

# Digestion

- The process by which food is converted into substances that can be absorbed and assimilated by the body.
- Mechanical & chemical breakdown of food into nutrients.

Four main macromolecules in food: **nucleic acids, proteins, fats, and carbohydrates.**



broken down into smaller molecules of **nucleotides, amino acids, fatty acids and glycerol, and simple sugars.**



being absorbed

Important minerals, vitamins, and water are also extracted from food during the process of digestion.

## Food Sources

Biologists categorize animals into three groups based on their food source.

- **Herbivores** obtain all food from plants.  
Examples: cows, horses, and nearly all rodents.
- **Carnivores** obtain all food from meat.  
Examples: cats, eagles, wolves, and frogs.
- **Omnivores** obtain food from both plants and meat.  
Examples: humans and bears.

An animal's digestive system is specifically suited to processing food obtained from its food source. For example, herbivores' digestive systems are equipped to break down plant material, and carnivores' are not.

# Digestive system(Tract)

The digestive tract is the area where digestion takes place.

- The digestive tract varies widely in complexity from species to species.
- The most primitive form found in nematodes is simply a tubular gut with no specialized features.
- The slightly more advanced digestive tract found in earthworms includes specialized areas for ingestion, storage, fragmentation, digestion, and absorption.
- The most advanced digestive tracts, found among the vertebrates, exhibit specialization on a much greater scale.

# Human Digestive system

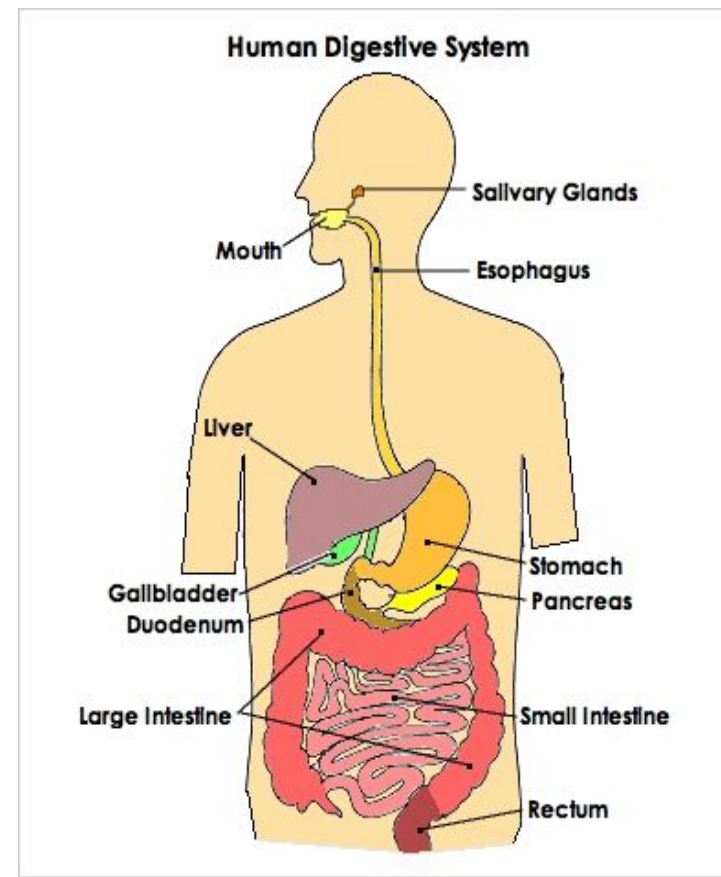
The Human Digestive System: a) the alimentary canal or gastrointestinal tract  
b) several accessory organs

## a) The alimentary canal or gastrointestinal tract:

- a tube, or gut, through which food travels in one direction

### Components:

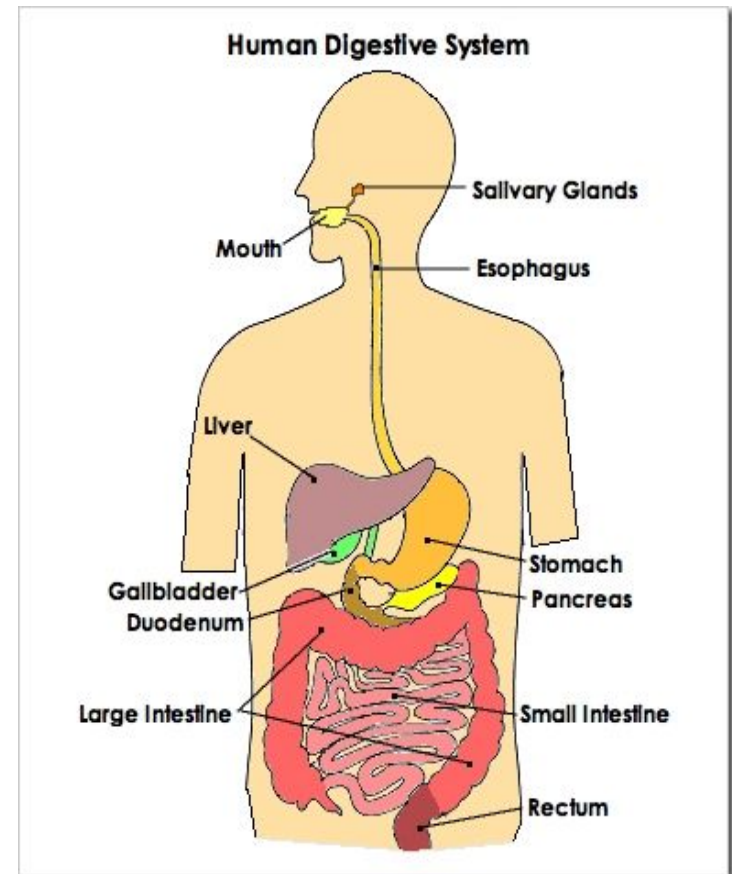
- Mouth
- Esophagus
- Stomach
- Small intestine
- Large intestine
- Rectum
- Anus



