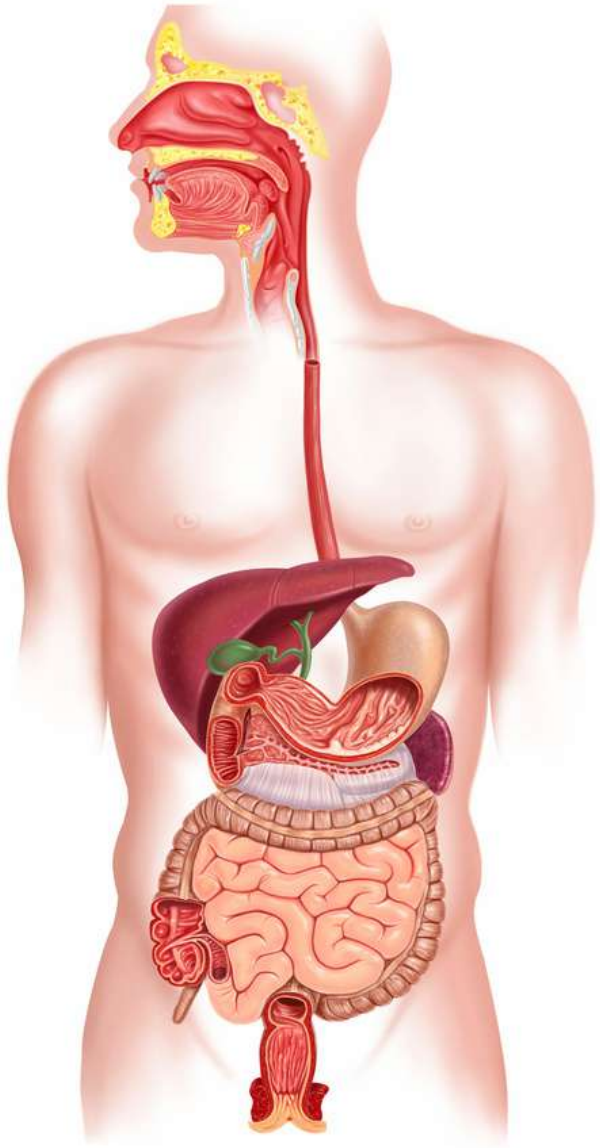
Contents

Learning Objectives

- Describe the function of the digestive system and its major components.
- Describe the relationships between the different components of the digestive system.
- Explain how the digestive system is interdependent with other organ systems.
- Explain how the digestive system maintains homeostasis in the body

Digestive System Overview

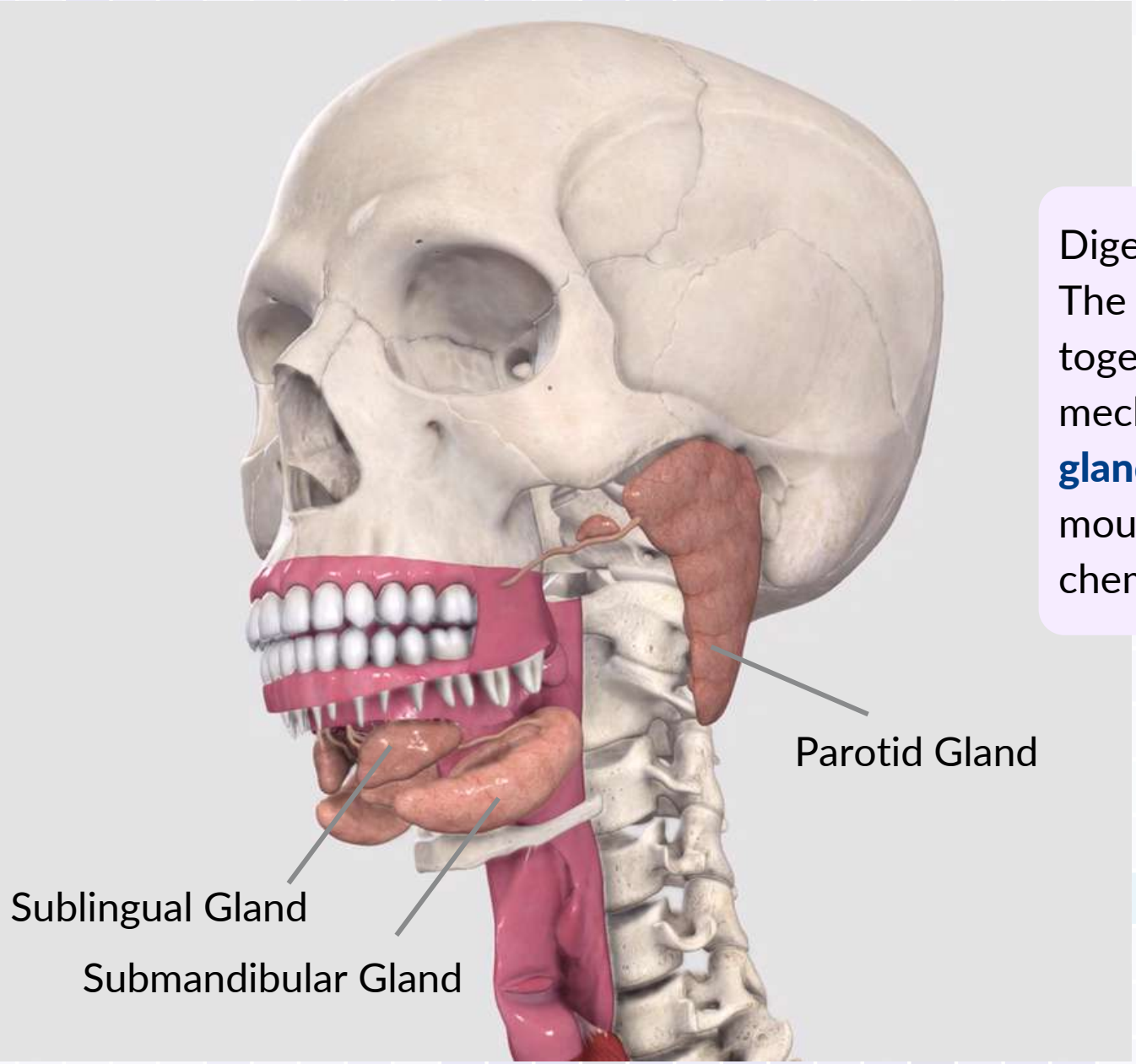
The digestive system is responsible for taking whole foods and **turning them into nutrients and energy**, which allows the body to function, grow and repair itself.



