

LZC502: Human Physiology

Unit 1: Nutrition and Digestion

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Process of digestion

Gastro intestinal tract or alimentary canal

(Mouth, Pharynx, Esophagus, Stomach, Small and Large Intestine)

Accessory digestive organs

(Teeth, Tongue, Salivary gland, Liver, Gall bladder and Pancreas)

What is Digestion ?

Digestion is the mechanical and chemical breakdown of food substances into smaller components that are more easily absorbed into blood stream.

Digestion is a form of catabolism that includes breakdown of large food molecules to smaller ones.

Digestive system

The organs involved in the breakdown of food are collectively called as digestive system.

Digestive system composed of two groups of organs-

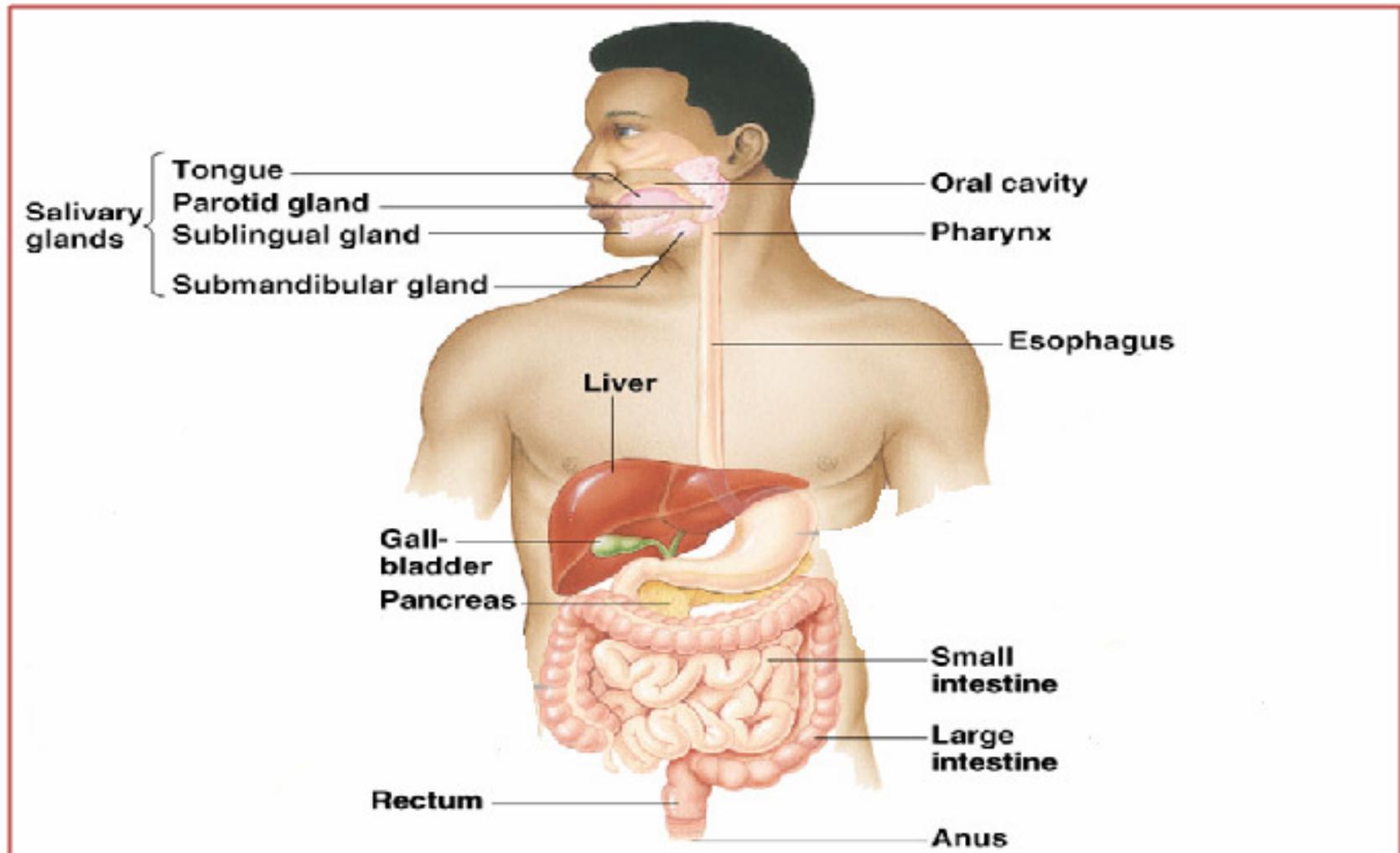
Gastro intestinal tract or alimentary canal