# Human Digestive system (contd.)

## b) Accessory organs:

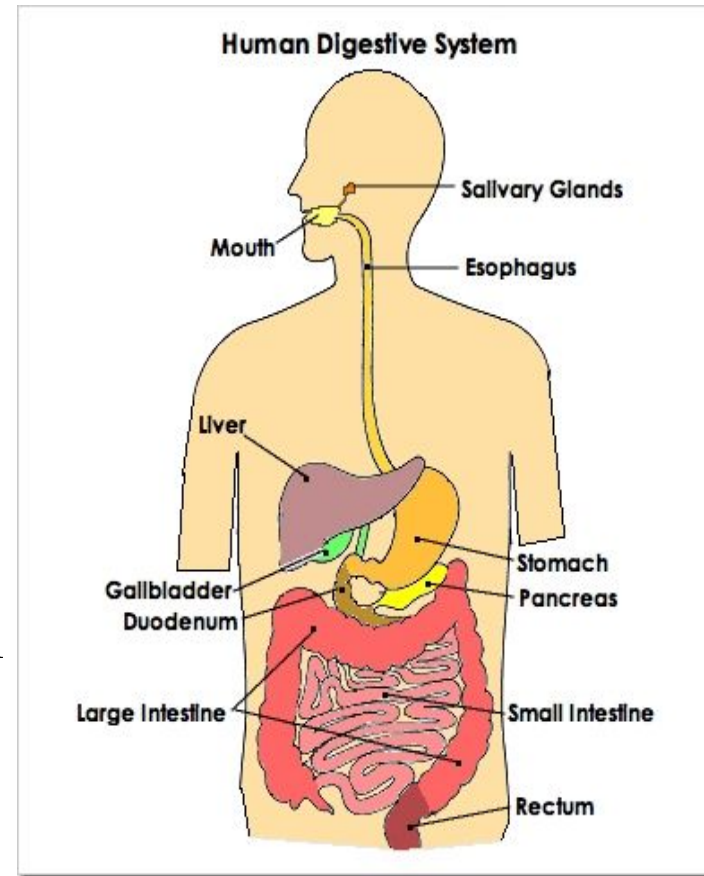
- Aid in digestion. However, food does not pass through
  - Liver
  - Gall bladder
  - Pancreas



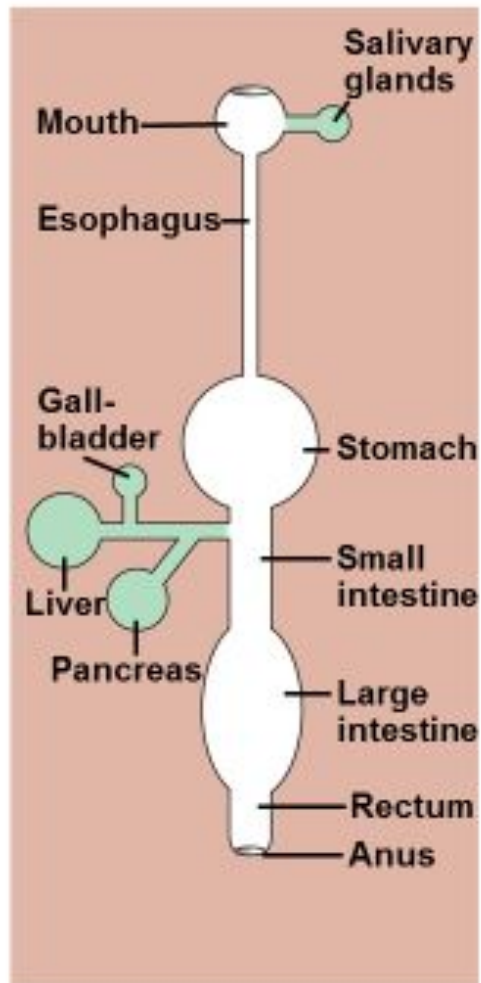
# Human Digestive system

## The human alimentary canal:

- The alimentary canal begins at the **mouth** and the **pharynx**.
- From here, food travels down a muscular tube called the **esophagus** and into the **stomach**.
- The stomach connects to the **small intestine**, which in turn connects to the **large intestine**.
- Some form of mechanical and chemical digestion breaks down food at every step along this tube and
- Nutrients are absorbed across the walls of both intestines.
- All products remaining after food travels through the large intestine are waste, which exit the body through the **anus**.