COMPONENTS

Mouth
Esophagus
Stomach
Small Intestine
Liver
Gallbladder
Pancreas
Large Intestine

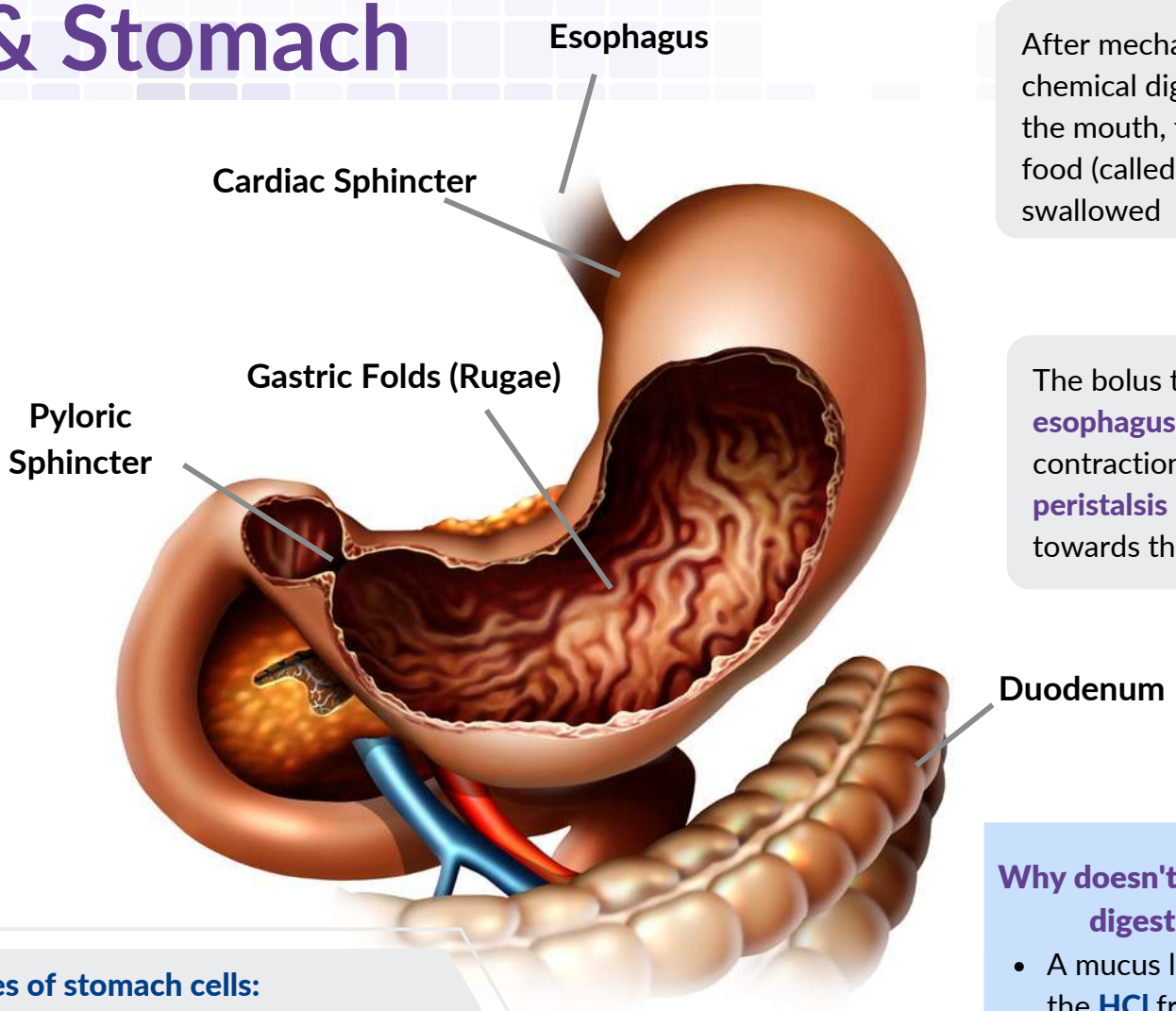
Mouth: Teeth, Tongue & Salivary Glands



Digestion begins in the **mouth**. The **teeth** and **tongue** work together to break down food mechanically. The **salivary glands** release saliva into the mouth to break down food chemically.

