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# **ANATOMY AND PHYSIOLOGY OF GIT**

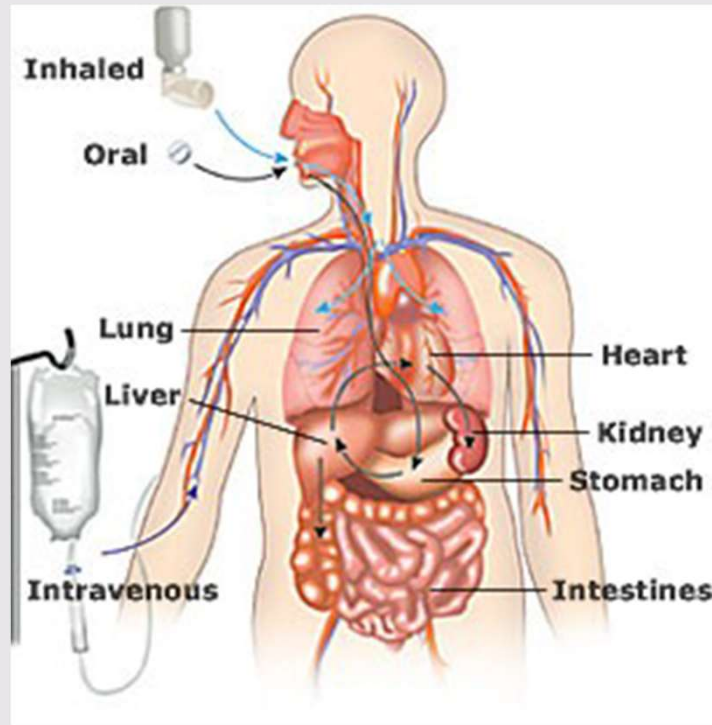
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**CUTM, Bhubaneswar**



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# Introduction



**A drug's life in the body:** Medicines taken by mouth (oral) pass through the liver before they are absorbed into the bloodstream.

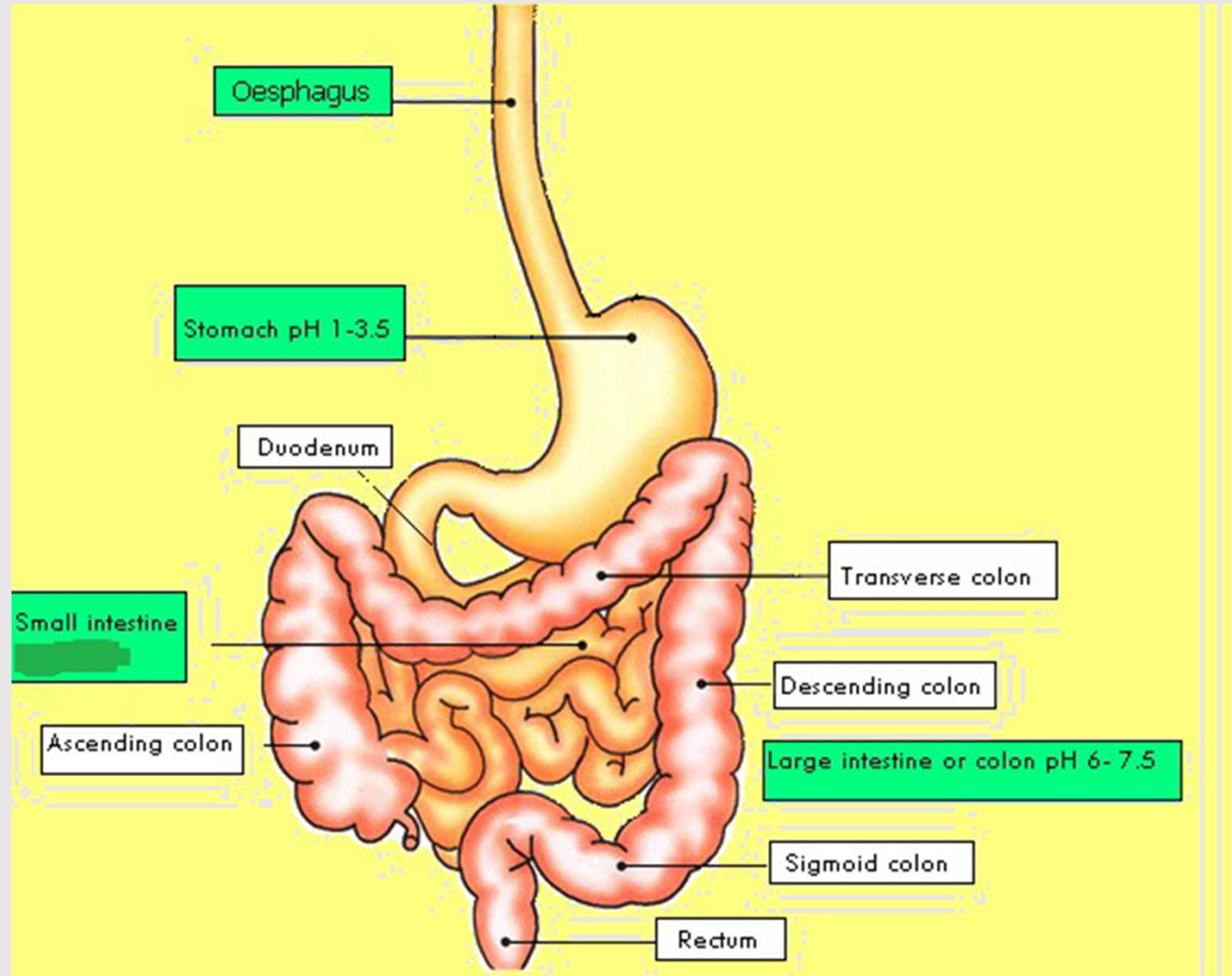
Other forms of drug administration bypass the liver, entering the blood directly.



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# ANATOMY AND PHYSIOLOGY OF GASTROINTESTINAL TRACT



**The key structures involved oral drug absorption.**



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# GASTROINTESTINAL TRACT

## ACCESSORY ORGANS

### Salivary glands

Secrete saliva, which contains enzymes that initiate breakdown of carbohydrates

### Liver

Produces bile, which emulsifies fat

### Gallbladder

Stores bile and introduces it into small intestine

### Pancreas

Produces and secretes pancreatic juice, containing digestive enzymes and bicarbonate ions, into small intestine

## ALIMENTARY CANAL

### Mouth

Mechanical breakdown of food; begins chemical digestion of carbohydrates

### Pharynx

Connects mouth with esophagus.

### Esophagus

Peristalsis pushes food to stomach

### Stomach

Secretes acid and enzymes. Mixes food with secretions to begin enzymatic digestion of proteins

### Small intestine

Mixes food with bile and pancreatic juice. Final enzymatic breakdown of food molecules; main site of nutrient absorption

### Large intestine

Absorbs water and electrolytes to form feces

### Rectum

Regulates elimination of feces

### Anus

**GI tract divided into two parts i.e Upper and Lower**





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## Upper gastrointestinal tract

The upper gastrointestinal tract consists of the **esophagus, stomach and duodenum.**

Some sources also include the mouth cavity and pharynx.

## Lower gastrointestinal tract

The lower gastrointestinal tract includes **most of the small intestine and all of the large intestine.**

According to some sources, it also includes the anus.



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## **Small intestine, which has three parts:**

**Duodenum:** The digestive enzymes break down proteins and bile emulsifies fats into micelles. Duodenum contains Brunner's glands which produce bicarbonate and pancreatic juice contains bicarbonate to neutralize hydrochloric acid of stomach

**Jejunum:** It is the midsection of the intestine, connecting duodenum to ileum. Contain plicae circulares, and villi to increase surface area.

**Ileum:** It has villi, where all soluble molecules are absorbed into the blood .

## **Large intestine, which has three parts:**

Cecum

Colon

Rectum and Anus



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# DIGESTION AND ABSORPTION

The gastrointestinal system is primarily involved in reducing food for absorption into the body.

This process occurs in 4 main phases:

- i) Fragmentation**
- ii) Digestion**
- iii) Absorption**
- iv) Elimination of waste products**

Initial fragmentation of food occurs along with the secretions of the salivary glands, in the oral cavity forming a bolus.

Bolus of food is then carried to the esophagus by the action of the tongue and pharynx (deglutition).



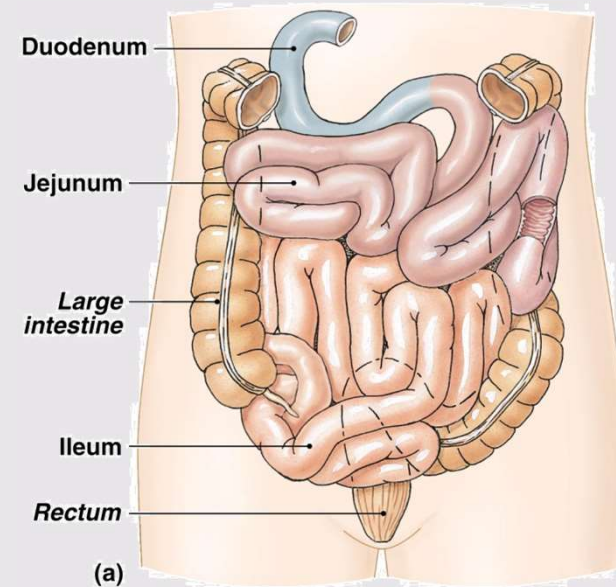
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Esophagus carries food from mouth to stomach, where fragmentation is completed and digestion initiated. (Eg: protein to polypeptides followed by small peptides and amino-acids).

In the stomach food is converted into semi-digested liquid (chyme) which passes through the pylorus, into the duodenum.

Unabsorbed liquid residue enters the cecum through ileo-cecal valve where water is absorbed and become progressively more solid as it passes into the anus







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# GASTROINTESTINAL TRACT STRUCTURE

**Contains 4 layers**

**1. Mucosa (lumen side): Epithelial tissue**

**2. Submucosa**

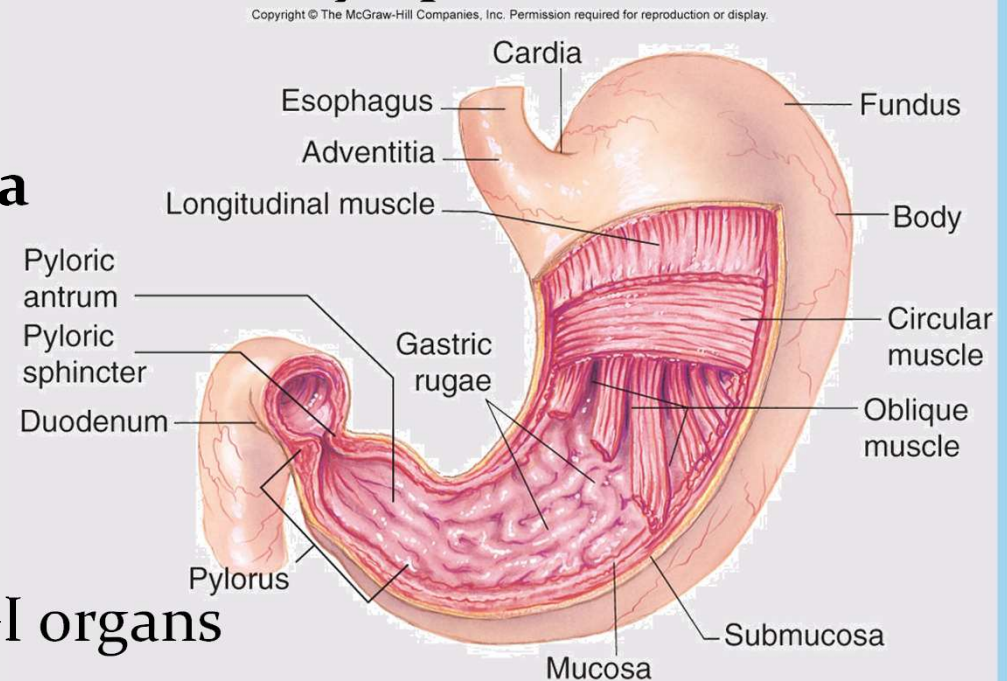
elastic connective tissue contains lymph and blood vessels

**3. Muscularis externa**

smooth muscle layers

**4. Serosa**

Outermost lining of GI organs





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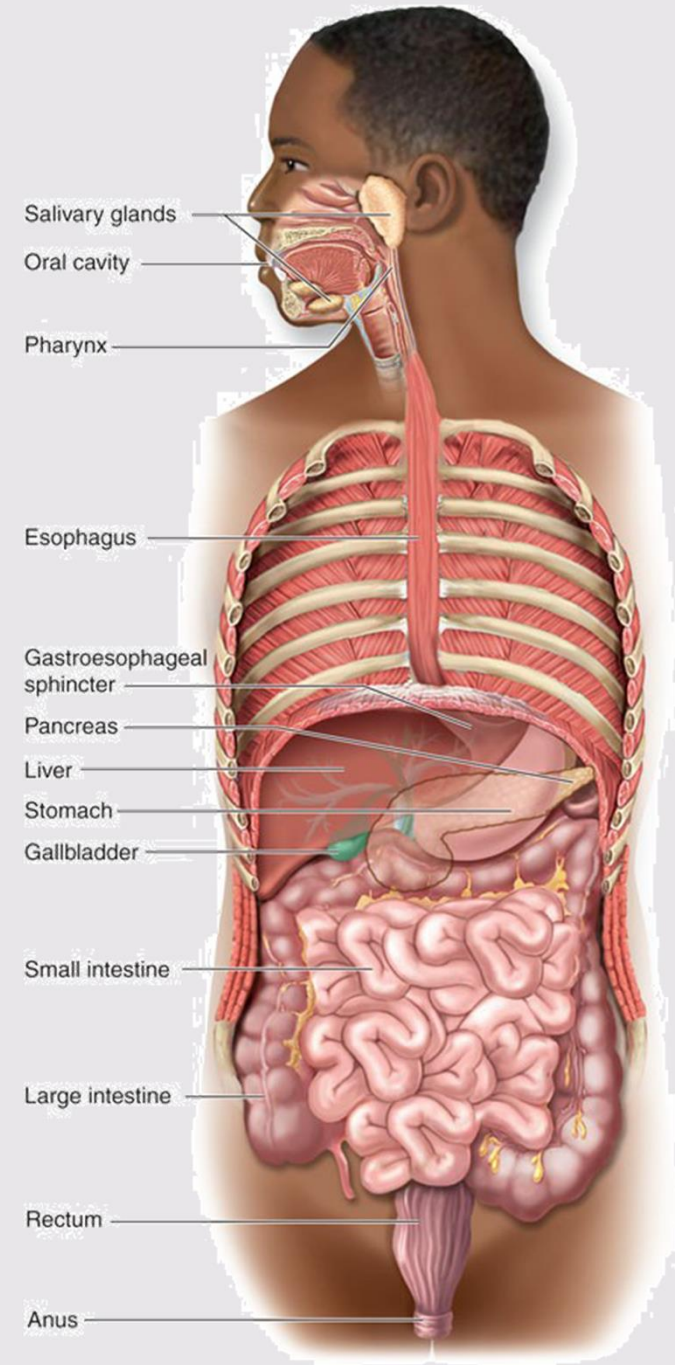
**Gastrointestinal Tract is a Muscular tube that extends from mouth to anus**

**Major organs:** mouth, esophagus, stomach, small intestine, large intestine

**Accessory organs:** liver, gall bladder and pancreas

**Function:** food digestion, nutrient absorption and distribution and waste elimination

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# MOUTH

Digestion begins in the mouth

Two types of Digestion occurs in mouth i,e

## 1. Mechanical digestion

- Biting and grinding actions of teeth breaks and mashes food into smaller pieces.