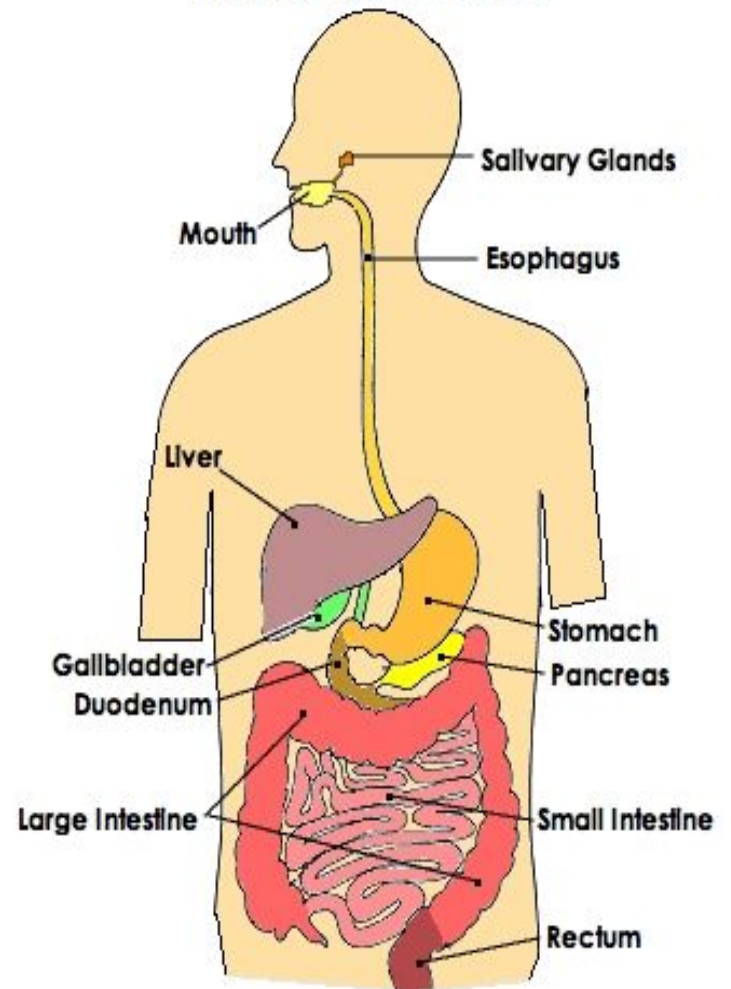


## A Schematic Diagram of the Human Digestive System



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## Human Digestive System





# Structure and functions of components of Human Digestive System

## The oral cavity (Digestion in Mouth):

Mouth, the teeth. the tongue, Salivary Glands.

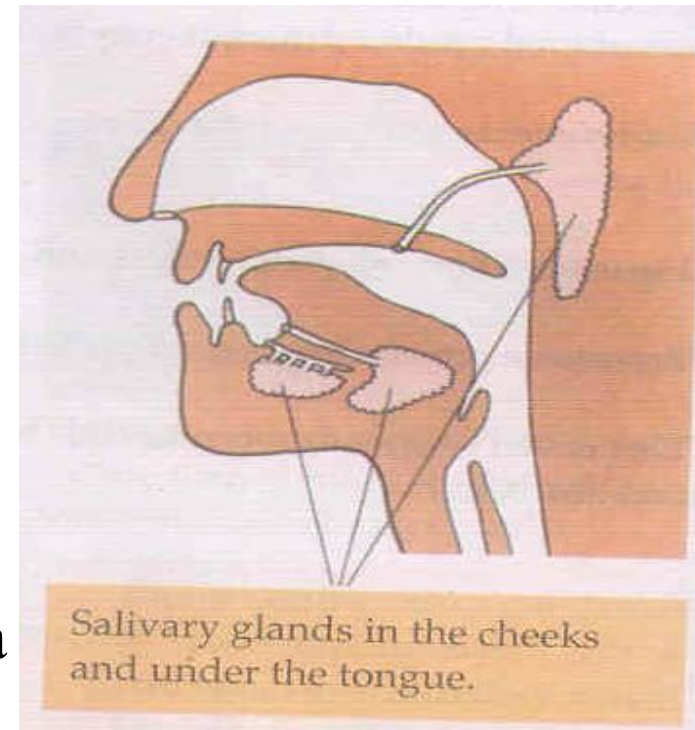
**The teeth:** break food into smaller pieces to expose more of the food's surface area to digestive enzymes.

**The tongue:** a muscle used to manipulate food and form it into a bolus, a round, easy-to swallow ball.

**Salivary glands:** secrete mucous saliva,

**Saliva:**

- contains water, salt and an enzyme called **salivary amylase**.
- **salivary amylase** breaks down starch into smaller sugars.
- contains **buffers**, substances that neutralize acidic foods
- **antibacterial substances** that kill bacteria in the food.
- also eases the passage of food through the pharynx and esophagus.