(Mouth, Pharynx, Esophagus, Stomach, Small and Large Intestine)

Accessory digestive organs

(Teeth, Tongue, Salivary gland, Liver, Gallbladder and Pancreas)

Human digestive system



Processes of Digestive system

- **Ingestion:** this is the consumption of or taking in of nutrients.
- **Secretion:** about 7 liter of water, acid, buffer and enzyme into the lumen.
- **Mixing and propulsion:** contraction and relaxation of smooth muscle.
- **Digestion:**
 - **Mechanical process:**
Breaking up food into smaller pieces.
 - **Chemical process:**
Breaking down food into molecules small enough to be absorbed into cells
- **Absorption:** the transport or delivery of digested nutrients to body tissues.
- **Defecation:** the elimination of food waste materials, bacteria and not absorbed digestive material from the body.

Accessory digestive organs: Teeth

Teeth are small whitish structures found in the jaws that are used to tear, scrape and chew food.

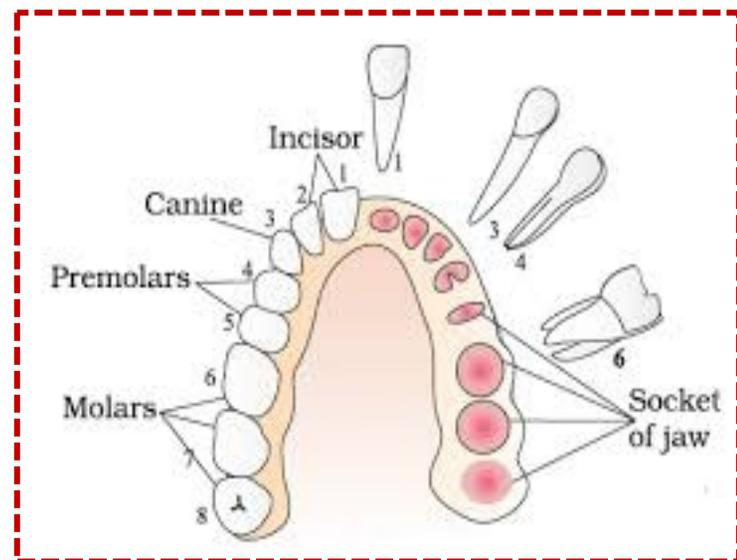
Human have to dentition:

❖ deciduous, primary or milk teeth

Dental formula: $\frac{2120}{2120}$

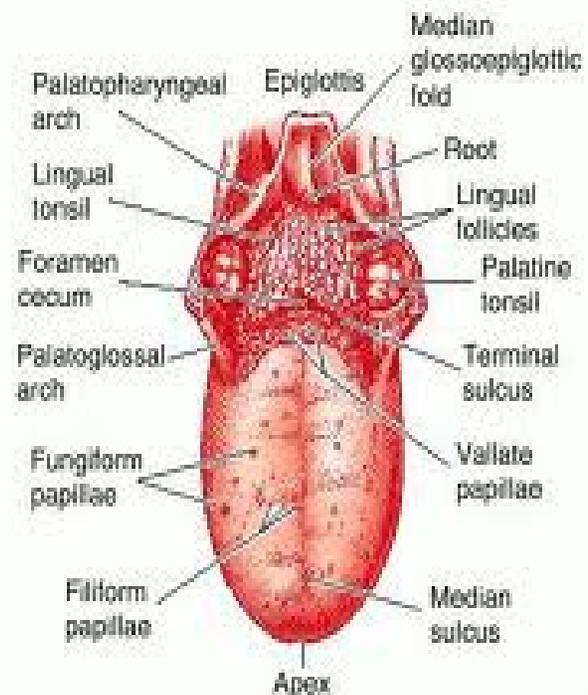
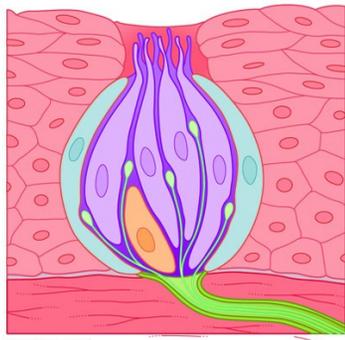
❖ permanent teeth

Dental formula: $\frac{2123}{2123}$



Accessory digestive organs: Tongue

- The tongue is an **accessory digestive organ** which along with the cheeks, keeps food between the upper and lower teeth until it's sufficiently **masticated**, or chewed.
- The tongue is also a **peripheral sense organ**, one that helps perceive the sensation of taste and responds to pressure, heat and pain.
- As the food particles dissolve in the saliva they penetrate the cells of the taste buds located on the tongue and cheeks.
- Humans can differentiate between -sweet, sour, salty and bitter.