## 2. Chemical digestion

- Saliva mixes and lubricates food.
- Salivary amylase and lipase begin breakdown of starch and fat, respectively.





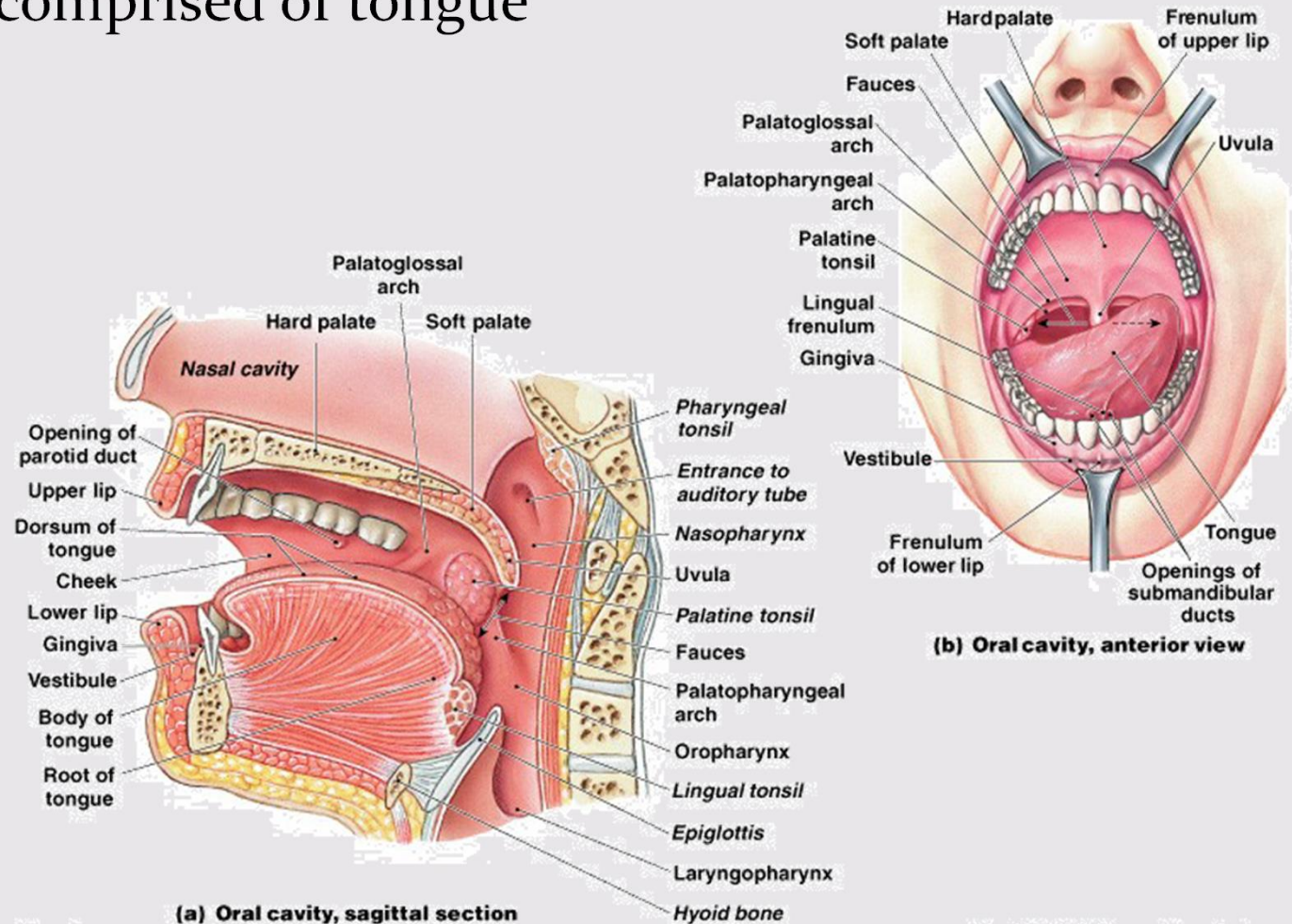
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# MOUTH (ORAL CAVITY)

Regions include the vestibule & oral cavity

Roof comprised of hard & soft palate; floor primarily comprised of tongue



**(a) Oral cavity, sagittal section**

**(b) Oral cavity, anterior view**





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# Tongue –

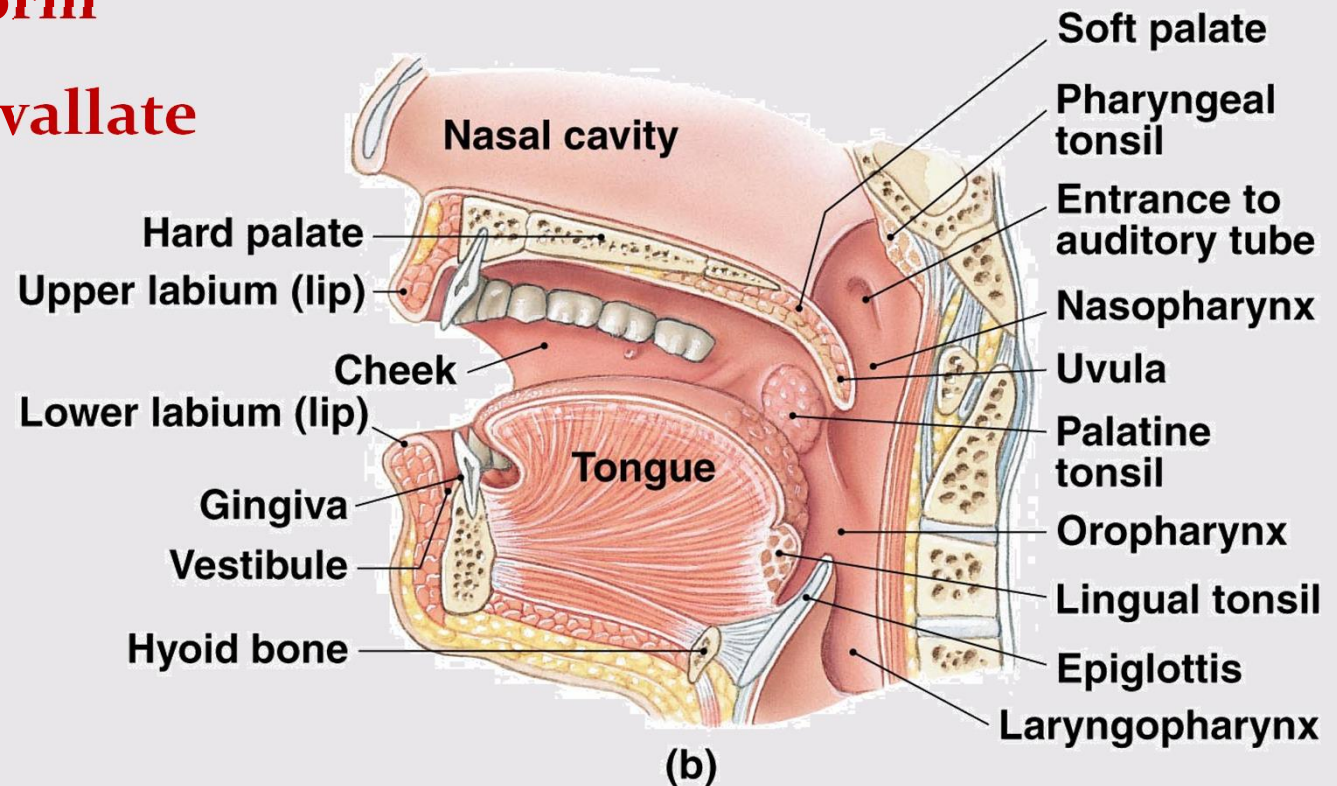
Made up of stratified squamous epithelium over skeletal muscle

Contains intrinsic & extrinsic muscles Papillae

**Filiform**

**Fungiform**

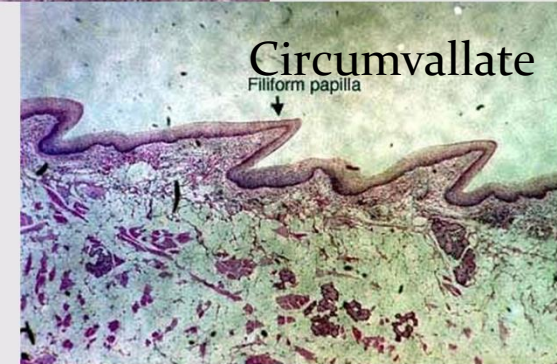
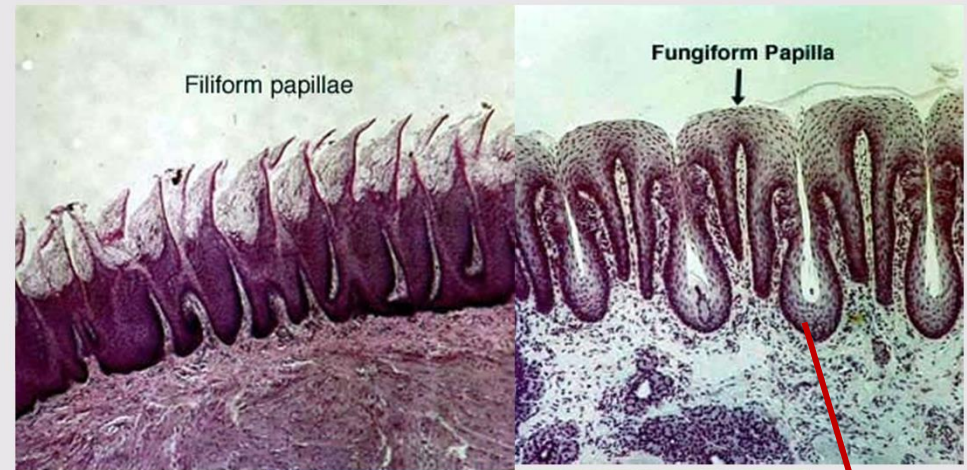
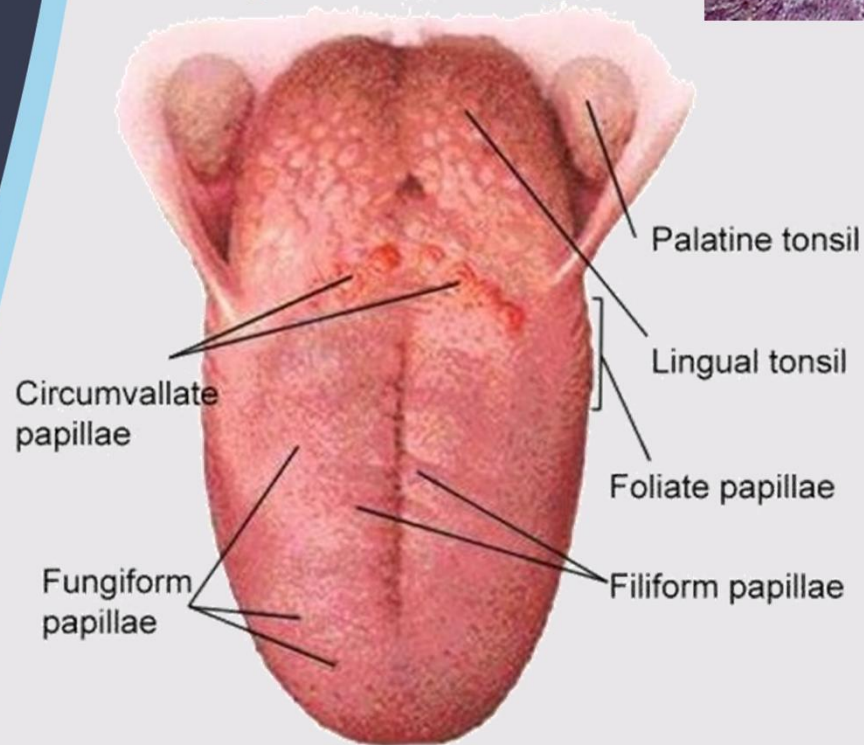
**Circumvallate**





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## Papillae of Tongue



taste buds





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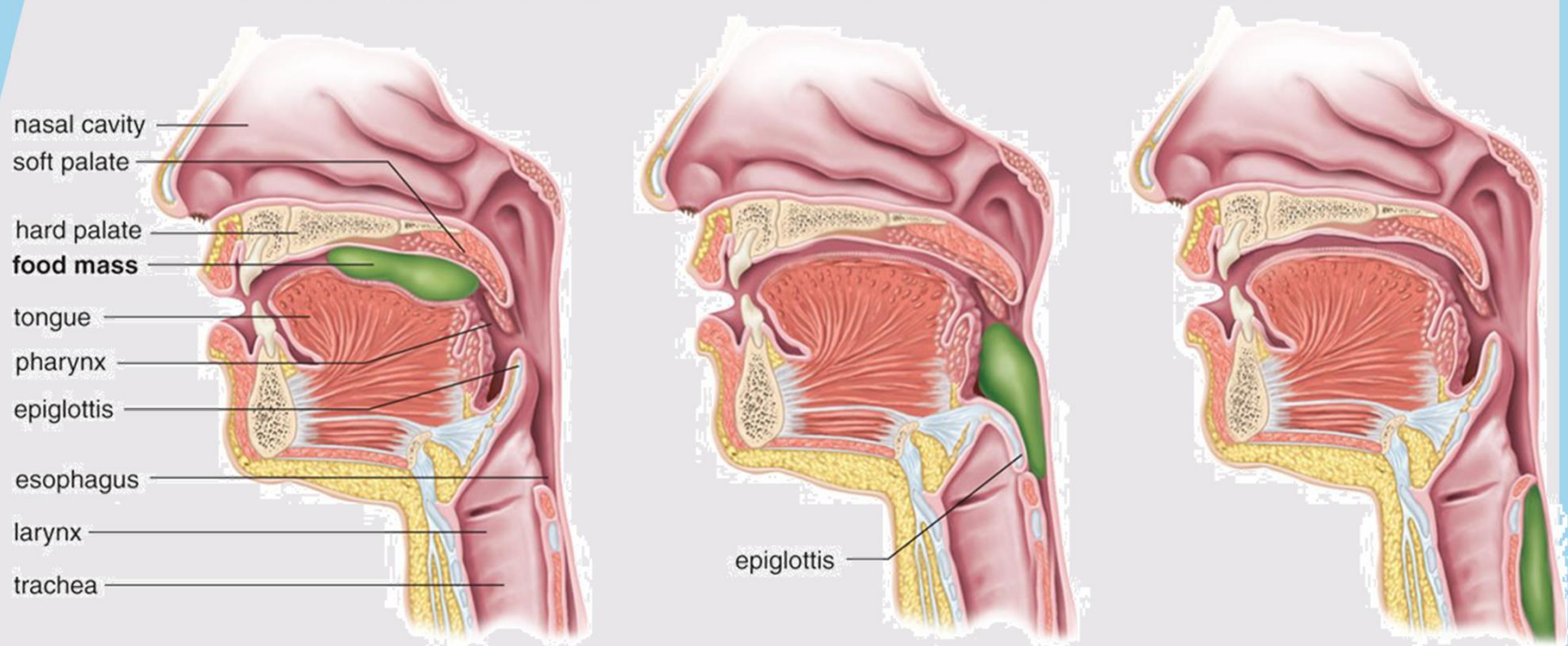
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# FROM THE MOUTH TO THE STOMACH