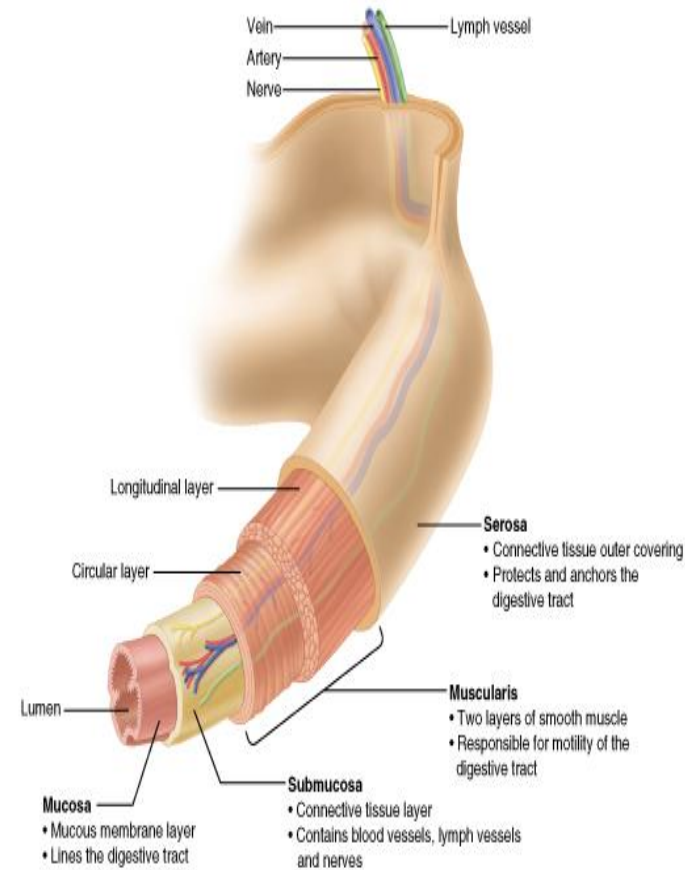




# Structure and functions of components of Human Digestive System

## The Esophagus

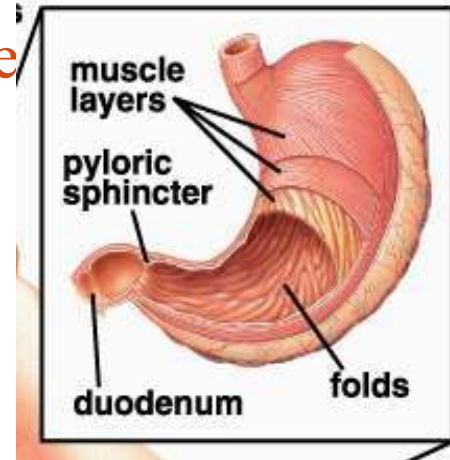
- The esophagus shuttles food from the pharynx (part of mouth) to the stomach.
- The muscles surrounding the esophagus perform **peristalsis**, the rhythmic and stepwise contraction of muscle that forces food to move along the esophageal passage.
- Sphincter muscles at each end prevent backflow.
- The wall of the digestive tube is composed of 4 basic layers:  
**Serosa, Muscularis, Submucosa** and **mucosa**.



# Structure and functions of components of Human Digestive System

## The Stomach

- a saclike organ.
- inner surface is highly convoluted, allowing it to fold up when empty and expand when full.
- Digestion occurs in the stomach as **gastric juice** is secreted by **gastric glands** located in the stomach lining.
- Gastric juice is an **acidic mixture** of **enzymes** and **mucus**.
- Gastric glands are composed of two types of cells:
  1. **Parietal cells:** secrete **hydrochloric acid (HCl)**
  2. **Chief cells:** secrete **pepsinogen**, the precursor to the enzyme **pepsin**.
- Protein digestion is initiated by the acidic environment of the stomach. The HCl, higher the acidity of the gastric juice to a **pH level of 2**.



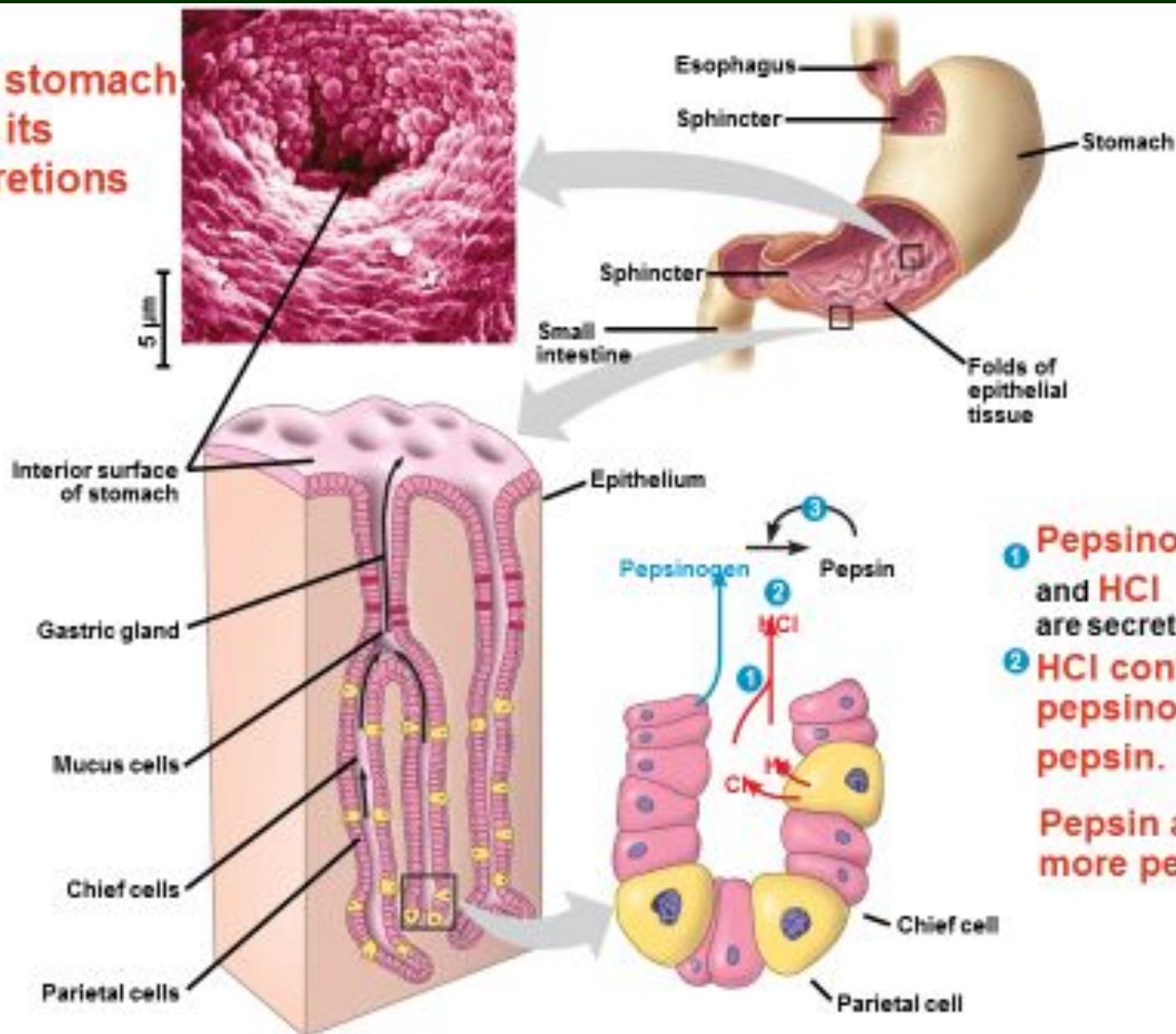
# Structure and functions of components of Human Digestive System

## The Stomach (Contd.)

- Low pH levels are necessary for **pepsinogen** to be converted into the active digestive enzyme **pepsin**, which further breaks down food proteins.
- If chief cells were to secrete pepsin directly into the stomach, the pepsin would digest the cells themselves.
- Additionally, mucus lines the stomach walls and prevents it from being digested.