Accessory digestive organs: Salivary Glands

Salivary glands secrete saliva into the oral cavity.

The mucous membrane of the mouth and tongue contains small salivary glands that opens directly, indirectly via short ducts to the oral cavity.

These glands are labial, buccal and palatal glands.

Three pairs of major salivary glands are-

parotid gland (located inferior and anterior to the ear)

sublingual gland (beneath the tongue)

sub mandibular gland (in the floor of the mouth)

Parotid gland secretes a watery or serous liquid that contain **salivary amylase**.

Sublingual gland contain mucous cells , that secretes a thicker fluid-mucous.

Sub mandibular glands are mixed glands.

Composition and Function of Salivary Juice

- Saliva contain 99.5% water and 0.5% solutes.
- **Salivary amylase** and **lingual lipase** is found in the oral cavity.
- **Mucus**
 - protects soft lining of digestive system
 - lubricates food for easier swallowing
- **Buffers**
 - neutralizes acid to prevent tooth decay
- **Anti bacterial chemicals**
 - kill bacteria that enter mouth with food

Accessory digestive organs: Liver and gall bladder

The liver is the heaviest gland of the body, that is divided into two parts a large right lobe and smaller left lobe.

The liver is composed of several components:

-hepatocytes, bile canaliculi and hepatic sinusoids.

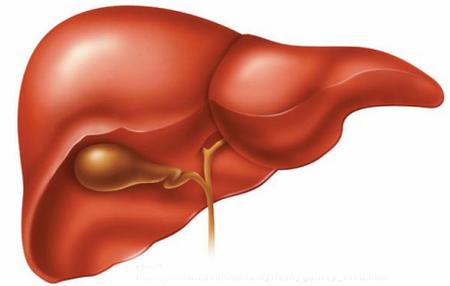
Gall bladder is a pear shaped sac that is located in the depression of the posterior surface of the liver.

Each day hepatocytes secrete 800-1000 ml bile. It is yellow, brownish liquid of pH 7.6 to 8.6. Bile consists of water, bile salt, cholesterol, bile pigment, lecithin and several ions.

Bile contains bile salts that emulsify fats which means it breaks them into smaller droplets so they can be digested.

Principal bile pigment is **bilirubin**, which is derived from heme.

Bile salts are sodium and potassium salt of bile acids.



Function of Liver

Carbohydrate metabolism

Protein metabolism

Lipid metabolism

Processing of drug and hormones

Excretion of bilirubin

synthesis of bile salt

Storage of vitamins

Phagocytosis

Activation of vitamin D

Accessory digestive organs: Pancreas

Pancreas is a retroperitoneal gland that is about 12-15 cm long and 2.5 cm thick.

The pancreas consists of head, body and tail.

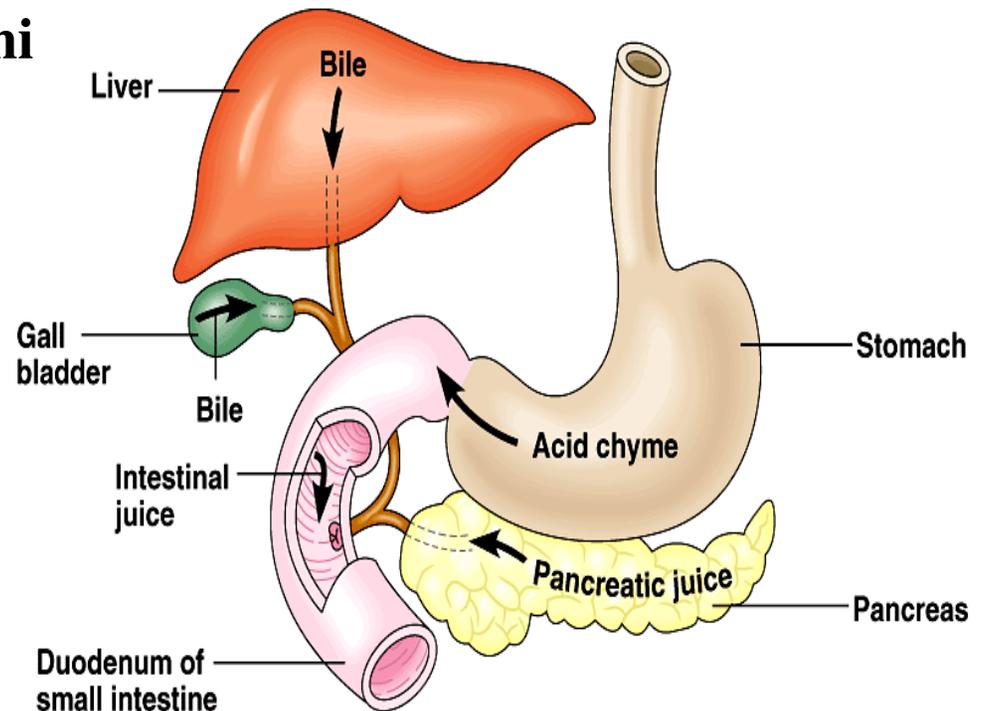
Pancreas 99% made up of small clusters of glandular cells, called acini.