**Esophagus** – Tube connecting pharynx to stomach

**Epiglottis** – Flap that folds down over trachea (windpipe) when you swallow

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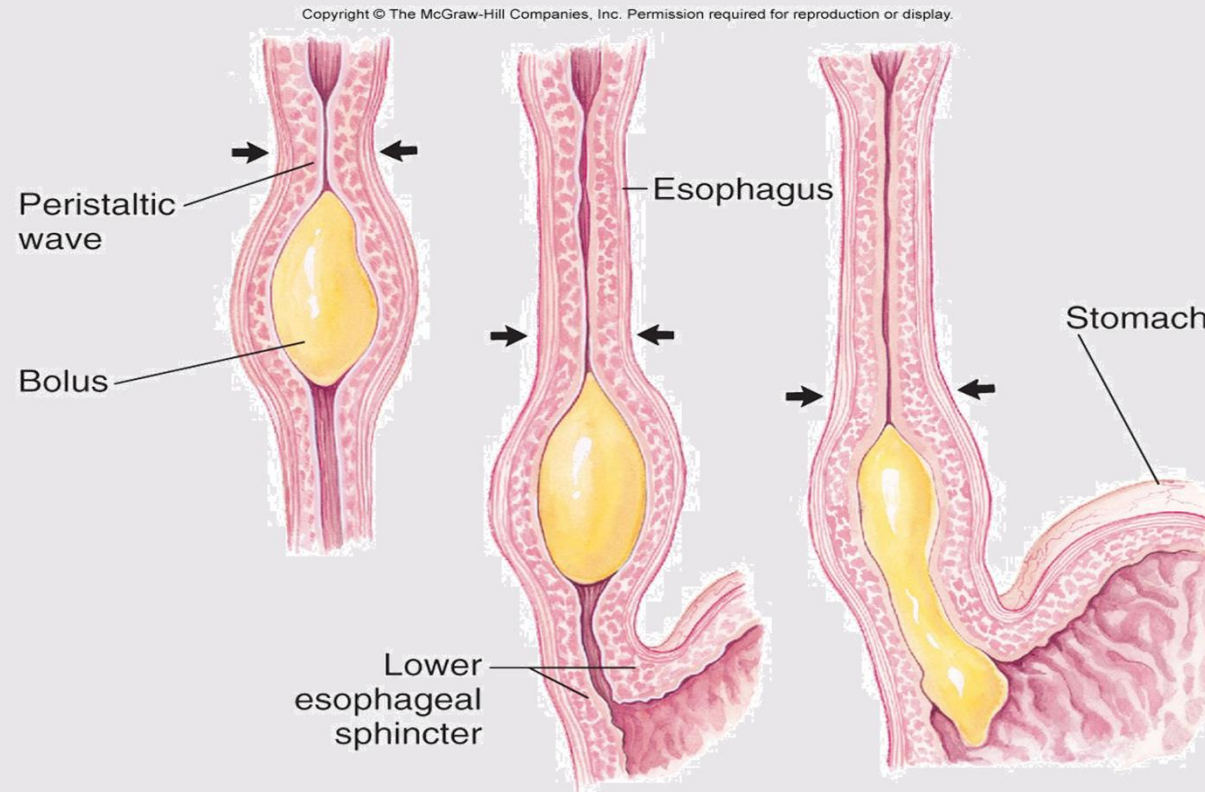
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# ESOPHAGUS

Transport food and water to stomach, secretes mucus

Movement of food bolus in esophagus (and rest of GI tract) via peristalsis

Empties into stomach through the *lower esophageal sphincter*







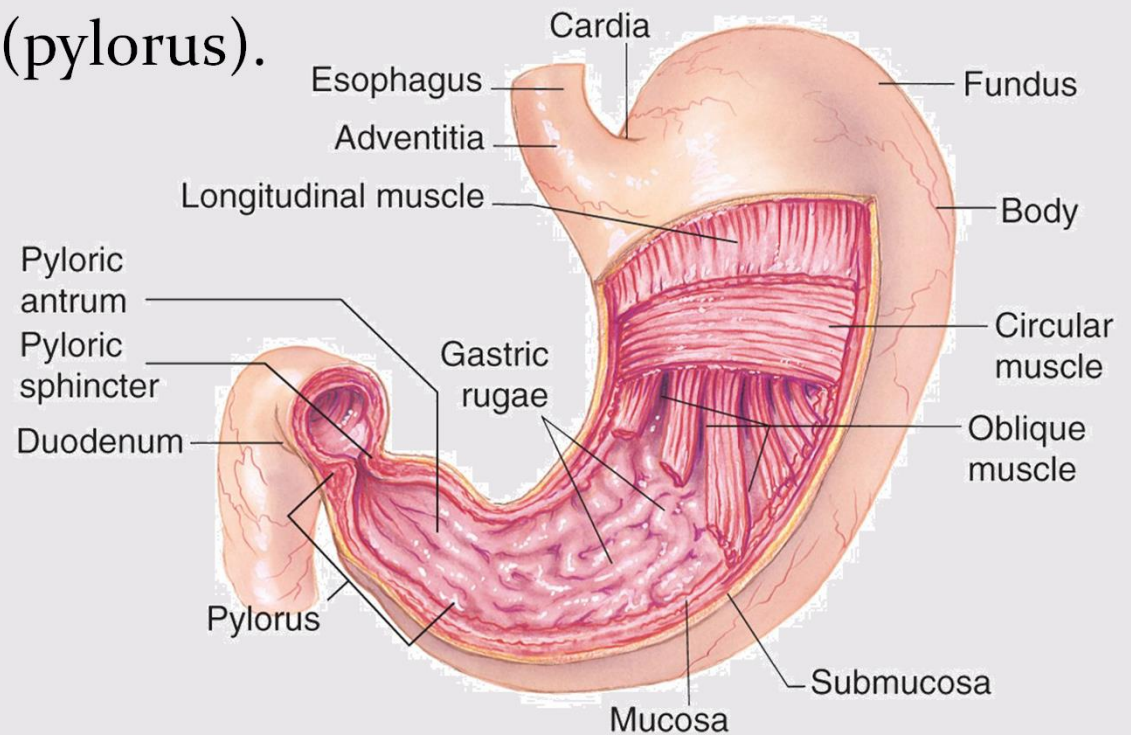
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# STOMACH

- J shaped Muscular sac-like organ
- Chemical and physical digestion forms **chyme**
- Stores food, releases small amts. to small intestine
- Takes 2-6 hours for stomach to empty
- Inner surface lined with *gastric rugae*
- Stomach is divided into 3 regions: fundus, body, and antrum (pylorus).

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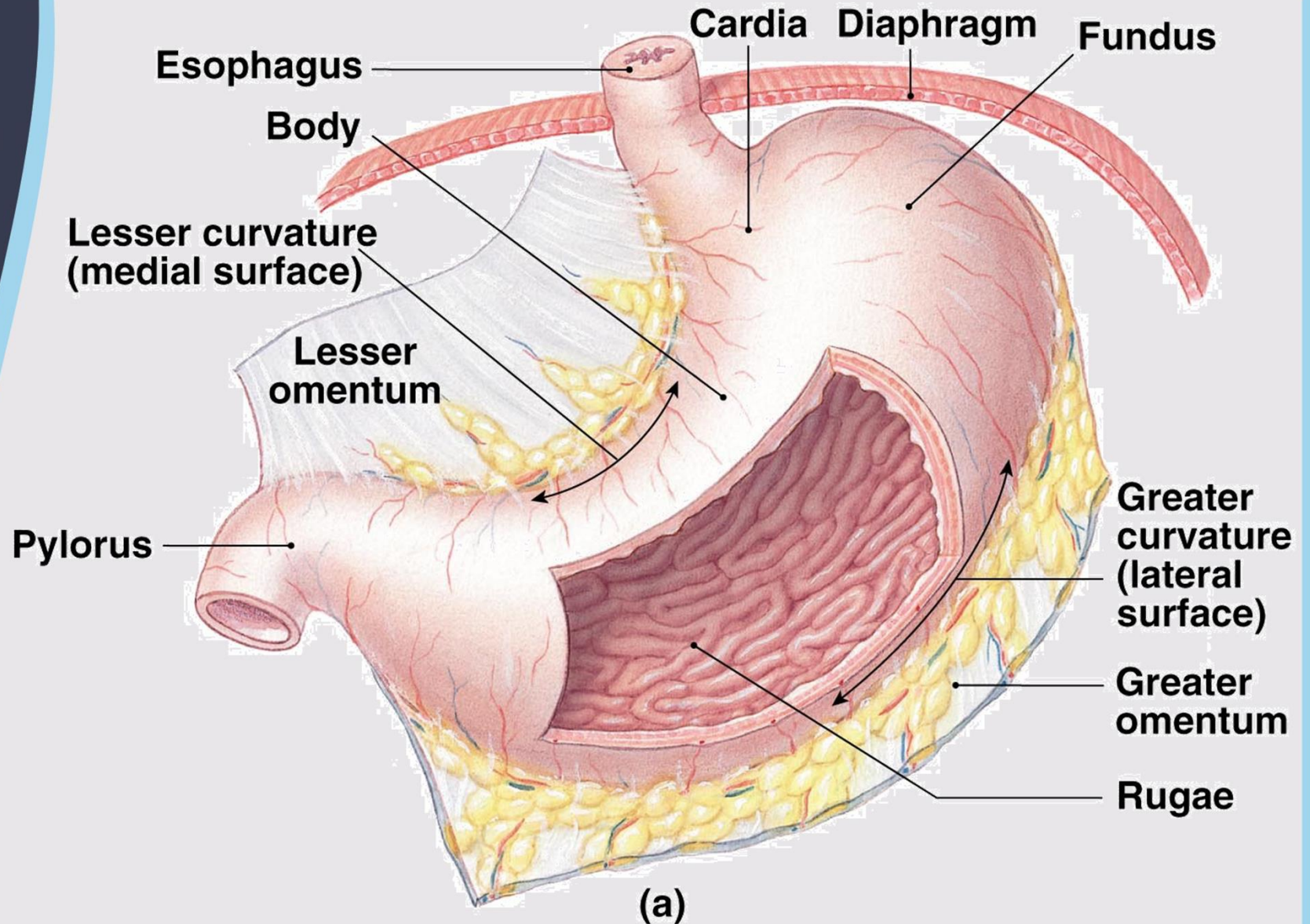




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# STOMACH - GROSS ANATOMY







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# STOMACH MUCOSAL CELLS

Gastric glands (small folds in mucosa) contain specialized **secretory cells**

**Parietal cells** – hydrochloric acid

**Goblet cells** – mucus

*Gastric Mucosal Barrier* protects stomach epithelium

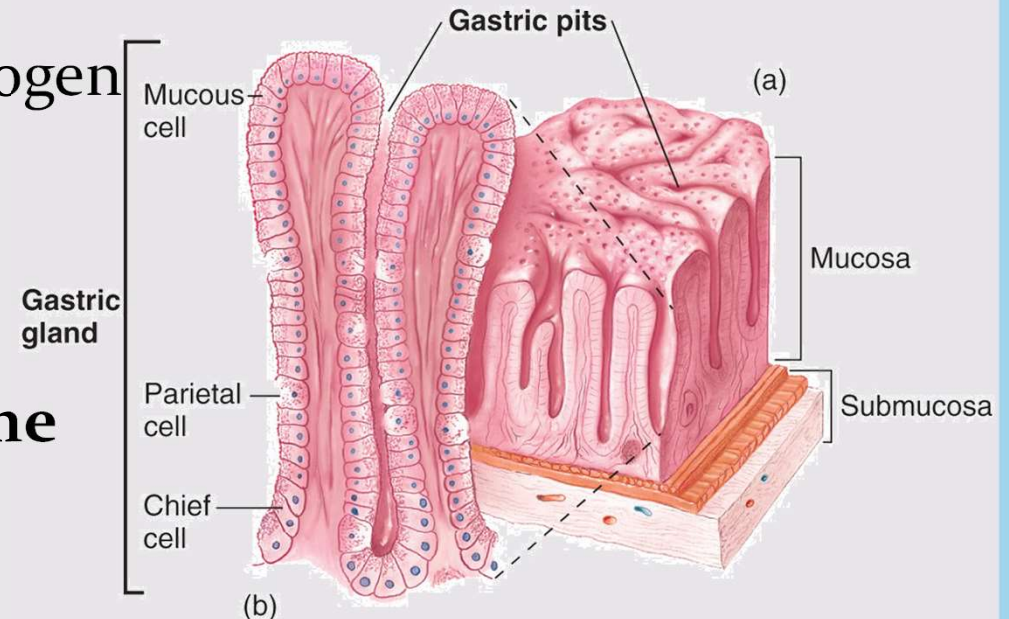
**Chief cells** - pepsinogen

Digests protein

**Endocrine cells**

**ECL cells** – histamine

**G-cells** – gastrin **Intrinsic factor** secreting-cells





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# REGULATION OF GASTRIC FUNCTION AND PHASES OF DIGESTION

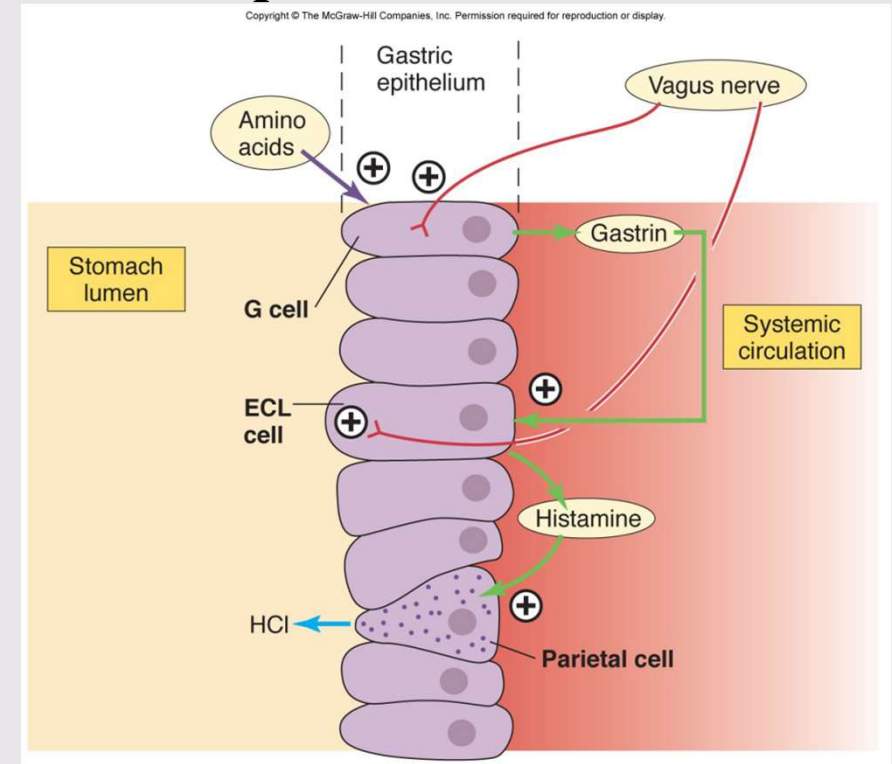
Three basic phases i,e **cephalic, gastric & intestinal**

## 1. Cephalic phase

– Regulation of stomach by the brain via the vagus nerve

– Stimulates G and ECL cell in response to stimuli associated with food

- ECL cells – **histamine**
- G-cells – **gastrin**







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## **2. Gastric phase**

Arrival of food in stomach

Distension of the stomach walls and...