A mixture of gastric acid and partially digested food called **chyme** passes out of the stomach.

## The stomach and its secretions



- 1 **Pepsinogen** and **HCl** are secreted.
  - 2 **HCl** converts pepsinogen to pepsin.
- Pepsin** activates more pepsinogen.

# Structure and functions of components of Human Digestive System

## The Small Intestine (Contd.)

The small intestine is split into three sections:

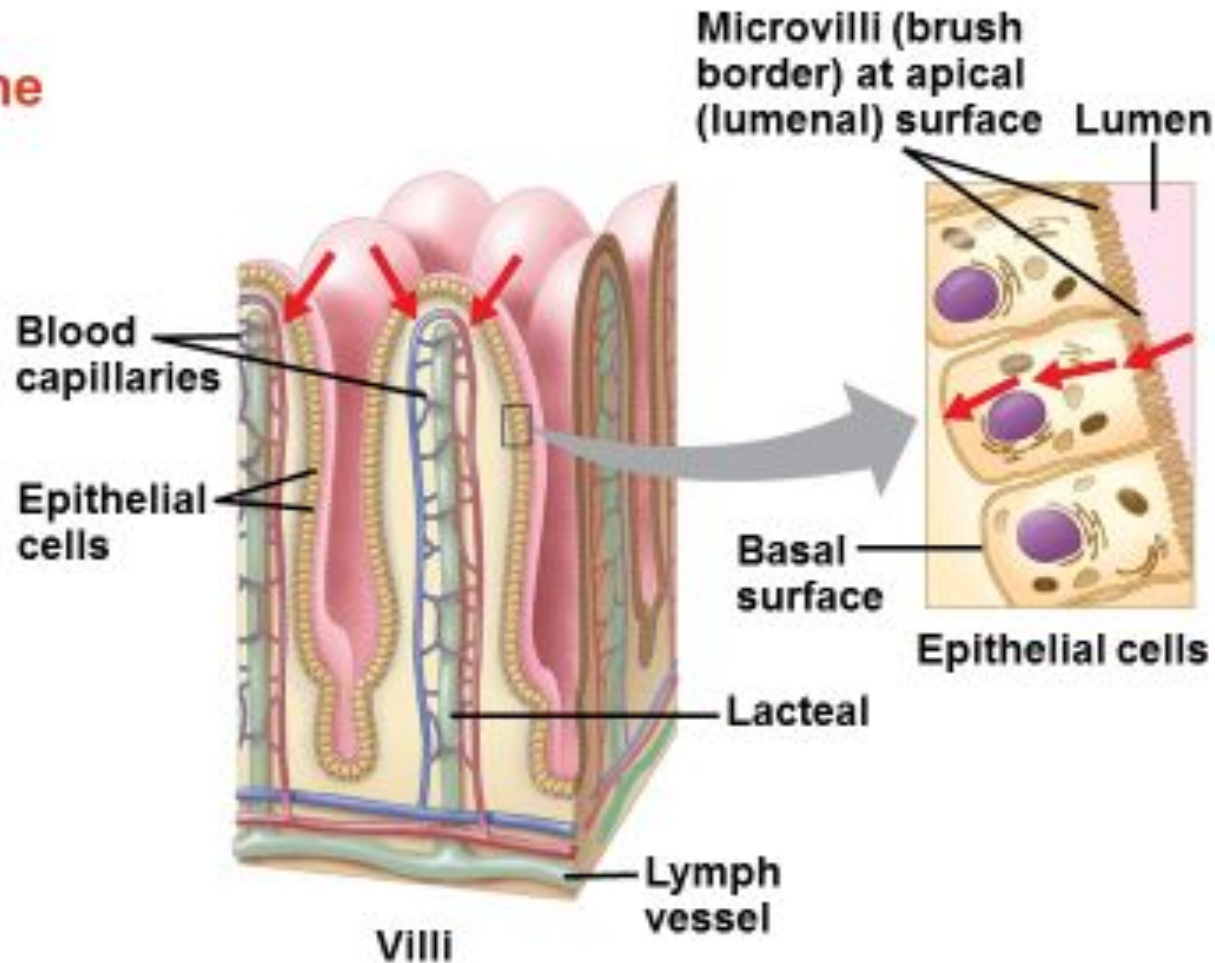
the duodenum, jejunum, and the ileum.

- Chemical digestion takes place in the duodenum and the jejunum.
- The ileum, the final section of the small intestine, is where most absorption of the nutrients takes place.
- Small projections called villi cover the ileum walls.
- Cells lining the villi are covered in folds of plasma membrane that form even smaller projections called microvilli.
- Villi and microvilli increase the ileum's surface area, providing more surface across which nutrients can be absorbed.
- Nutrients pass through capillaries in the lining of the villi and into the bloodstream, where they circulate first to the liver, then throughout the rest of the body.
- Villi and microvilli projections also contain digestive enzymes to further digest food.