Esophagus & Stomach

- Location: dorsal and posterior to the liver
- Structure: muscular organ
- Function: muscular organ that continues the **chemical and mechanical digestion** that started in the mouth



After mechanical and chemical digestion in the mouth, the chewed food (called a **bolus**) is swallowed

The bolus then enters the **esophagus**. Muscle contractions called **peristalsis** push food along towards the stomach.

There are 3 types of stomach cells:

- **Mucus cells**: secrete protective coat
- **Parietal cells**: secrete **HCl** (pH 3) which kill bacteria and help breakdown food
- **Peptic cells**: secrete **pepsinogen**, which forms the enzyme **pepsin** when combined with **HCl**. Pepsin is a **hydrolytic enzyme** that breaks down proteins into smaller amino acid chains called **peptides**
- Peptides are broken down into individual amino acids further on in digestive system by other enzymes

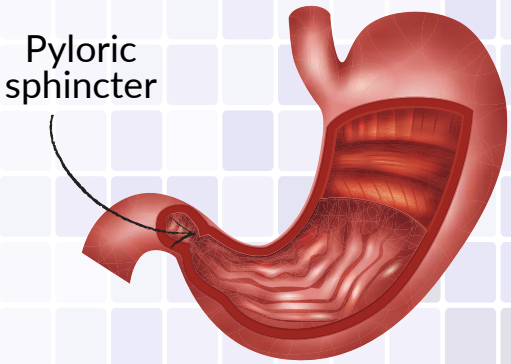
Protein + H2O --- Pepsin ---> Peptides

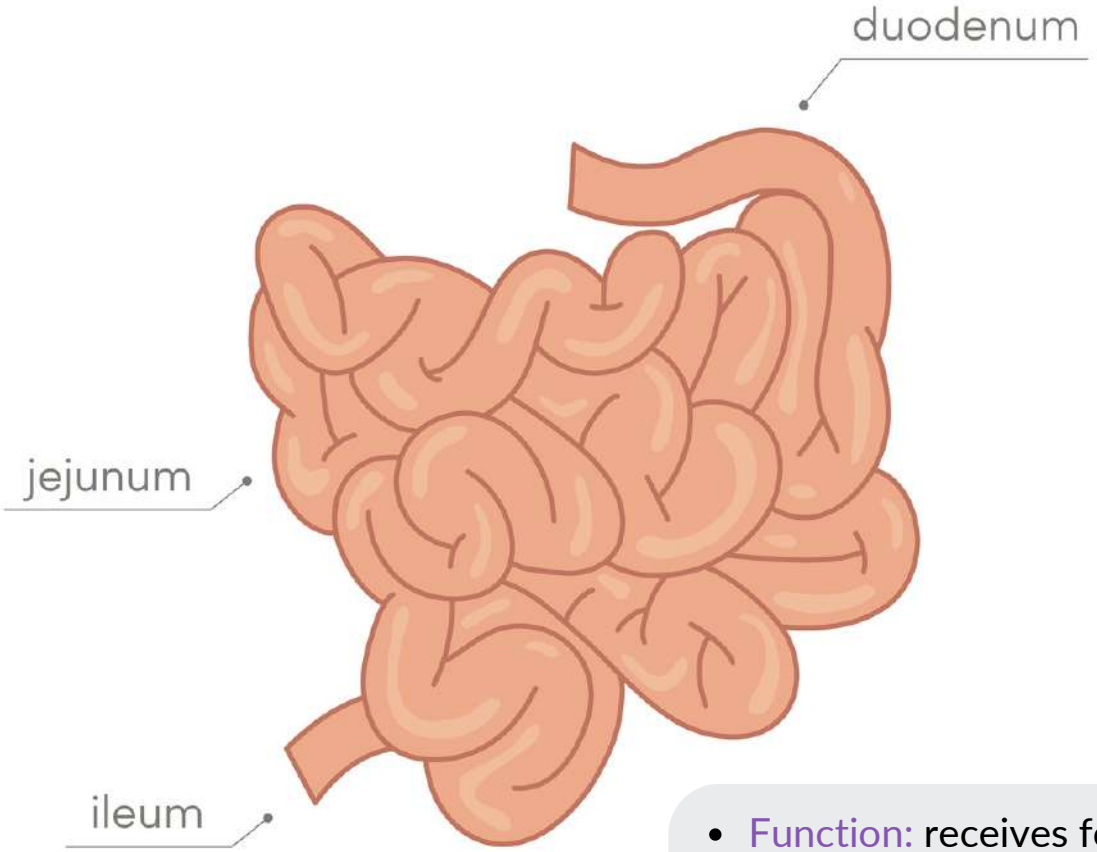
Why doesn't the stomach digest itself?