Presence of amino acids and short polypeptides stimulate pepsinogen and gastrin secretion

## **3. Intestinal phase**

Arrival of chyme in small intestine stimulates neural reflex that inhibits gastric motility and secretion

Fats in chyme stimulate secretion of enterogastrones from the intestine that inhibit stomach function



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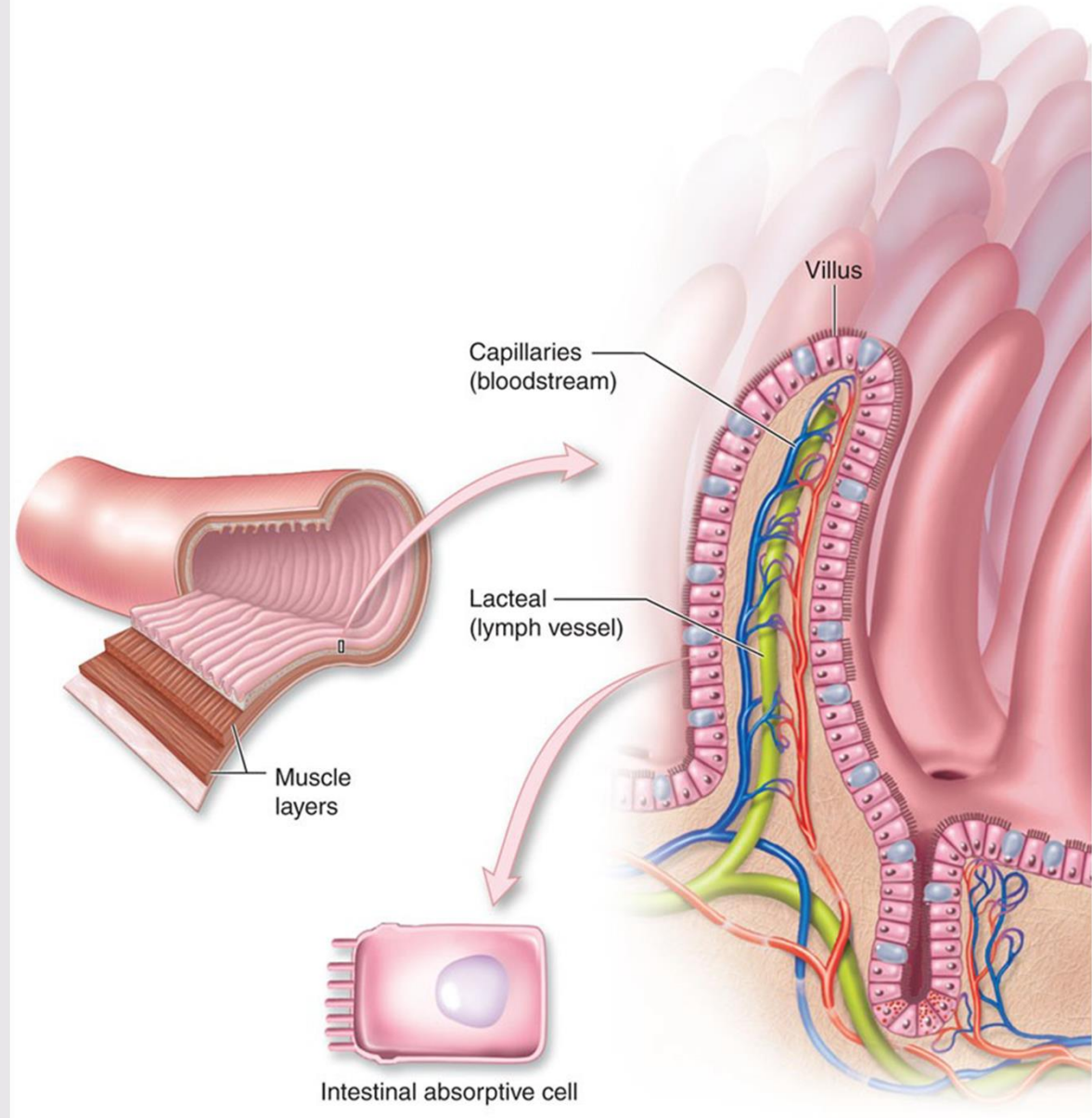
# Small Intestine

Where most nutrients are digested and absorbed.

Duodenum

- Jejunum
- Ileum

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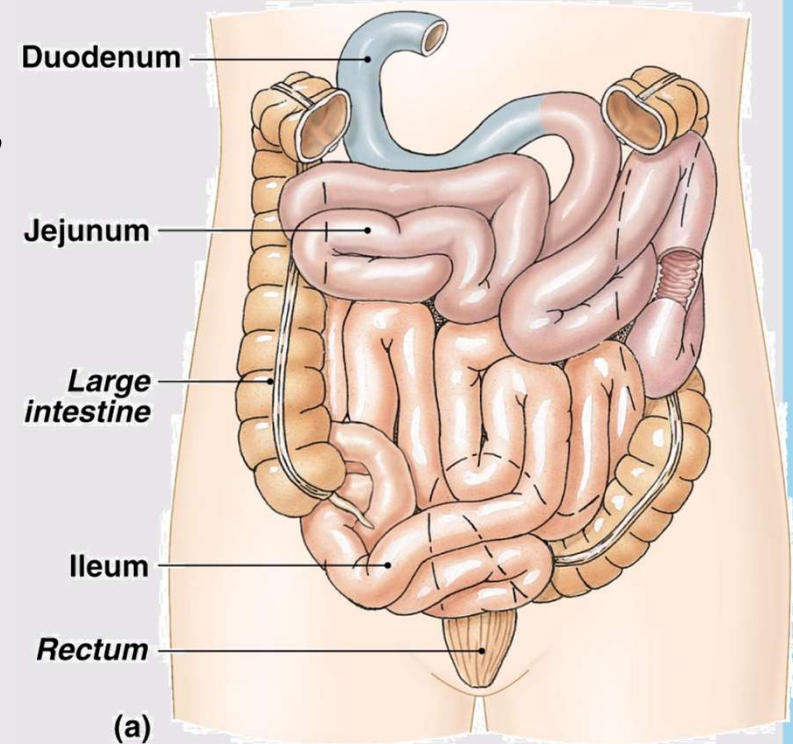
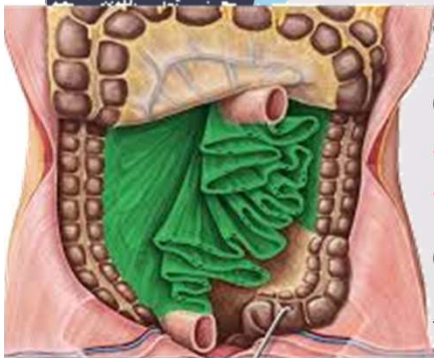


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# SMALL INTESTINE - ANATOMY

- connects stomach to large intestine; 15-20' long; 1" diameter; held together in abdominal cavity by **“mesentery proper”**
- site for completion of chemical digestion & absorption of nutrients
- comprised of three regions:
  - Duodenum** – 10” in length; receives chyme from stomach, secretions from liver, gallbladder & pancreas
  - Jejunum** – 8' long; most digestion & absorption occurs here
  - Ileum** – 12' long; connects to cecum of large intestine at ileocecal valve (sphincter)



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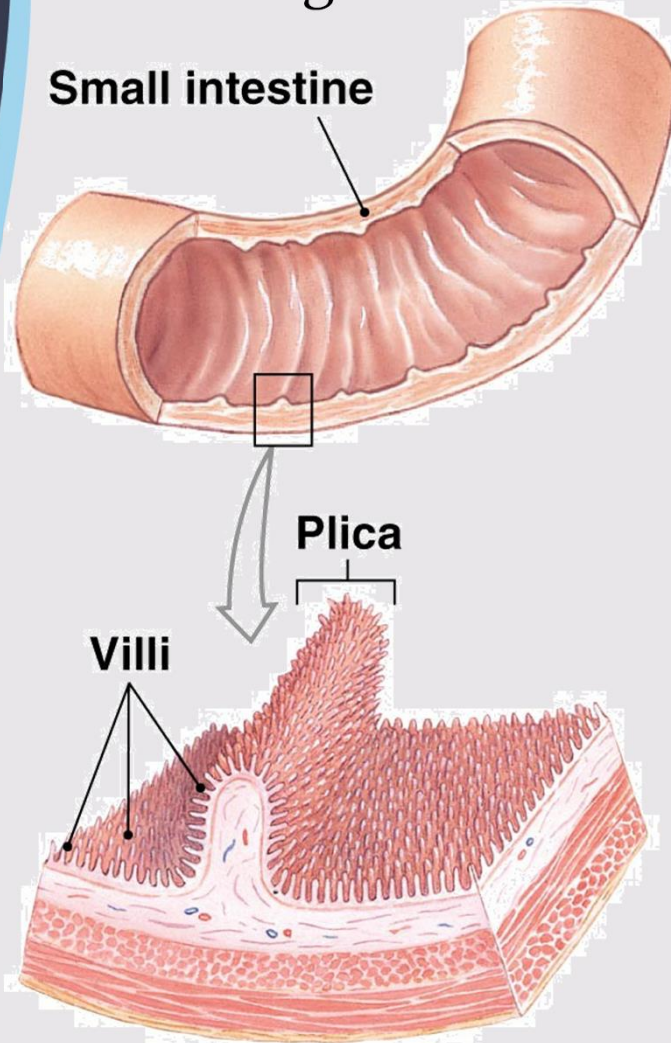


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# SMALL INTESTINE

Modifications in mucosa & submucosa of intestinal wall designed to increase functional surface area:



**Small intestine**

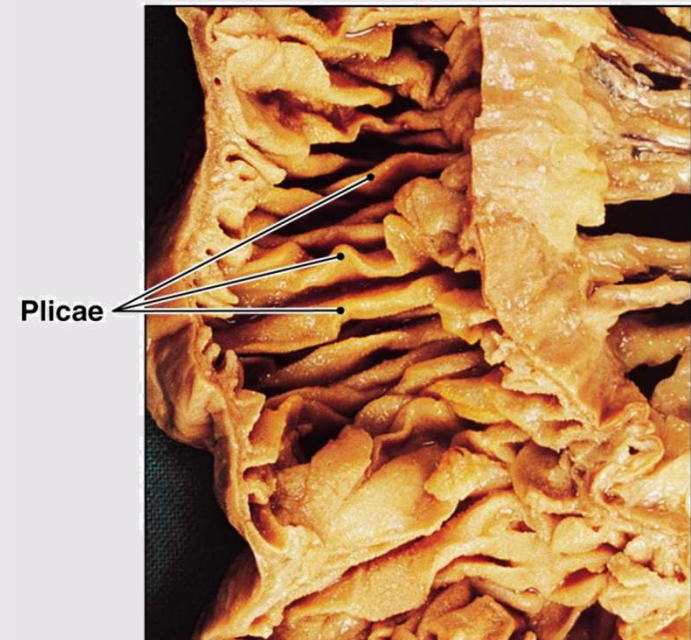
**Plica**

**Villi**

**(a)**

Plicae circulares (circular folds) – large transverse ridges; most abundant in jejunum

Villi – small finger-like projections of mucosal folds across surface of intestine