# Structure and functions of components of Human Digestive System

## Small Intestine



# Structure and functions of components of Human Digestive System

**Duodenum:** Controls the release of food into the small intestine

## The Small Intestine

- Most of the chemical breakdown (Digestion) and absorption of Food takes place here.
- **Bile salts** break down **fats in the chyme** while **pancreatic fluid**, composed of **bicarbonate**, **neutralizes the acid**.
- The small intestine also contains a host of enzymes that help digest various food molecules.

The **enzymes present in the small intestine** and their functions are outlined in the table below.

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|                                                            |         |
|------------------------------------------------------------|---------|
| Pancreatic amylase, maltase, sucrase, lactase              | Starch  |
| Trypsin, chymotrypsin, aminopeptidase,<br>carboxypeptidase | Protein |
| Nucleases<br>acids                                         | Nucleic |
| Bile salts, lipase                                         | Fats    |

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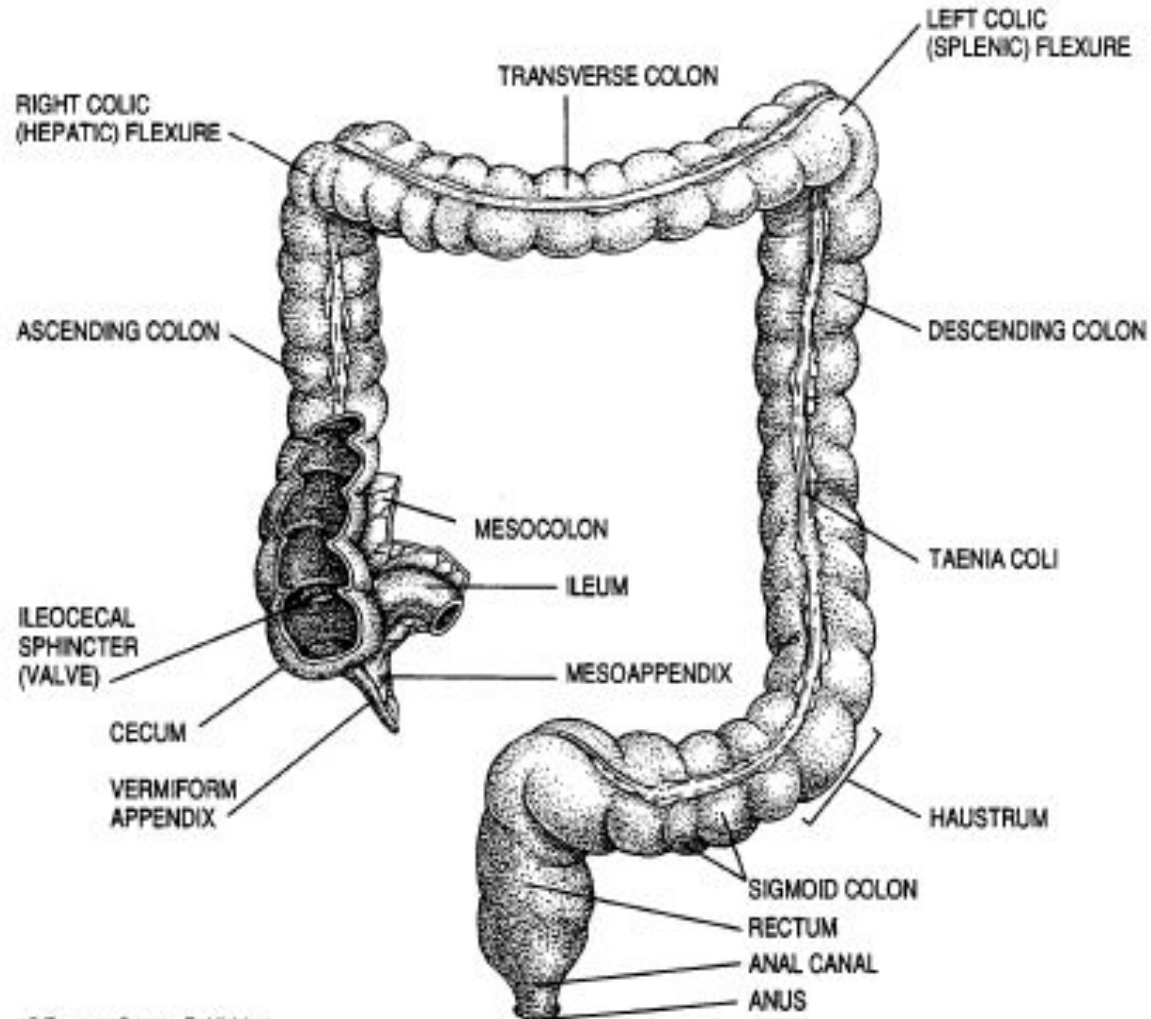
# Structure and functions of components of Human Digestive System

## The Large Intestine

- Food from the small intestine empties into the large intestine, or **colon**.
- No digestion and only a small percentage of absorption take place in the large intestine.
- The large intestine **primarily functions to concentrate waste material into a form called feces**.
- Movements of the large intestine compact feces and move it into the rectum, where it is exited from the body through the anus.
- Feces is expelled from the body through the voluntary movements of muscles surrounding the rectum.