Acini constitute the exocrine portion.

Pancreatic juice is secreted by exocrine cells into small ducts that ultimately unite to form two larger ducts:

-Pancreatic duct: joins bile duct and form common duct or hepaatopancreatic ampula.

-Accessory duct or duct of Santorini



Composition and function of Pancreatic Juice

Pancreas produces about 1200-1500 ml of pancreatic juice everyday.

It is a clear colourless liquid consisting of water, salt and enzymes.

Its pH is about 7.1 to 8.2.

It helps in the digestion of protein, carbohydrate, lipid, and nucleic acids.

Enzymes:

Carbohydrate digestive enzymes: Pancreatic amylase

Lipid digestive enzymes: Pancreatic lipase

Protein digestive enzymes: Trypsin

Chymotrypsin

Elastase

Carboxypeptidase

Nucleotide digestive enzymes: Rionucleases

Deoxyribonucleases

Gastro intestinal tract: Pharynx

Pharynx is a funnel shaped structure that is composed of skeletal muscles.

It is divided into 3 parts

Nasopharynx

Oropharynx

Laryngopharynx

The muscular contraction of these areas help propel the food into the esophagus and then into the stomach.

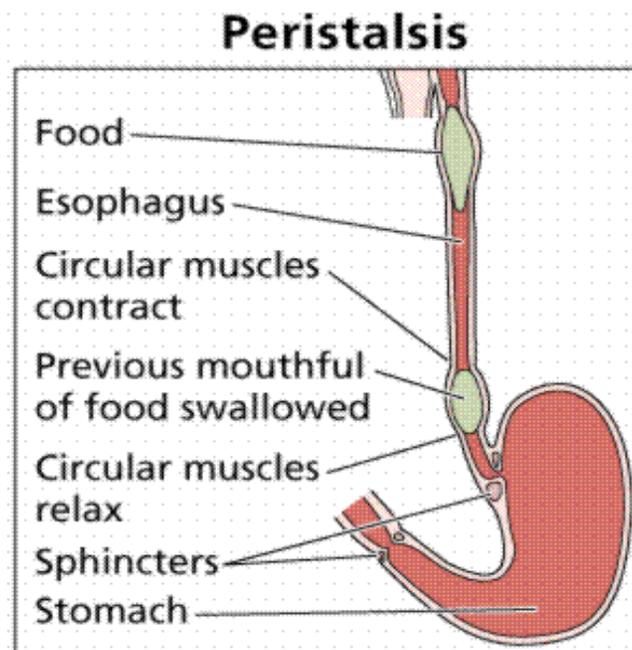
Gastro intestinal tract: Esophagus

Esophagus is a muscular tube like structure that connects the pharynx to the stomach.

After chewing, the food is swallowed and it enters the esophagus.

A bolus moves through peristalsis movement.

Swallowing center in brain stimulates successive one-directional waves of contraction.



Gastro intestinal tract: Stomach

The stomach is a J shaped enlargement that acts as a temporary storage site for food.