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# ABSORBING NUTRIENTS

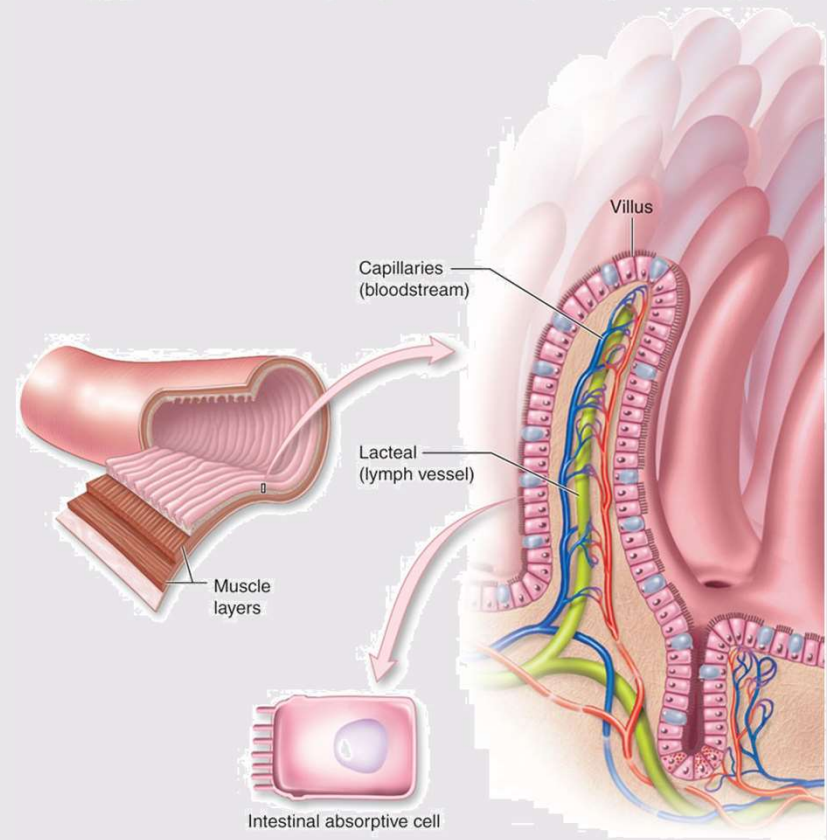
## Villi

Tiny projections that line the small intestine

## Absorptive cells

Remove nutrients from chyme and transfer them into intestinal blood or lymph

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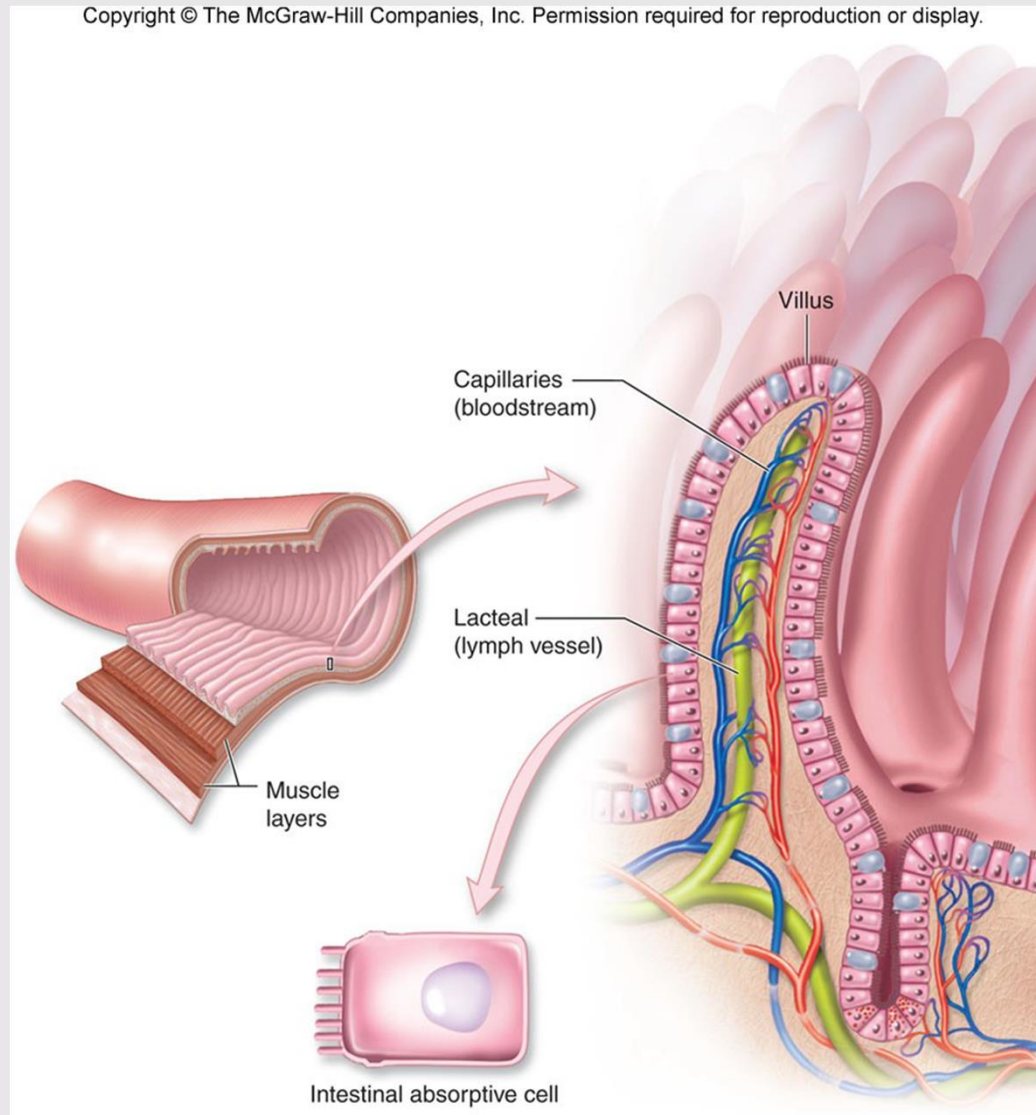
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Water-soluble nutrients enter the capillary of a villus, and travel to the liver via **portal vein**.

Most fat-soluble compounds are formed into chylomicrons, that enter a lacteal of the lymphatic system and eventually reach the bloodstream.

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## HOW IS INTESTINE SERVE AS A BEST SITE FOR ABSORPTION

- Very large surface area.
- Blood flow to Small Intestine is very high.
- PH range 5-7.5 which is favorable for most of drugs to remain unionized.
- Peristaltic movement of intestine is slow compared to stomach.
- Residence time of dosage form in SI is long.
- Permeability is very high.



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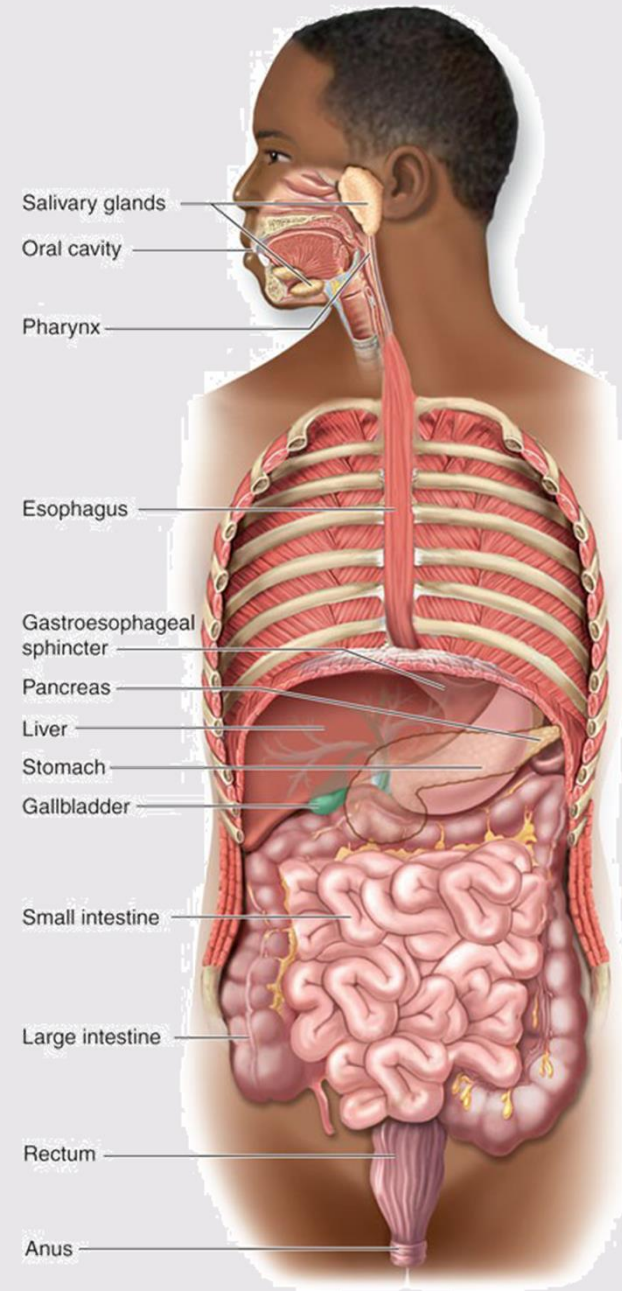
# LARGE INTESTINE

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Absorption of water and minerals

**Feces** – form as chyme becomes Semisolid

**Rectum** – lower part of large intestine where feces are stored



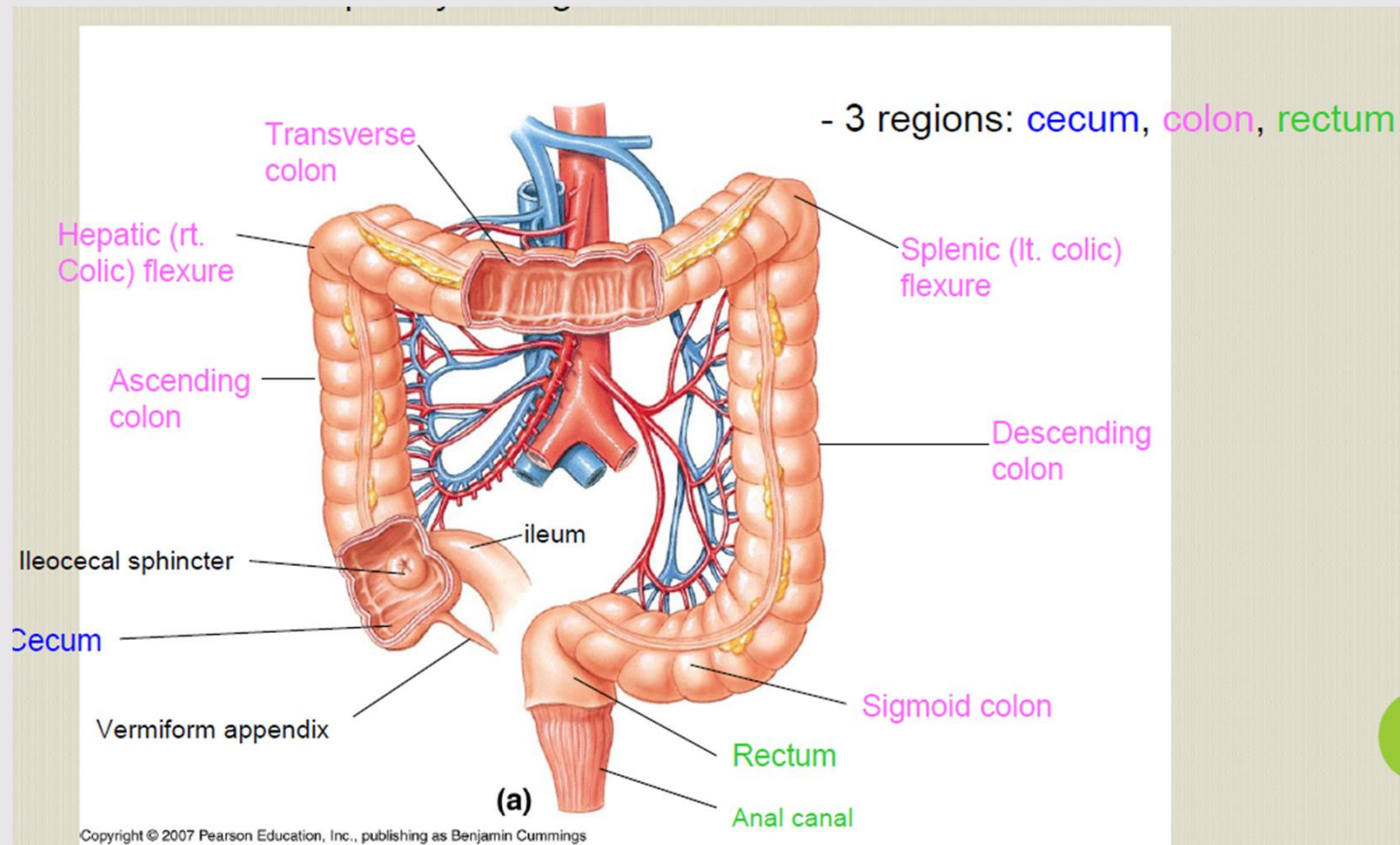


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# LARGE INTESTINE

- Begins at the ileum & ends at the anus; 5' long; 3" in diameter
- Main functions – H<sub>2</sub>O reabsorption; absorption of some vitamins & minerals; formation & temporary storage of fecal material







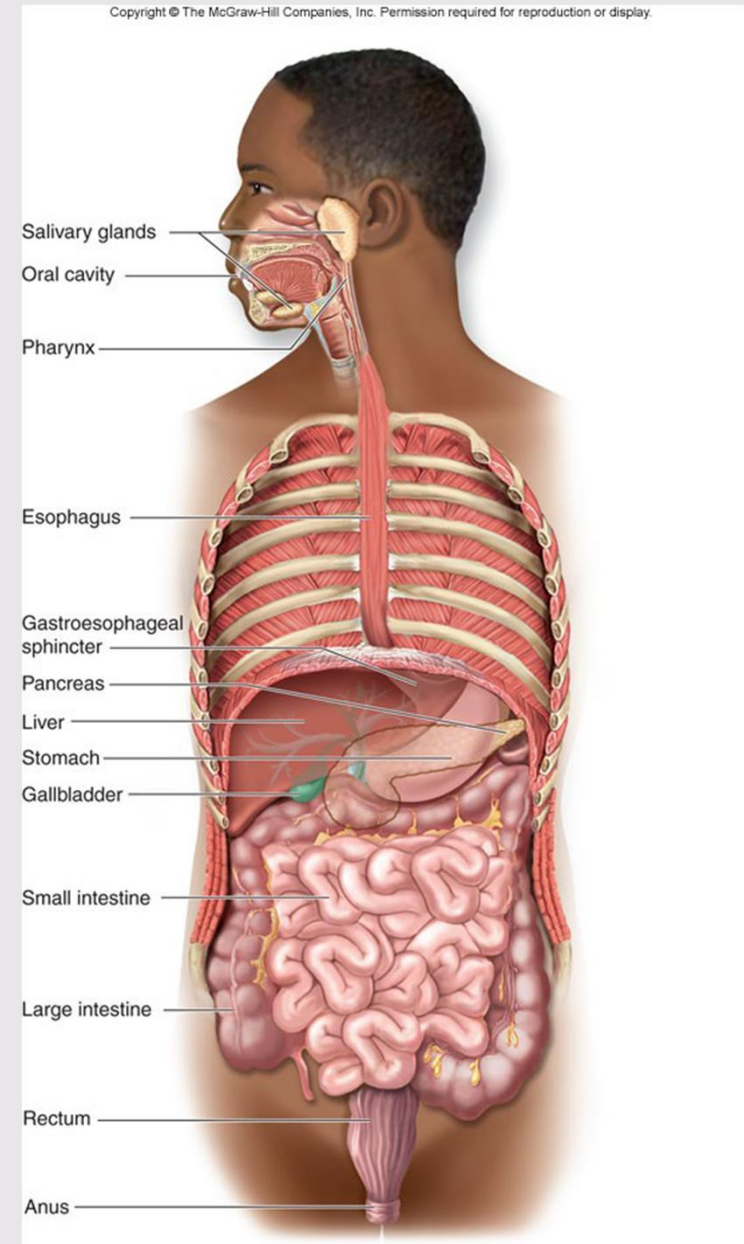
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# Accessory Organs

**Pancreas** – produces and secretes many digestive Enzymes

**Liver** – processes and stores many nutrients makes cholesterol

**Gallbladder** – stores bile that the liver makes





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# ACCESSORY DIGESTIVE ORGANS: PANCREAS

Produces Pancreatic Juice

**Bicarbonate** - neutralizes stomach  
Acidity

## Enzymes

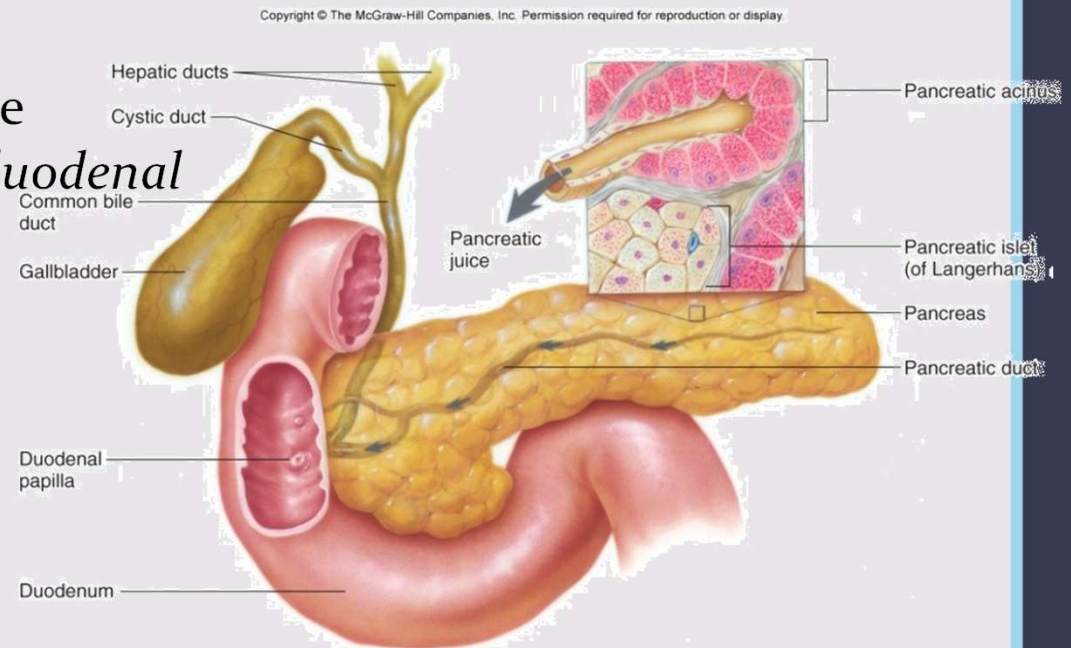
**Pancreatic amylase** - breaks down  
starch