- A mucus layer prevents the **HCl** from eating through
- **Pepsin** could digest protein in the stomach cells, but pepsin is inactive until it mixes with HCl
- HCl isn't formed until it crosses the stomach lining

Small Intestine

The food travels to the **small intestine** from the **stomach** through the **pyloric sphincter**





- Location: slender coiled tube, starting at the **stomach**, and connects the **large intestine** at the **caecum**
- Structure: consists of **duodenum, jejunum, and ileum**, supported and wrapped by a membrane of **mesentery**

- Function: receives food from stomach
  - Completes **digestion** started earlier
  - Most food **absorption** and **chemical** digestion occurs here

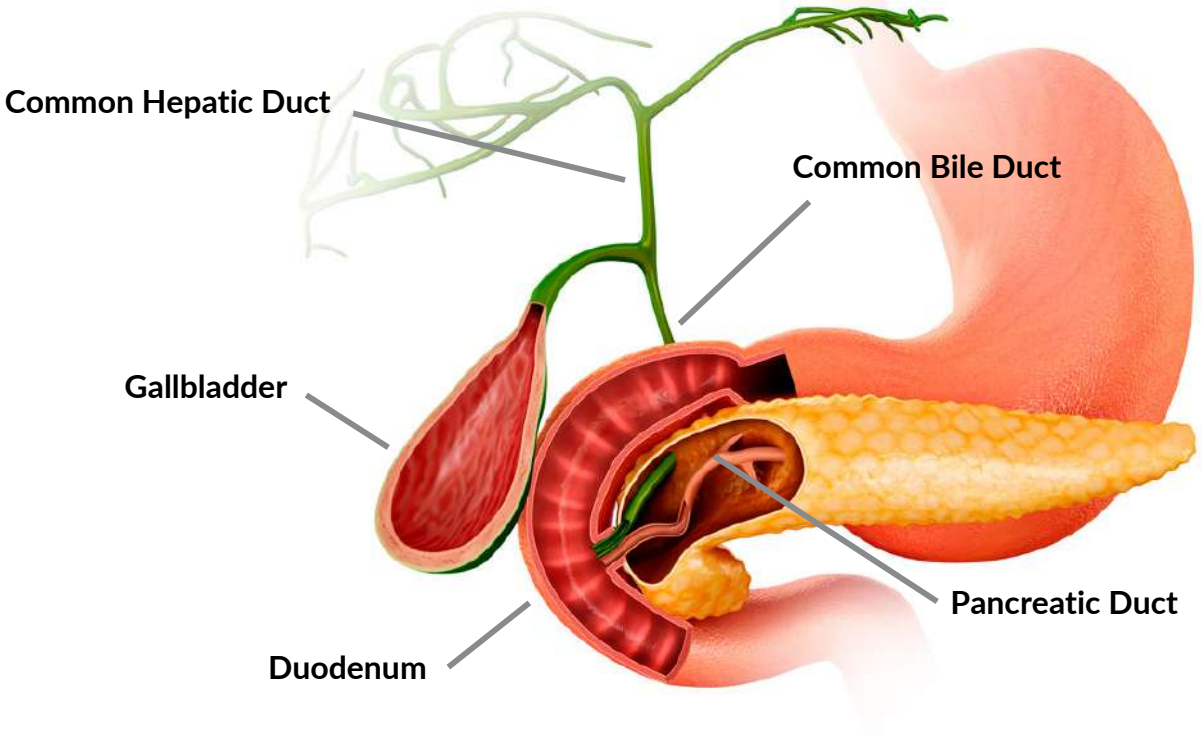
Pancreas

Exocrine Functions: cell secretions are released into a duct

- **Produces bicarbonate ions (HCO3).**
  - These neutralize stomach acids and make pH of intestine 7-8 (alkaline).
  - released through pancreatic duct. Small intestine enzymes are optimum at basic pH
- **Produces digestive enzymes**: amylases, peptidases, lipases, and nucleases
  - released through pancreatic duct into the duodenum of the small intestine