# Structure and functions of components of Human Digestive System

## The Large Intestine (Contd.)



# Structure and functions of components of Human Digestive System

## Rectum

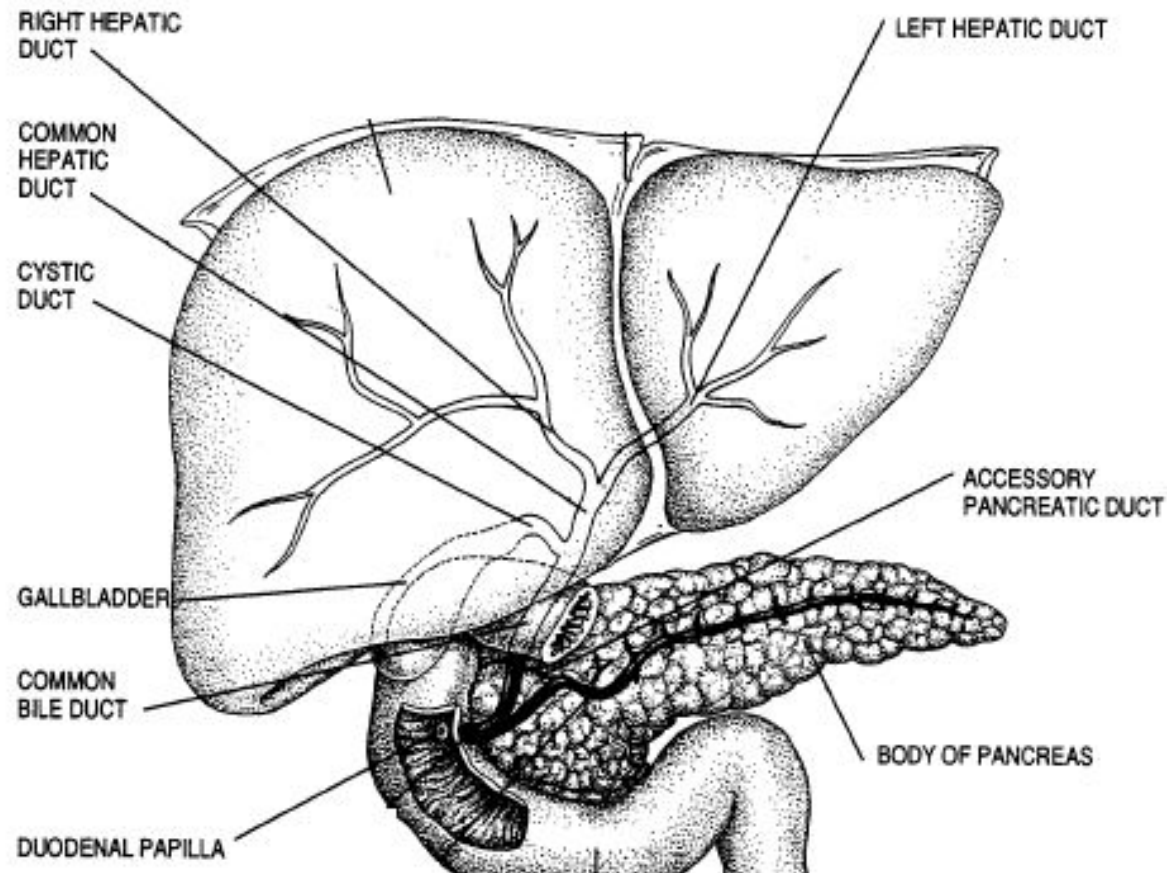
Muscular storage chamber where the undigested food (feces) is held and molded before being pushed through anus during expulsion.

## Anus

- The exit of alimentary canal
- It is closed by a ring of muscle (the anal sphincter)
- The ring is relaxed during expulsion of feces.

# Accessory organs

- Produce and store digestive chemicals
- Food does not pass through these



# Accessory organ

- **Liver** - Produces bile; Stores glucose as glycogen & releases glucose into blood stream
- **Gallbladder** - Stores bile, Squirts bile into small intestine when fat arrives
- **Pancreas** - Makes enzymes. Empties into small intestine

Pancreatic juice: enzymes, bicarbonate

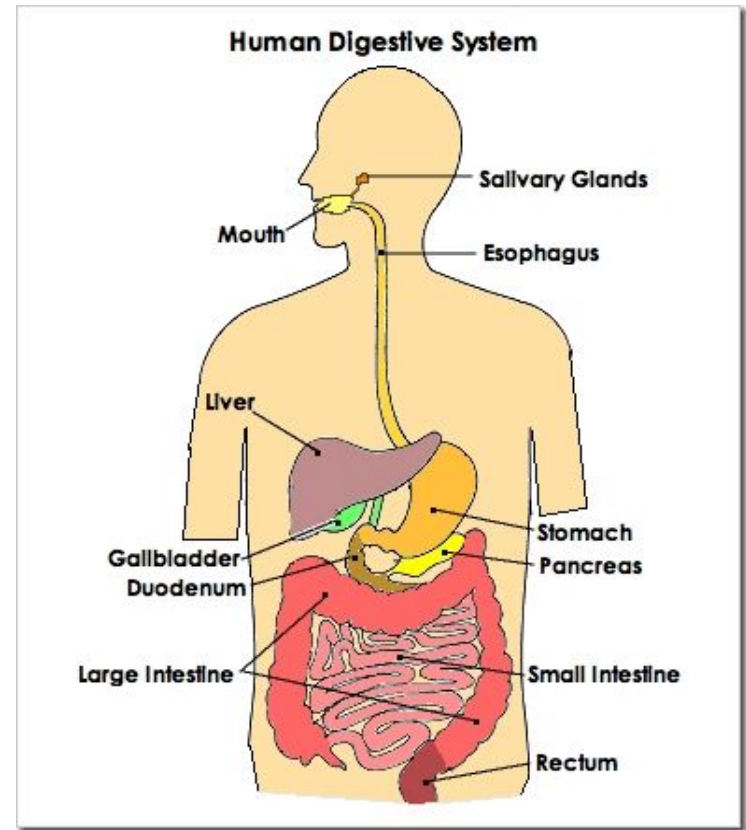
Insulin and glucagon secreted directly into blood