**Trypsin and other proteases** -  
break down polypeptides

**Pancreatic lipase** - digests  
triglycerides

**Others** ( nucleases)

Pancreatic juice enters the  
duodenum through the *duodenal  
papilla*





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# PANCREAS

**Pancreatic juice** – mixture of enzymes & buffers (sodium bicarbonate) secreted by acinar cells into pancreatic duct & released into duodenum  
pancreatic amylase

Starch  $\longrightarrow$  Maltose

Lipase

Lipids  $\longrightarrow$  fatty acids + monoglycerol

Proteases (trypsin, chymotrypsin, carboxypeptidase)

Proteins & polypeptides  $\longrightarrow$  small peptides  
tri & dipeptides

**Nucleases** – digest RNA & DNA

**Sodium bicarbonate** – neutralizes acidic chyme because enzymes in small intestine need an alkaline pH





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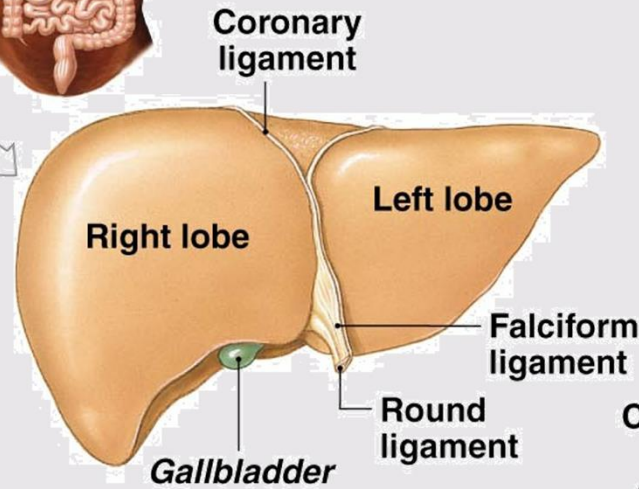
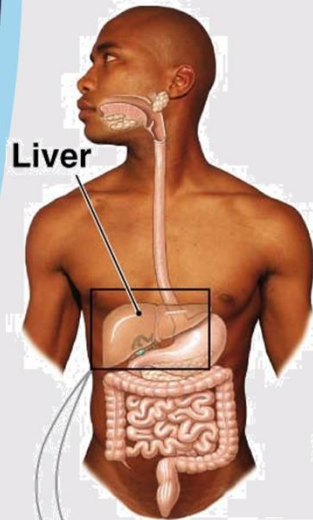
# LIVER - ANATOMY

Largest organ *within* the body

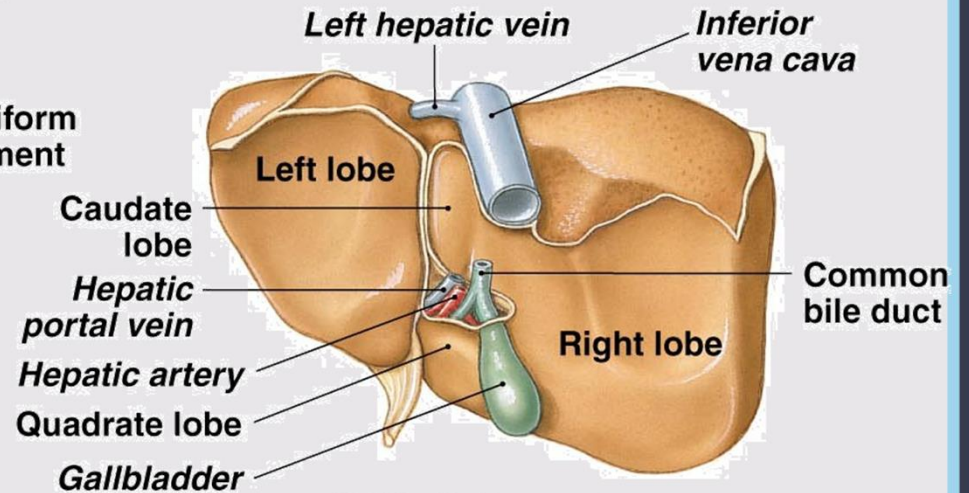
Comprised of 4 lobes:

Large **right & left** lobes divided by falciform ligament; small **caudate & quadrate** (by gall bladder) lobes

Lobes of liver functionally divided into microscopic lobules



(a) Anterior surface



(b) Posterior surface



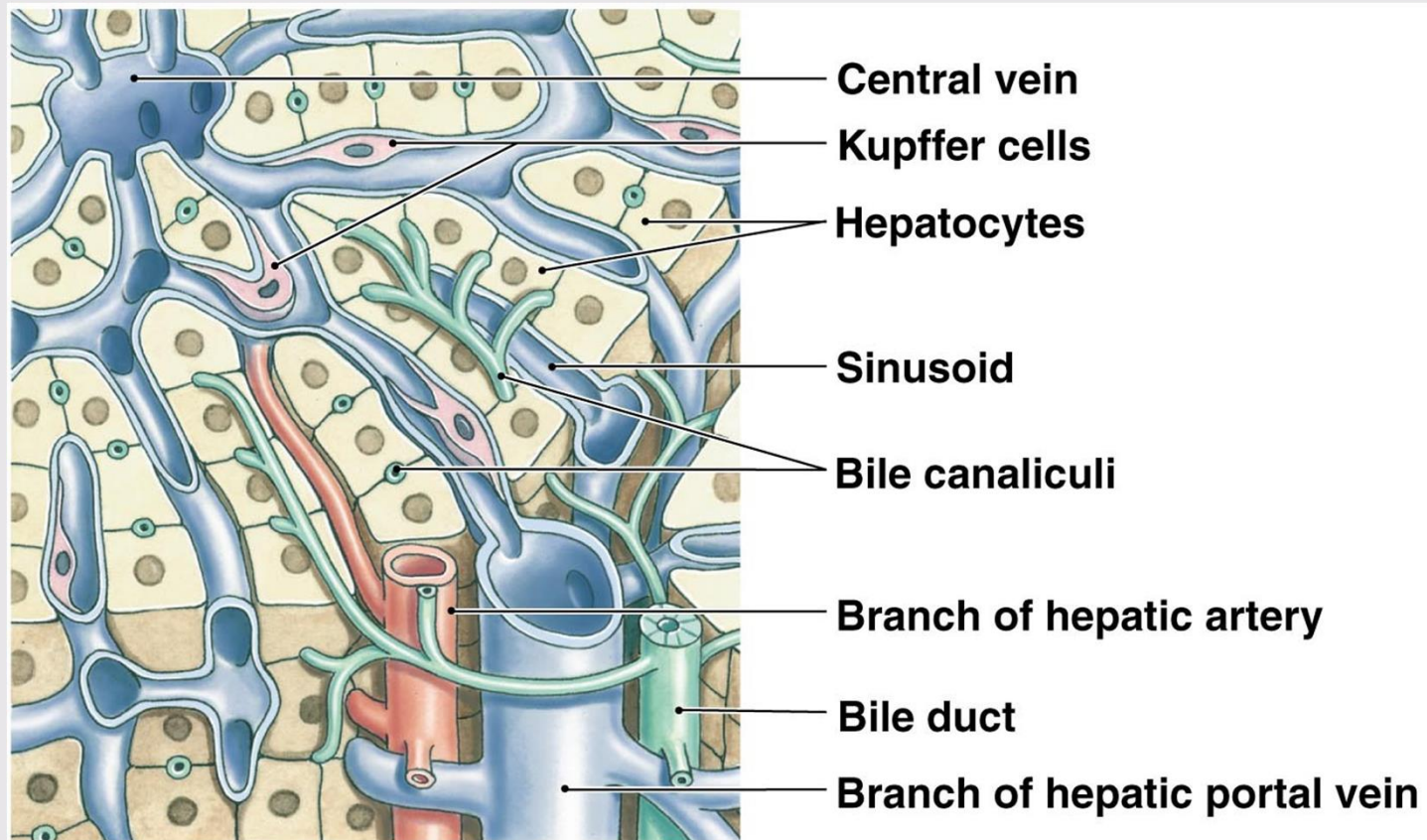
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# LIVER

Hepatocytes produce bile, which gets secreted into bile canaliculi of lobule

Bile canaliculi merge to form bile ducts which eventually merge to create the right & left hepatic ducts

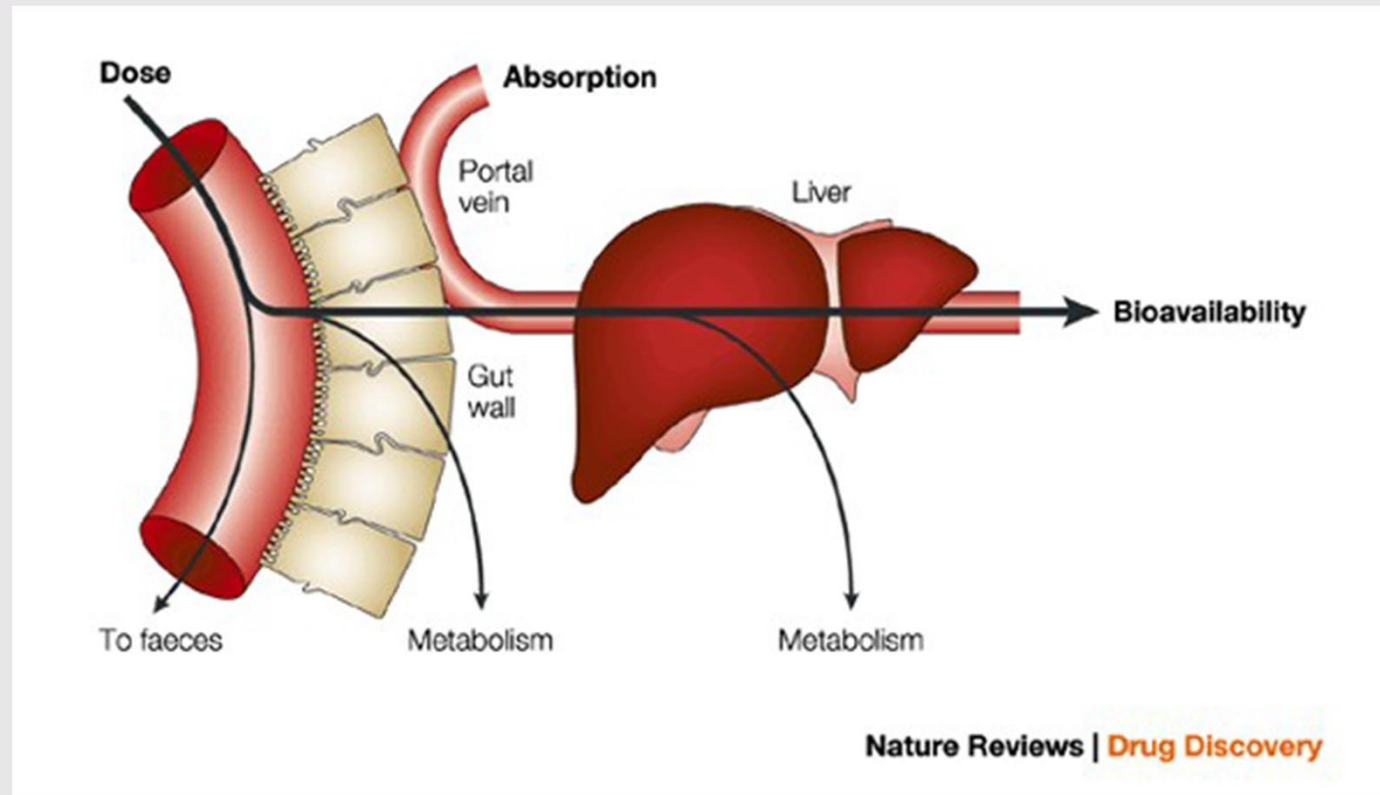


(b)



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The figure shows where metabolism occurs during the absorption process.

The fraction of the initial dose appearing in the portal vein is the fraction absorbed, and the fraction reaching the blood circulation after the first-pass through the liver defines the bioavailability of the drug.