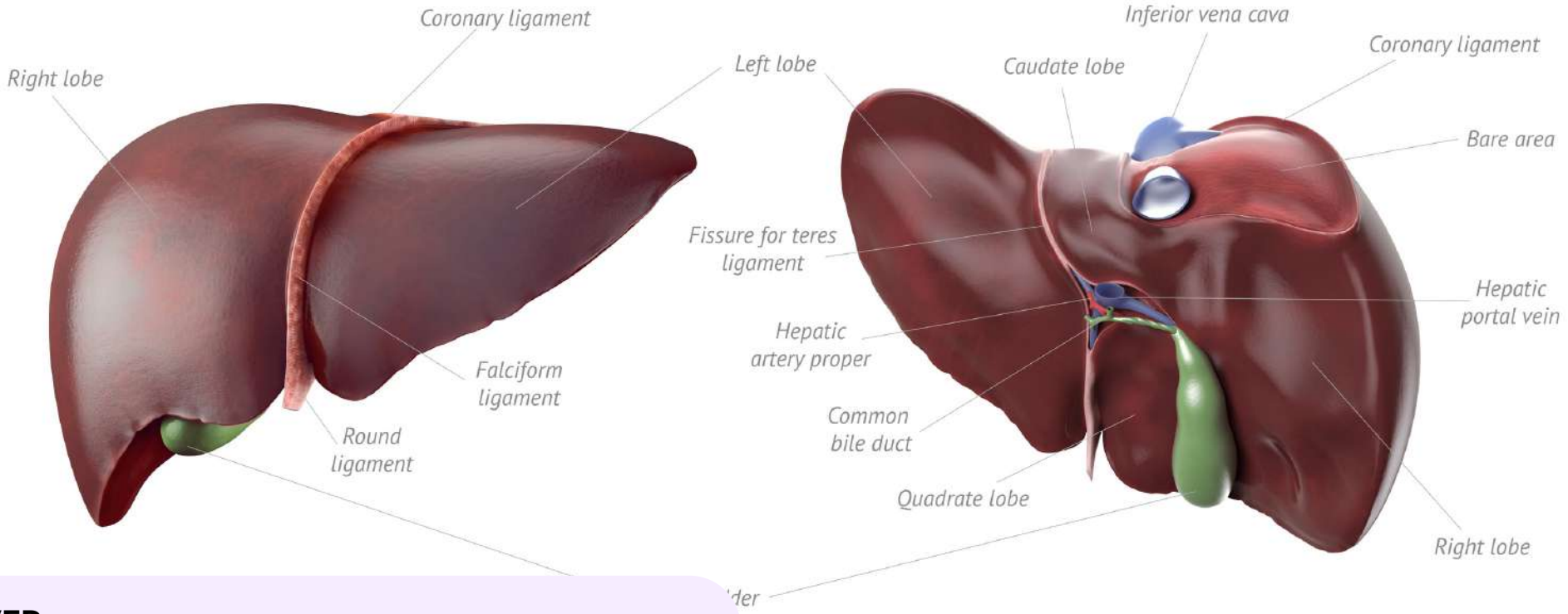
Endocrine Functions: cell secretions released into blood

- **Produces insulin**: controls cellular uptake of glucose and its conversion into glycogen (insulin secreted when low glucose levels in blood).
- **Produces glucagon**: stimulates conversion of glycogen into glucose (glucagon secreted when high glucose levels detected in blood)
- This regulates blood sugar.



Just after eating **high glucose** level food, **insulin** is secreted which causes cells to take up glucose in the liver and muscle. Glucose is then converted into **glycogen** for storage. When fasting, glucagon converts glycogen in the liver and muscle into glucose.

Liver & Gallbladder



LIVER

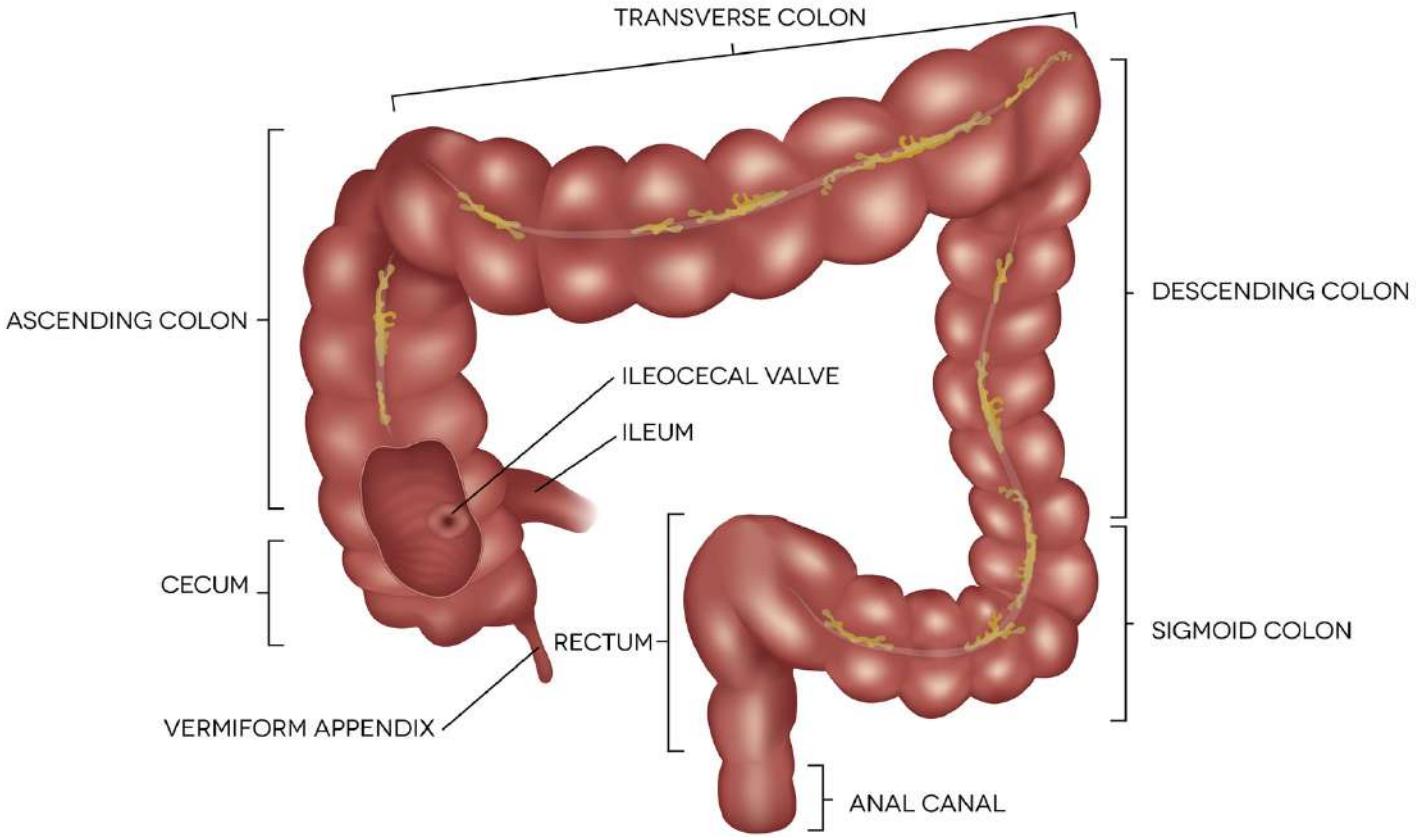
- Location: ventral & anterior to the **stomach**
- Structure: dark red/brown wedge-shaped organ with **2 lobes**
- Function: multipurpose organ
  - Produces bile
  - Removes toxins
  - Stores carbs
  - Regulates blood sugar levels