**Insulin:** Enables cells to use glucose (glucose enters cells) & promotes formation of glycogen in liver

**Glucagons:** Signals to the liver to convert glycogen into glucose & release it into the bloodstream

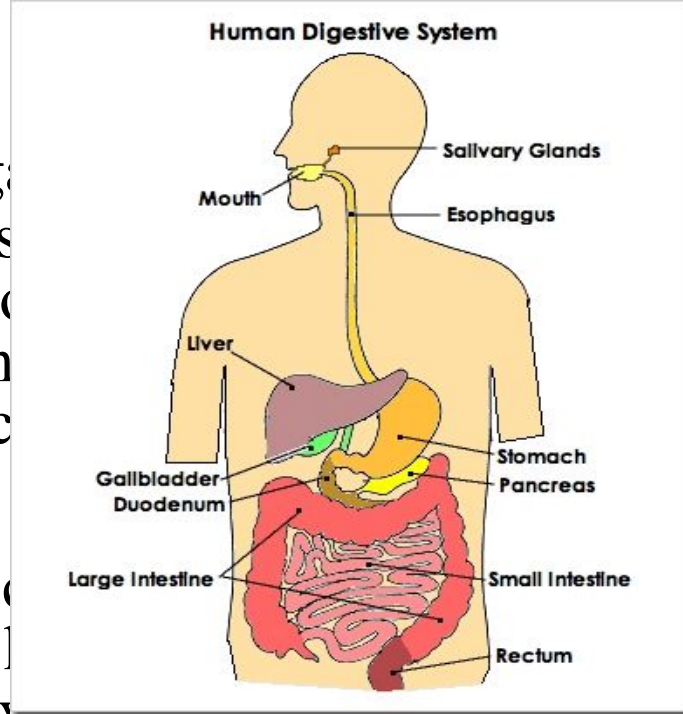
# Liver

- Largest internal organ
- Called the ‘chemical factory’
- The liver has multiple functions:
  - its main function within the digestive system is to process the nutrients absorbed from the small intestine.
  - Bile from the liver secreted into the small intestine also plays an important role in digesting fat.
  - the liver is the body's chemical "factory." It takes the raw materials absorbed by the intestine and makes all the various chemicals the body needs to function.
  - the liver also detoxifies potentially harmful chemicals. It



# Gallbladder and Bile

- The **gallbladder** (or cholecyst sometimes gall bladder) is a pear-shaped organ that stores about 50 mL of bile (or "gall") until the body needs it for digestion. It is connected to the liver and the duodenum by the biliary tract.
- **Bile** is a complex fluid containing water, electrolytes and a battery of organic molecules including bile acids, cholesterol, phospholipids and bilirubin that flows through the biliary tract into the small intestine.



## Two fundamentally important functions of bile:

- Bile contains bile acids, which are critical for digestion and absorption of fats and fat-soluble vitamins in the small intestine.
- Many waste products, including bilirubin, are eliminated from the body by secretion into bile and elimination in feces.

The gall bladder stores and concentrates bile during the fasting



# Pancreas

- Leaf like organ which lies between the stomach and duodenum
- It secretes pancreatic juice which passes to the duodenum to help in digestion
  - Amylase – for digesting starch
  - Protease – protein
  - Lipase – fat

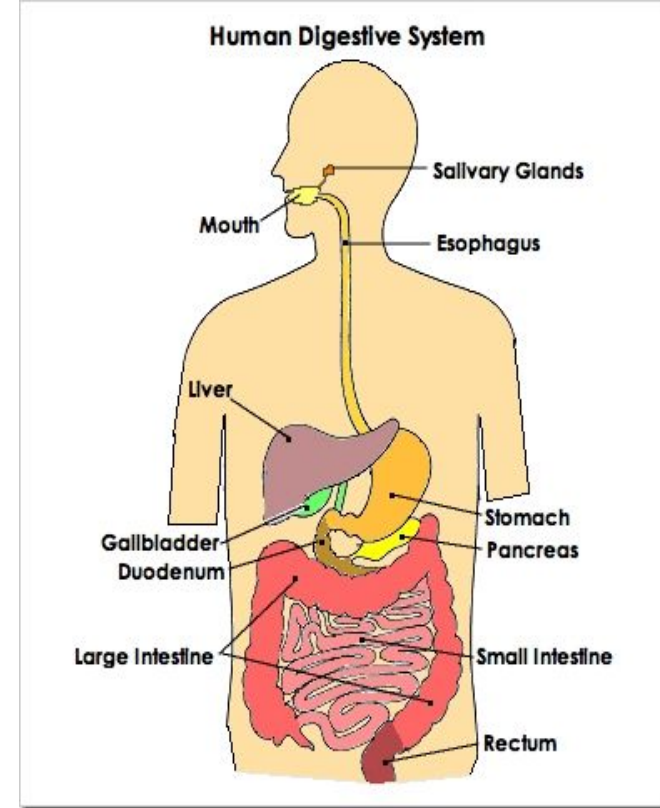
Starch  $\xrightarrow{\text{amylase}}$  glucose

Proteins  $\xrightarrow{\text{protease}}$  polypeptides

Fats  $\xrightarrow{\text{lipase}}$  fatty acid + glycerol

## Role in Digestion:

- enzymes break down protein, fats, and carbohydrates.
- Bicarbonate in the pancreatic juice neutralizes the acidic nature of chyme from stomach.
- The pancreas also makes hormone insulin, secreting it directly into the bloodstream. Insulin is the chief hormone for metabolizing sugar.



# Digestion animation