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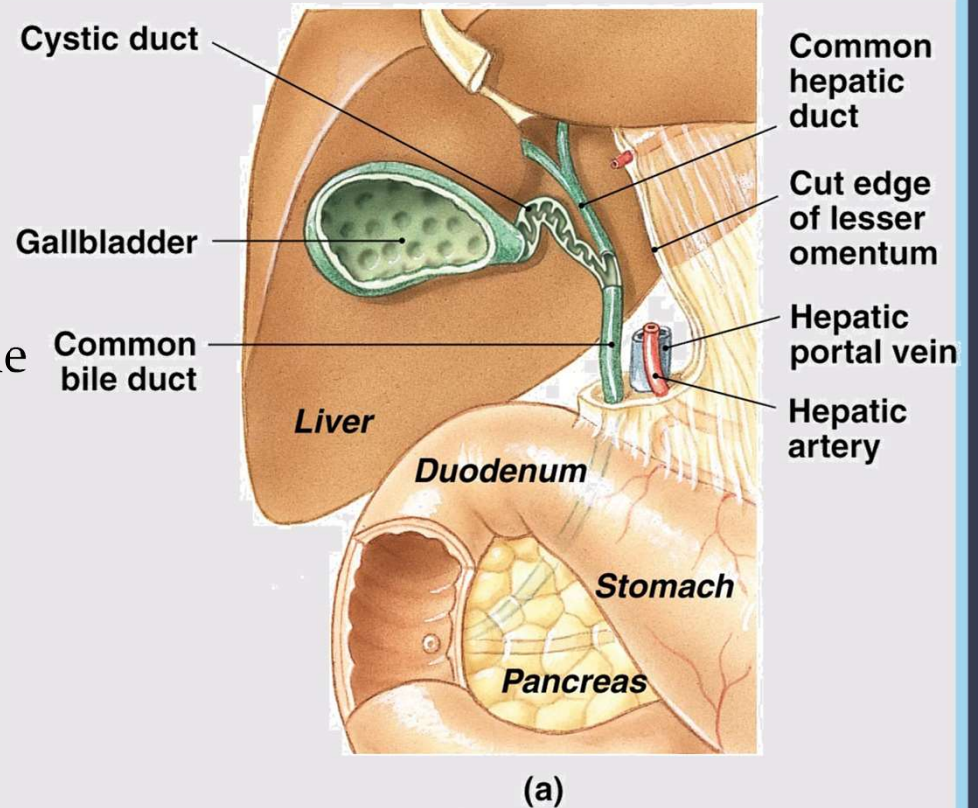
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# LIVER & GALL BLADDER

Right & left hepatic ducts unite to form common hepatic duct which merges with cystic duct of gall bladder to form common bile duct which joins with pancreatic duct & enters the duodenum

**Gall bladder** – hollow muscular sac under right lobe of liver; stores & concentrates bile; releases bile through cystic duct

Bile released into duodenum functions in emulsification of lipids, absorption of fats (due to presence of bile salts), & excretion of bilirubin



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# ENZYMES

## Gastric enzymes

- **Pepsin**

Main enzyme in stomach  
Breaks down protein to peptides

- **Gelatinase**

Breaks down proteins

- Gastric amylase

- Gastric lipase

## Small Intestine enzymes

- **Sucrase**

- **Maltase**

- **Lactase**

- **Intestinal lipase**

## Pancreatic enzymes

- **Trypsin**

- **Chymotrypsin**

- **carboxypeptidase**

- **Nuclease**

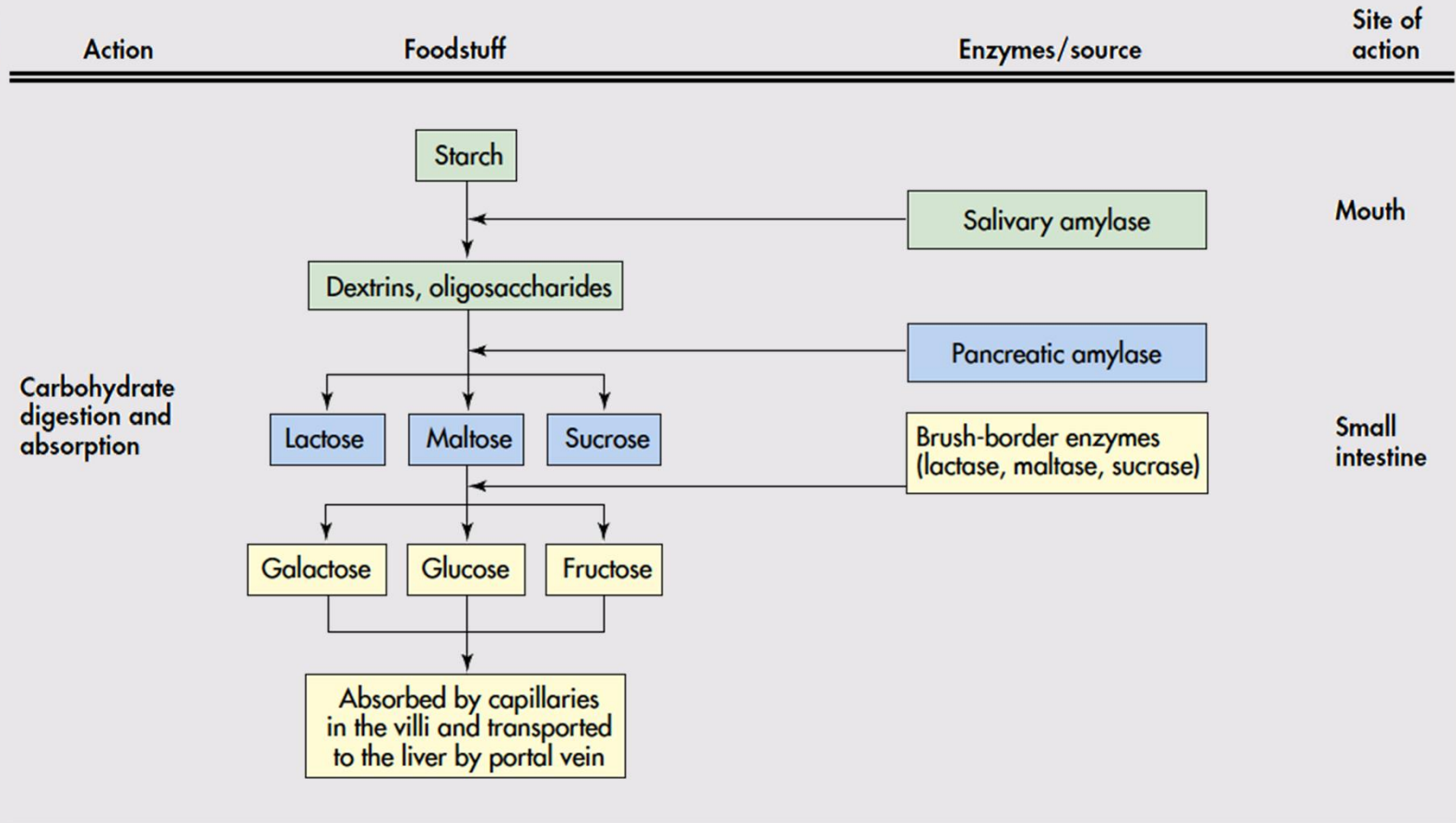
- **Pancreatic amylase**



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# CARBOHYDRATE DIGESTION AND ABSORPTION



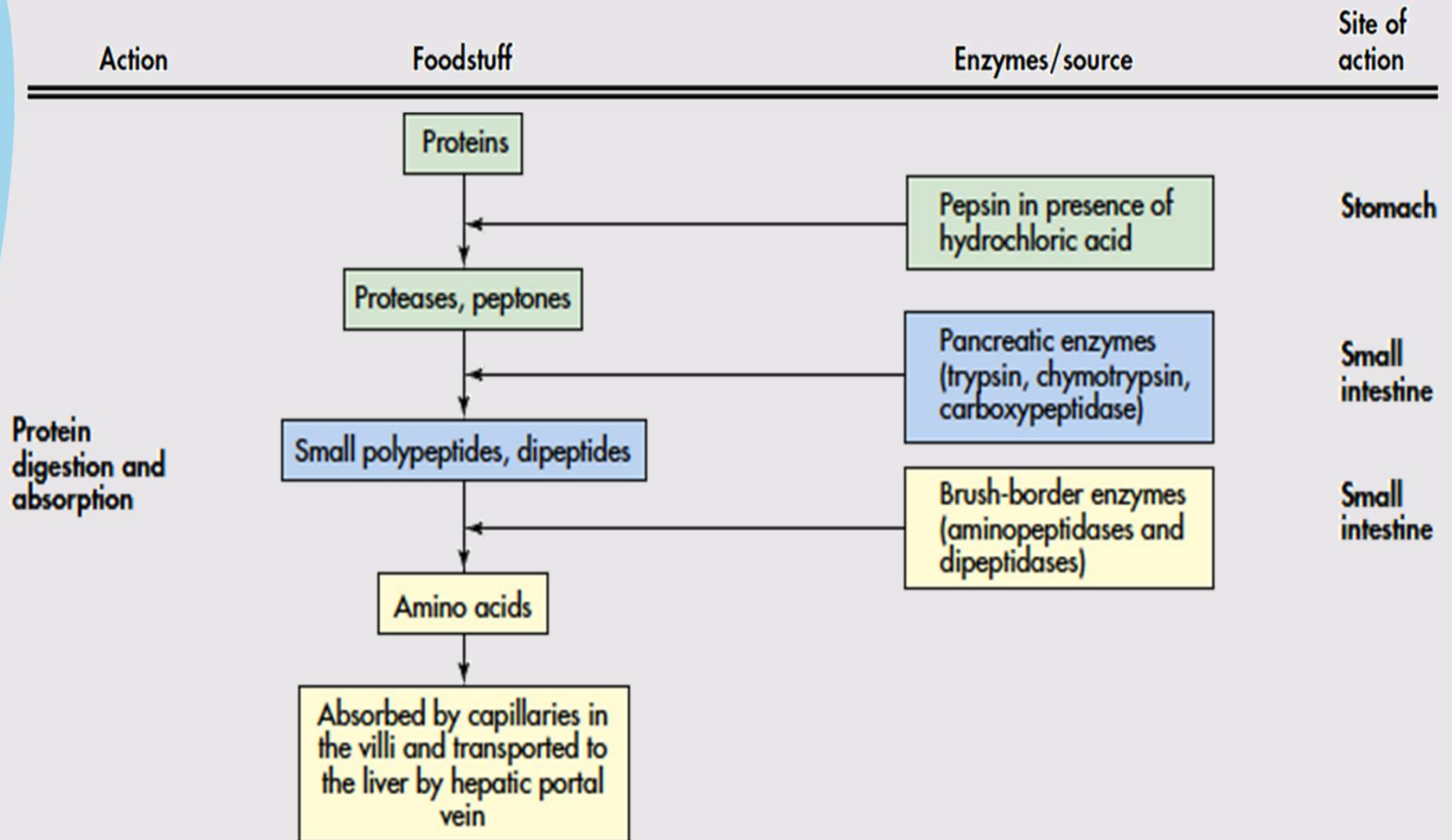




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# PROTEIN DIGESTION AND ABSORPTION

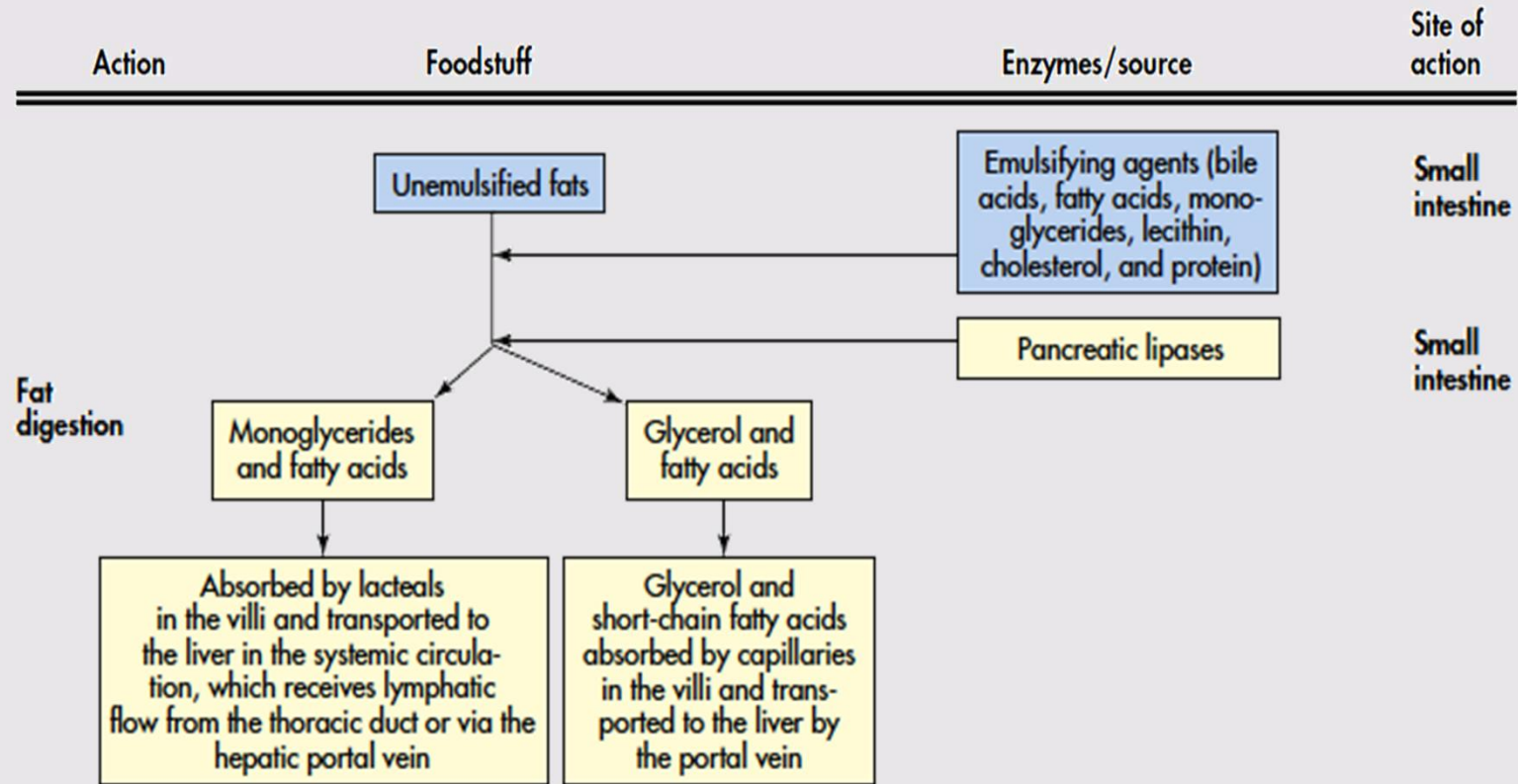




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# FAT DIGESTION AND ABSORPTION





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# **DISEASES OF GASTRO INTESTINAL TRACT**





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# I. DISEASES IN THE MOUTH

## 1. ACUTE STOMATITIS

An acute inflammation of the mucous membrane of the mouth, occurring most frequently in children, though no age is exempt.

**Symptoms:** The inflammation is attended by the following symptoms: **heat, pain, redness, and swelling**. At first the mouth is dry and hot, with a burning, smarting sensation; but soon secretion is established, and mucus and saliva are found in excess. This condition is often called **catarrhal stomatitis**.

**Treatment:** thoroughly cleansing the mouth with a weak solution of pyrozone, or a wash of boracic acid.





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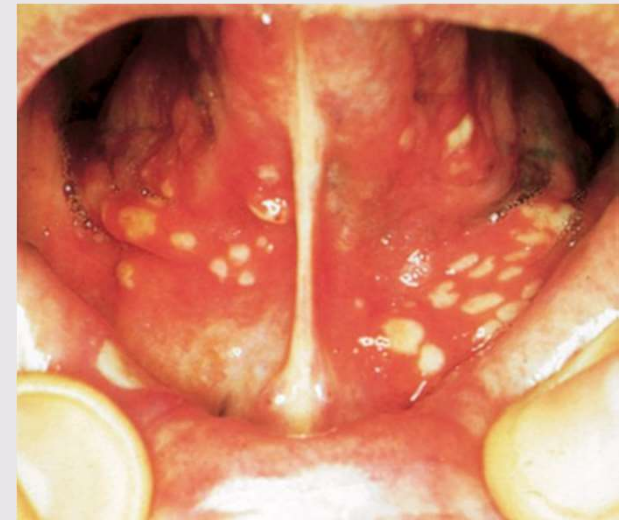
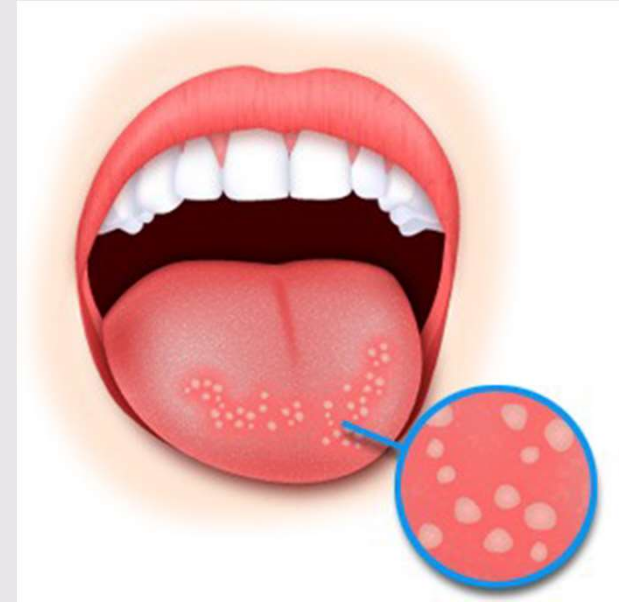
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## 2. APHTHOUS STOMATITIS

A variety of stomatitis, characterized by small, round, white patches upon the mucous membrane of the tongue, gums, and cheeks. Small vesicles appear upon an inflamed base, and later form small ulcers.