The **gallbladder** stores the **bile** produced by the liver.

The **common bile duct** joins with the **pancreatic duct** to deposit digestive enzymes (from pancreas) and bile (from liver) into the **duodenum** of the small intestine.

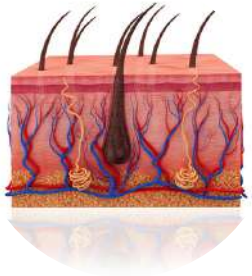
Large Intestine

- Structure: consists of **ascending, transverse and descending colon** and **rectum**
  - Muscular contractions in large intestine initiate defecation
- Function: storage of undigested materials that have passed through the small intestine
  - **Reabsorbs water** from digested food



The **ascending colon** absorbs water and nutrients; the **transverse colon** absorbs water, salts and some nutrients; the **descending colon** stores feces.

Digestive System & Other Organ Systems



Integumentary System

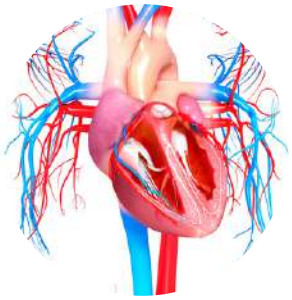
The skin provides **vitamin D**, which plays an integral role in the absorption of **vitamin C** in the digestive tract, and helps protect the digestive tract. The digestive system provides nutrients required by skin, hair, and nails.

Muscular System

Peristalsis is created by **smooth muscles**, while **skeletal muscles** aid in voluntary sphincter control, swallowing, and protect and support abdominal organs. The digestive system provides cellular energy (**ATP**), which is required by muscular cells, from micro-nutrients produced in the digestive tract. Lactic acid build up after muscle activity is metabolised by the liver.

Endocrine System

Endocrine hormones aid in secretion regulation in accessory organs and digestive glands; glucose storage in the liver is controlled by insulin and glucagon. Hormones are also produced by the small intestine and stomach.



Cardiovascular System

Blood vessels transport nutrients from the digestive system to various other parts of the body. Nutrients from the digestive system are provided for the formation of blood cells and plasma protein. Plasma proteins are produced by the liver. It also destroys old red blood cells and detoxifies blood.