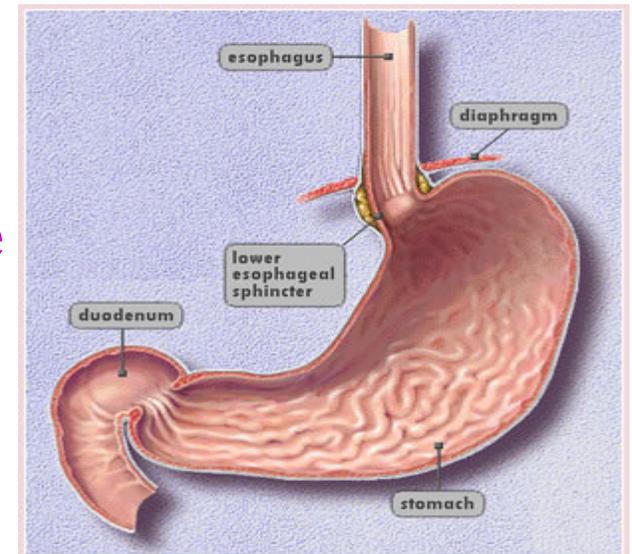
Four main regions of stomach are cardia, fundus, body and pylorus.

Food usually spends about 4 hours in the stomach.

It has ridges which allow it to expand to store about 1.5 litres of food.

Stomach contains three kinds of exocrine gland cells:

- **Mucus neck cells-** mucus
- **Parietal cell-** intrinsic factor, HCl
- **Chief cells-** pepsinogen and gastric lipase



Composition and Function of Gastric Juice

Each day stomach secreted about 2 liters gastric juice.

The pH is about 2.0 and specific gravity is

Parietal cell secretes HCl that partially denatures the protein.

Chief cells secreted

- **Protein digestive enzyme:**
 - Pepsinogen (inactive form)**
 - Pepsin (active form)**
- **Lipid digestive enzyme:**
 - Gastric lipase.**

Gastro intestinal tract: Small intestine

The small intestine is divided into three parts:

Duodenum: shortest region about 25 cm.

Jejunum: about 1 m long

Ileum: longest region about 2 m

The food after being processed in the stomach, is passed to the small intestine, where majority of digestion and absorption occurs.

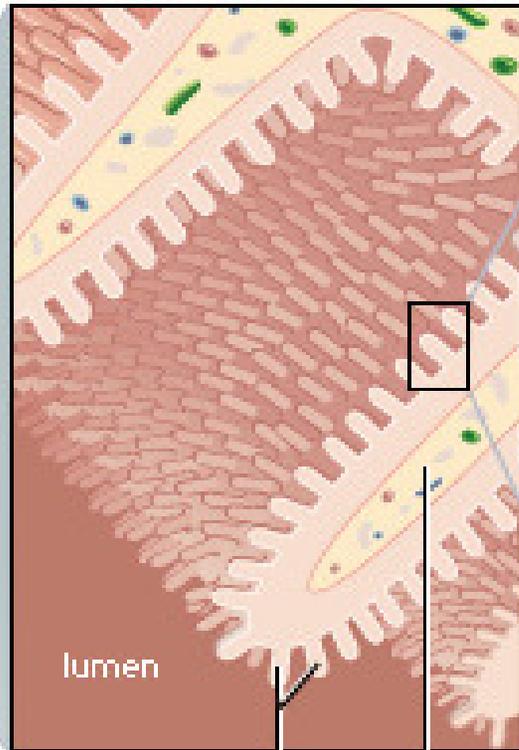
The epithelial cells of mucosa contain absorptive cells (absorption), goblet cells (mucus), intestinal glands (**crypts of Lieberkuhn intestinal juice**), paneth cells (lysozyme) and enteroendocrine cells (secretin, cholecystokinin and glucose dependent insulinotropic peptide).

The submucosa contain duodenal or Brunner's gland, which secrete alkaline mucus.

Special structural features are circular fold, villi and microvilli.