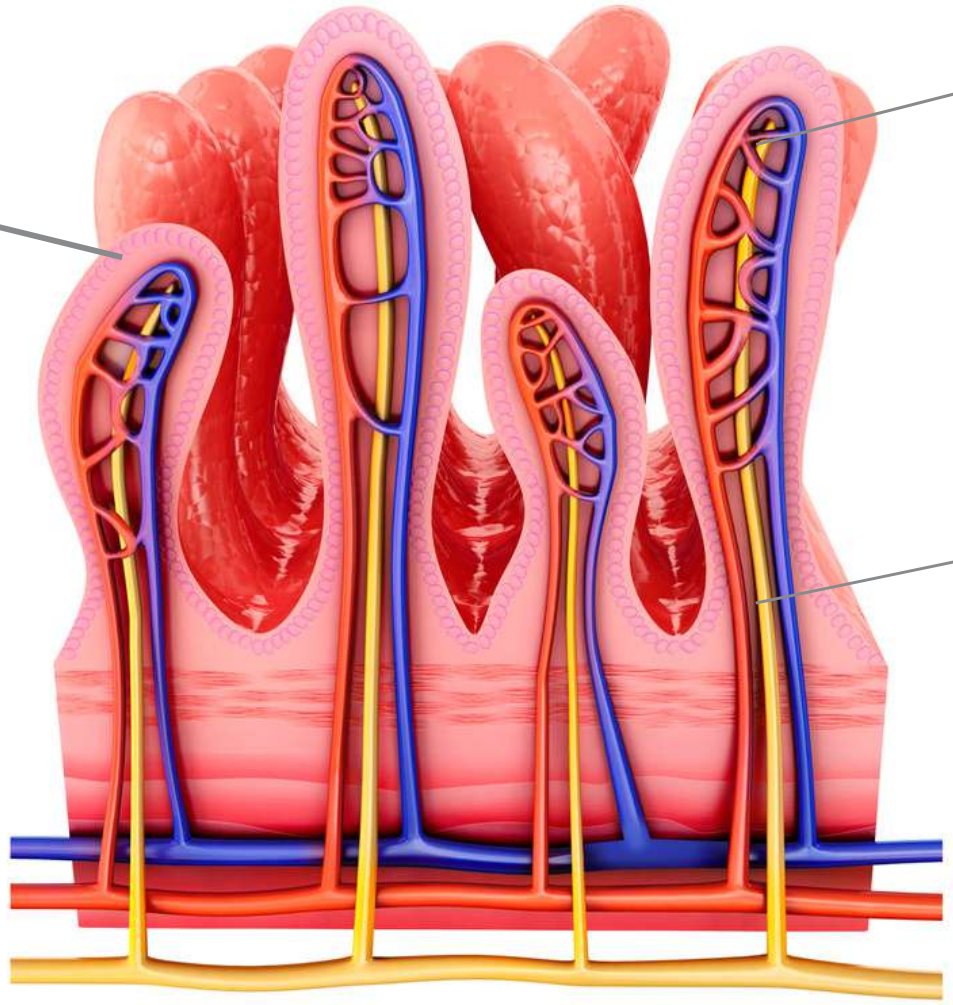
Intestinal Villi

Interdependence of digestive, cardiovascular and lymphatic systems

Epithelial cells

Outer layer of villi one cell thick to increase rate of diffusion. Can be covered in various types of cells with different functions:

- **Microvilli** for absorption
- **Glandular** cells produce and release enzymes/mucus into intestinal lumen
- Some have **digestive enzymes** bound to their outer membrane



Blood Capillaries

Absorb amino acids and glucose, and carry them back to the hepatic portal vein, liver and mesenteric vessels

Lacteal

Lymph vessel that returns lipoprotein droplets and fluid to bloodstream

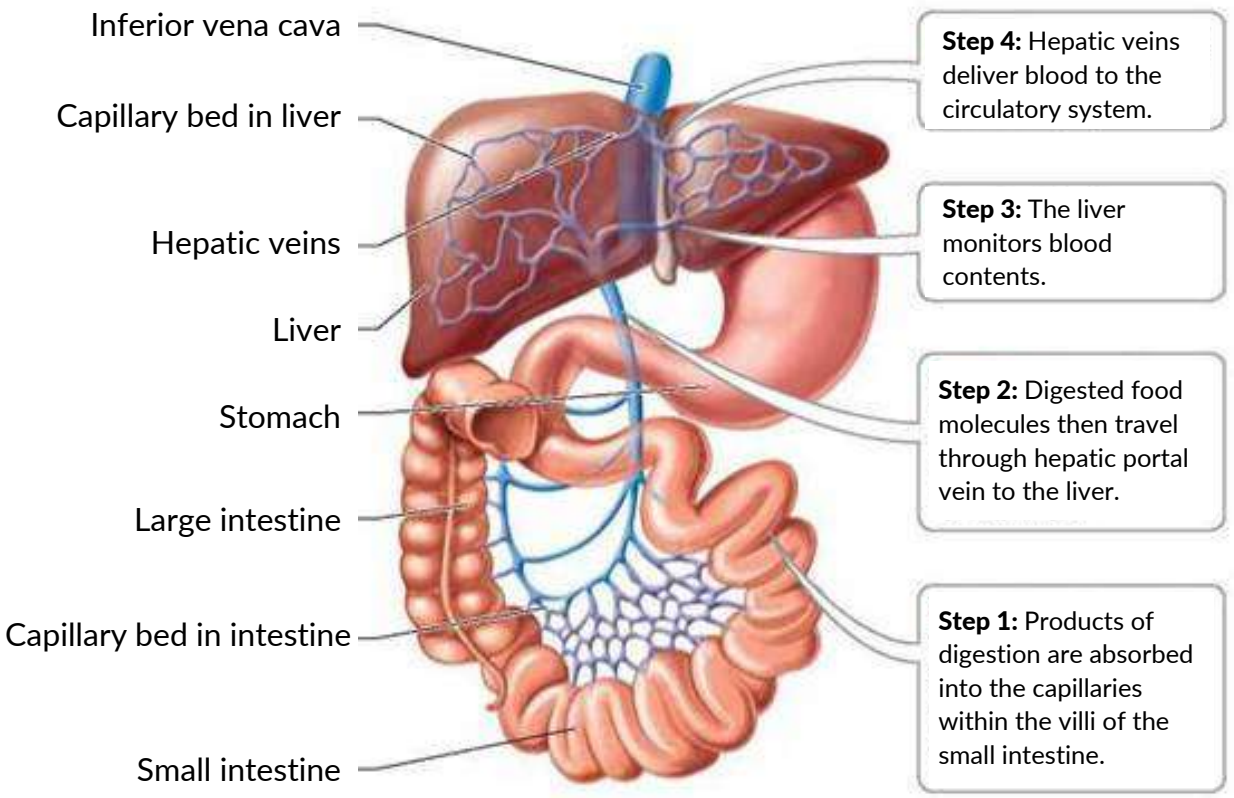
Hepatic Portal System

Interdependence of digestive and cardiovascular systems

The **hepatic portal system** is a series of veins that carry blood from the capillaries of the stomach, intestine, spleen, and pancreas to capillaries in the liver. It is part of the body's filtration system. Its main function is to deliver de-oxygenated blood to the liver to be detoxified further before it returns to the heart.