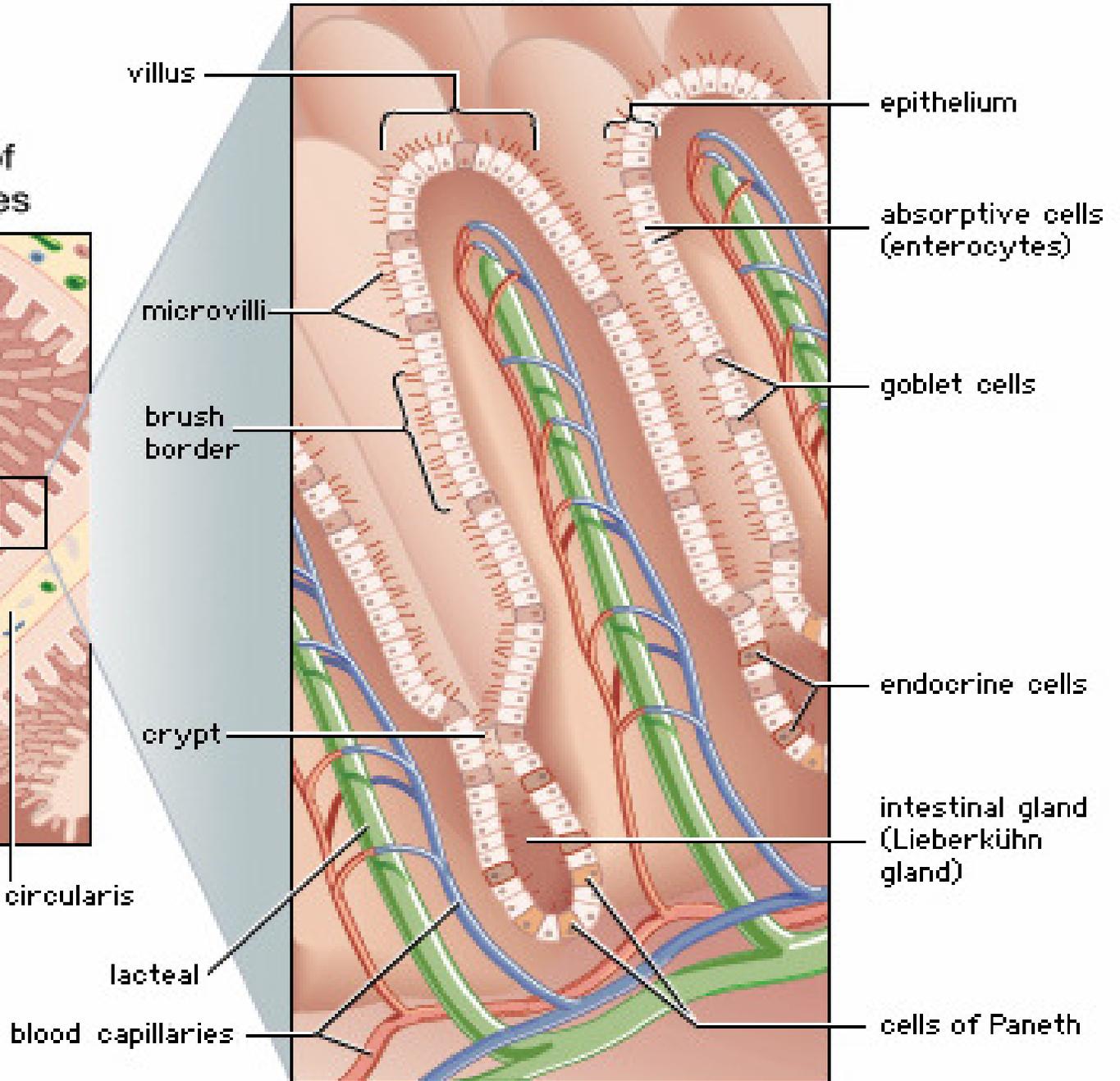
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Enlargement of plicae circulares



villi
plica circularis

Structure of a villus



villus
epithelium
absorptive cells (enterocytes)
goblet cells
endocrine cells
intestinal gland (Lieberkühn gland)
cells of Paneth
crypt
lacteal
blood capillaries
brush border
microvilli

Composition and Function of Intestinal Juice

About 1-2 liters intestinal juice is secreted each day. It is a clear yellow fluid that contains water and mucus.

It is slightly alkaline and pH is about 7.6.

It synthesizes several enzymes called as brush border enzymes.

Brush border enzymes are:

Carbohydrate digestive enzymes:

α-Dextrinase, maltase, sucrase and lactase.

Protein digestive enzymes:

Peptidases (aminopeptidases and dipeptidases)

Nucleotide digestive enzymes:

Nucleosidases and phosphatases

Gastro intestinal tract: Large intestine

It is about 1.5 m long and 6.5 cm in diameter. It extends from ileum to the anus.

It is divided into three parts

Cecum: a small pouch about 6 cm.

Colon: a long tube divided into ascending, transverse, descending and sigmoid portions.

Rectum: about 20 cm long last part of the GI tract.

The mucosa contains

absorptive cells

goblet cells (mucus).

Circular folds and villi are absent.