The hepatic portal system consists of:
Hepatic portal vein - This is the main vein connected to the liver. It forms at the connection of the inferior and superior mesenteric veins.
Inferior mesenteric vein - This vein takes blood from the colon and rectum and connects with the portal vein.
Superior mesenteric vein - This drains blood from the small intestine and connects with the hepatic portal vein.
Gastrosplenic vein - This tributary is formed by the union of the splenic vein from the spleen and the gastric vein from the stomach. It joins with the mesenteric vein inside the pancreas.

The hepatic portal system is designed to rid the body of toxins, but it cannot detect those that are designed to help it. Some drugs must be taken under the tongue, through the skin, or via suppository to avoid entering the hepatic portal system and being prematurely metabolized in the liver before reaching general circulation.



Digestive System & Homeostasis

To keep the internal environment in the body functioning properly, maintaining homeostasis is required. The digestive system, along with other body systems, help maintain energy homeostasis.

Provide Nutrients

For all systems to work properly, the body needs **macro** and **micro-nutrients**. Chemical and mechanical digestion break down ingested food to gain access to these nutrients. This begins in the **mouth**, where food is mixed with **enzymes and saliva**, and continues as it enters the stomach, where it is mixed and **gastric juices** and churned into **chyme**. The **stomach** also produces several hormones that regulate digestion of food. Once the chyme enters the **small intestine**, it is further digested by bacteria. Nutrients are **absorbed** by the small intestine, with some further absorption of water occurring in the **large intestine**.

Bacterial flora located in the intestine are essential in the role of **homeostasis**. They both allow for nutrient absorption by breaking down the food, and produce vitamins such as **biotin** and **vitamin K**, which help protect harmful bacteria from entering the system.

Digestive Organs

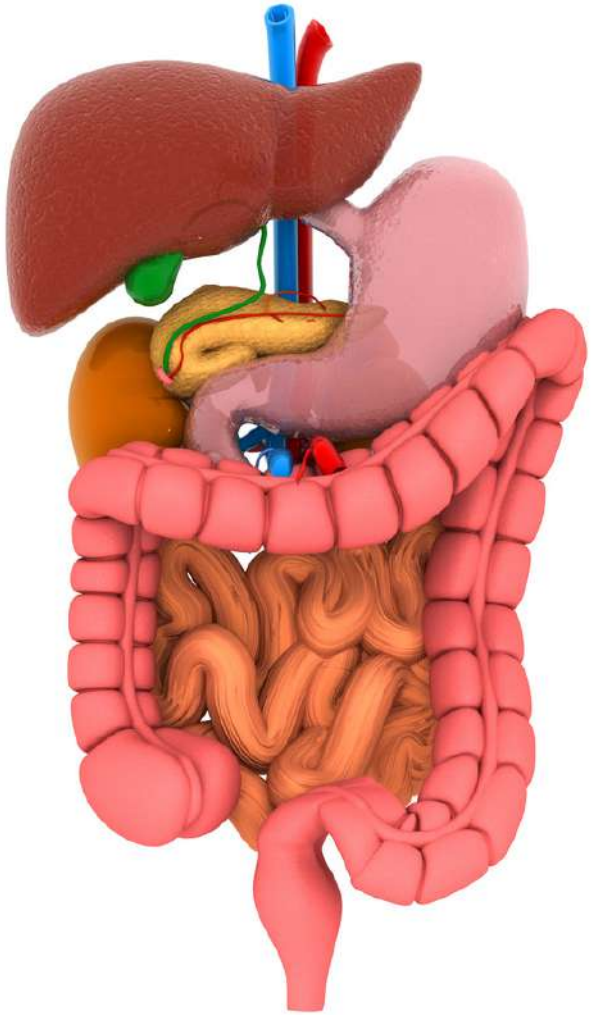
The **bile salts** manufactured by the **liver** that enter the intestines help **emulsify fats**, simplifying their absorption and digestion process. The liver is a vital player in the role of homeostasis. It breaks down alcohol, drugs, and other toxic substances. It stores **glucose** as **glycogen** after meals, and produces **plasma proteins**. In between meals, it releases glucose to keep the concentration of blood glucose constant, regulating the body's blood sugar.

Review Break

- What is one way the digestive system maintains homeostasis within the body?
- What is one way the digestive system interacts with other body systems?
- What are the main structures food moves through from the time a person takes a bite to the time they poop?

QUIZ!

Label the digestive system diagram below (without looking back through your workbook!).



Thank you for choosing these materials to support your anatomy adventures!

These Humane Science Education materials were developed by **Elisabeth Ormandy** for the Canadian Society for Humane Science (2015-2022) working to achieve better science without animals. By choosing these unit plans, you have joined a growing family of Humane Science Educators!

Proud Partner of humane education coalition

We gratefully acknowledge the support of the following funders of this Humane Science Education Program:

LUSH FRESH HANDMADE COSMETICS

vancouver foundation

BCSPCA SPEAKING FOR ANIMALS

BRITISH COLUMBIA

BCFNAR

AWFC THE ANIMAL WELFARE FOUNDATION OF CANADA FONDATION DU BIEN-ÊTRE ANIMAL DU CANADA

A SEED OF CHANGE

THE ROBERT AND JUDITH CLARK FOUNDATION

THE MCLEAN FOUNDATION