**Symptoms:** The mouth is exquisitely tender, and, when nursing or attempting to eat, a burning sensation follows.

**Treatment:** Cleanliness is of the greatest importance, and the mouth should be rinsed with lukewarm water after each feeding.





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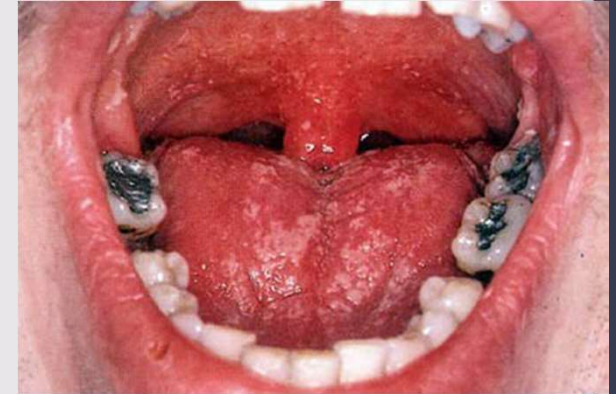
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### 3. THRUSH

A specific fungous disease of the buccal mucous surfaces, characterized by whitish or yellowish deposits, in which are found the *saccharomyces albicans*.

**Symptoms:** The child is fretful and peevish, the result of the burning pain, and frequently a diarrhea, with greenish stools, occurs.

**Treatment:** Mouth-washes will be selected to correct this condition ; hence the alkalies are used; bicarbonate of sodium, boracic acid, potassium chlorate, etc. After each feeding, the mouth is to be carefully washed, every particle of food being removed. Sweets of all kinds are to be avoided, as they favor fermentation.







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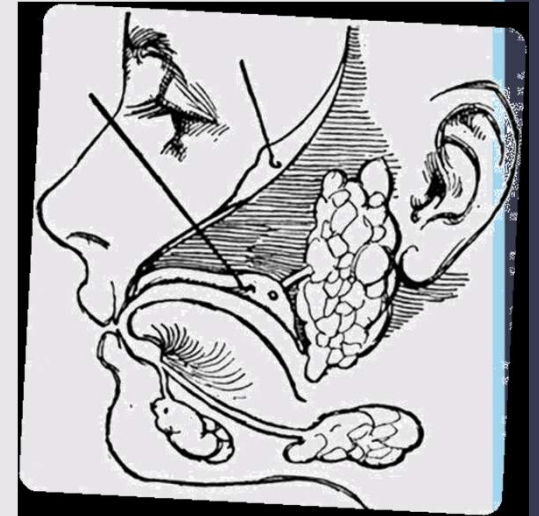
## II. DISEASES IN THE SALIVARY GLANDS

### 1. HYPERSECRETION

An excessive secretion of saliva.

**Symptoms:** The mouth is constantly bathed with saliva, which necessitates frequent spitting on the part of the patient.

Where it is very excessive, talking is carried on with difficulty. The almost constant wetting of the lips may be attended by chapping and cracking at the angles of the mouth.





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## 2. XEROSTAMIA

Dry mouth; a defect or arrest of the salivary and buccal secretions.

**Symptoms:** The mouth is dry, red, or parched, resulting in difficulty in mastication, deglutition, and talking.

Digestion is more or less impaired, and gastric symptoms may be present.





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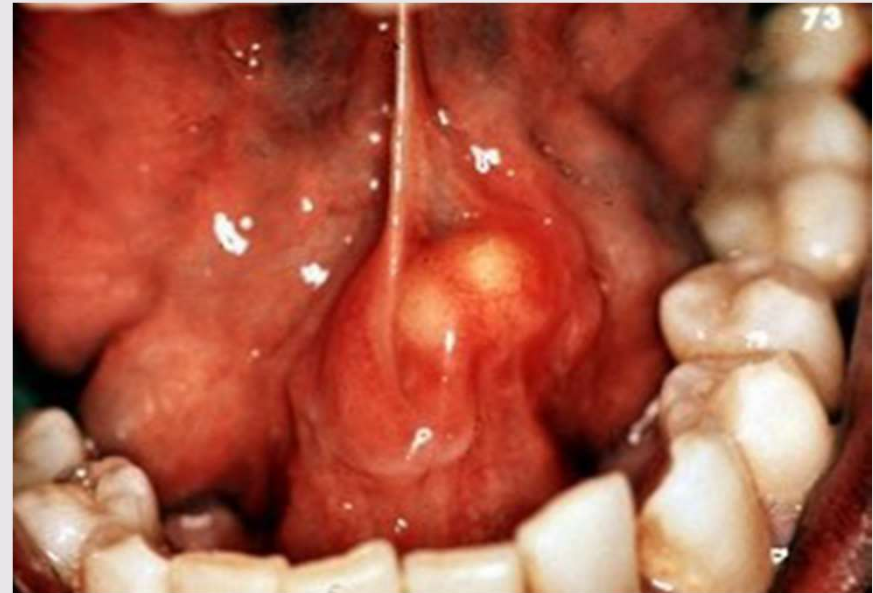
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### 3. INFLAMMATION OF THE SALIVARY GLANDS

A secondary inflammation of the parotid gland, with greater tendency to **suppuration** than in specific parotitis or mumps.

**Symptoms:** During the course of the primary disease, or following an injury, the gland becomes swollen, tender, and more or less dusky and livid.

**Treatment:** The cause being septic conditions of the blood, the treatment will very naturally be the administration of antiseptics; hence, echinacea, in five to- ten drop doses, will fit many cases.







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# III. DISEASES OF THE PHARYNX

## 1. ANGINA SIMPLEX (SORE THROAT)

An acute inflammation of the mucous membrane of the pharynx, and sometimes of the entire pharyngeal structure.

**Symptoms:** The symptoms of sore throat are characteristic, the patient complaining of pain and fullness in the throat, especially when swallowing. The surfaces are dry and swollen, and the patient swallows frequently to give relief.





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## 2. CHRONIC PHARYNGITIS

A chronic inflammation of the mucous surfaces of the pharynx and adjacent tissues.

**Symptoms:** The patient experiences a sense of stuffing up in the upper part of the throat, and, to get relief, there is frequent effort to remove it by hawking, or, where the surface is dry, there is almost constant swallowing. A short, dry, hacking cough reveals laryngeal complications, and the voice is more or less husky.





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### 3. ULCERATION OF THE PHARYNX

An indolent ulceration of the mucous membrane and deeper tissues of the pharynx.

**Symptoms:** There is usually slight fever, loss of appetite, a coated tongue, bad breath, and painful deglutition.







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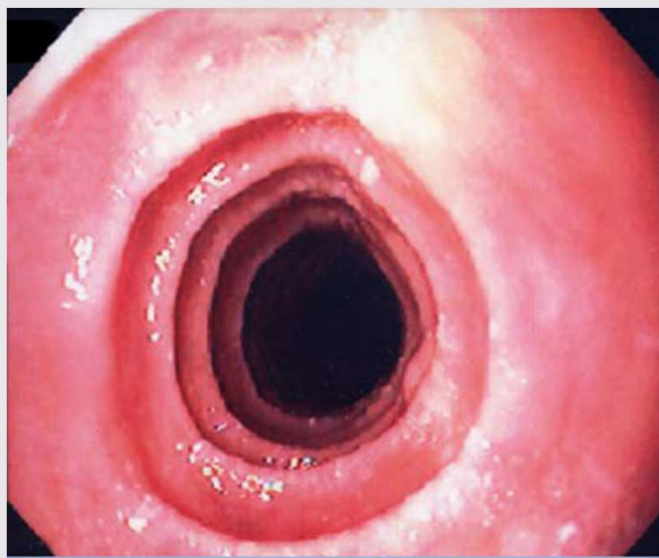
# IV. DISEASES OF THE ESOPHAGUS

## 1. ESOPHAGITIS

An acute inflammation of the mucous membrane of the esophagus, frequently involving the submucous tissues.

**Symptoms:** A dull, uneasy feeling, or sometimes a burning, smarting sensation. Swallowing is difficult, and aggravates the pain.

**Treatment:** Only the blandest form of diet should be used. Milk in some form, either as whey or malted milk, is preferable. In some cases small bits of ice are gratefully received.





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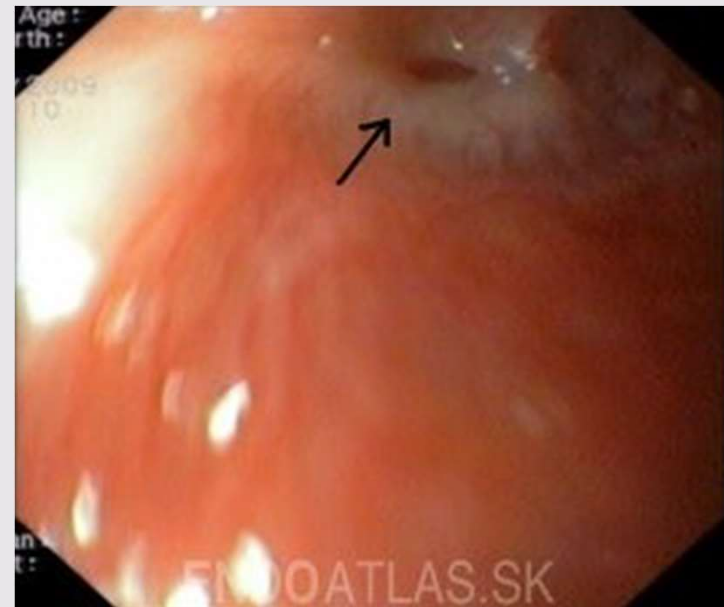
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## 2. STENOSIS

Bleeding veins in the esophagus, caused by a liver disease.

**Symptoms:** Blood in the stool or vomit, fainting, dizziness, cirrhosis of the liver

**Treatment:** a rubber band is placed on the varicose vein to cut off its blood supply (**rubber band treatment**); a **sclerosant**, usually a chemical or saline solution, is injected into the varicose vein to induce a clot and block its blood supply. This will cause the vein to shrivel and die. (**Sclerotherapy**)





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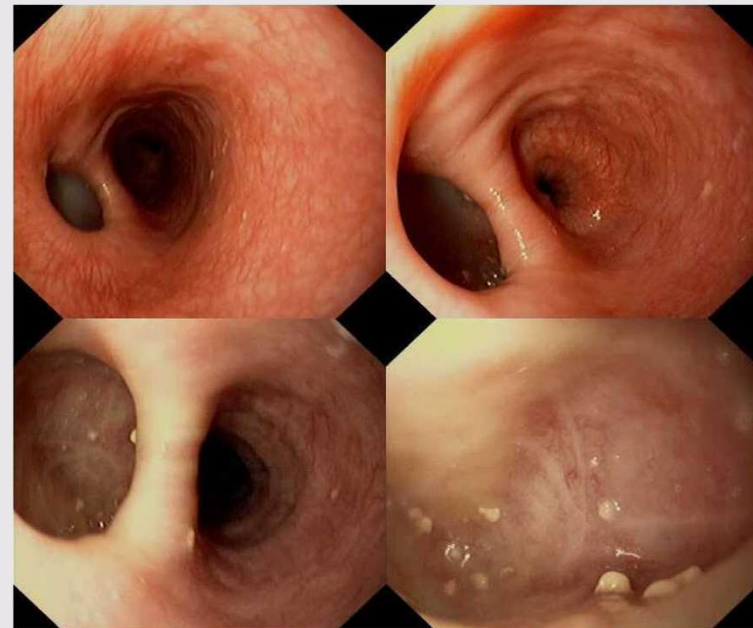
### 3. ESOPHAGEAL SPASM

Pain and difficulty in swallowing due to abnormal clenching of the muscles in the **esophagus**.

**Symptoms:** Dull or intense pain under the breast bone, difficulty swallowing, involuntary regurgitation of food

#### **Prevention & Treatment:**

swallowing only well-chewed food in small pieces, avoiding hot food or hot and cold drinks, reducing stress, or taking in **psychiatric drugs** for panic attack and depression.







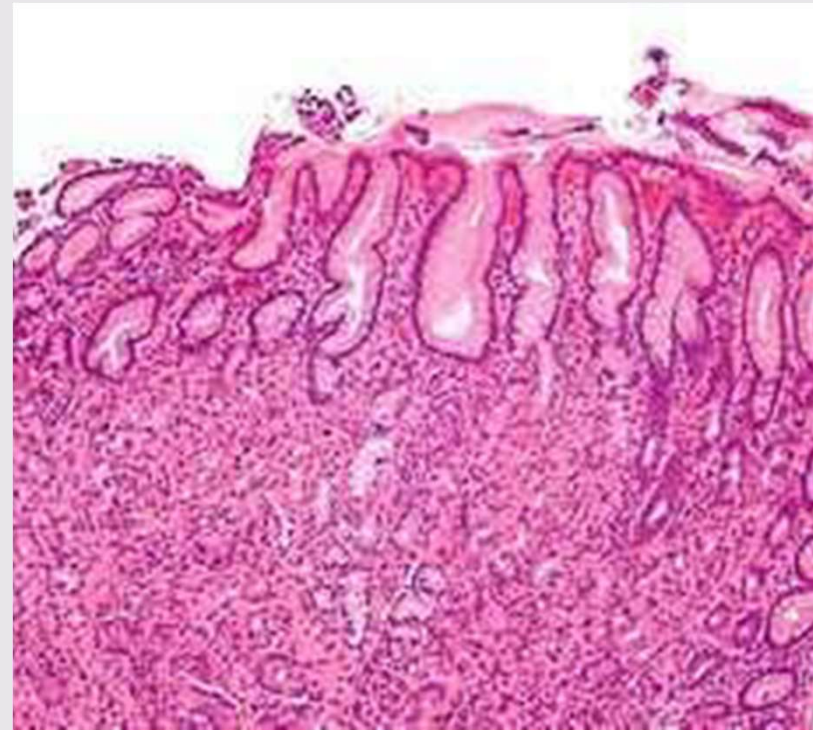
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# V. DISEASES OF THE STOMACH

## 1. GASTRITIS

It is the disease where there is severe inflammation of stomach lining. It occurs due to the **consumption of too much alcohol**, continuous use of **drugs like aspirin and ibuprofen** or infection by bacteria like **H. pylori**. The symptoms of gastritis are belching, abdominal bloating and pain.



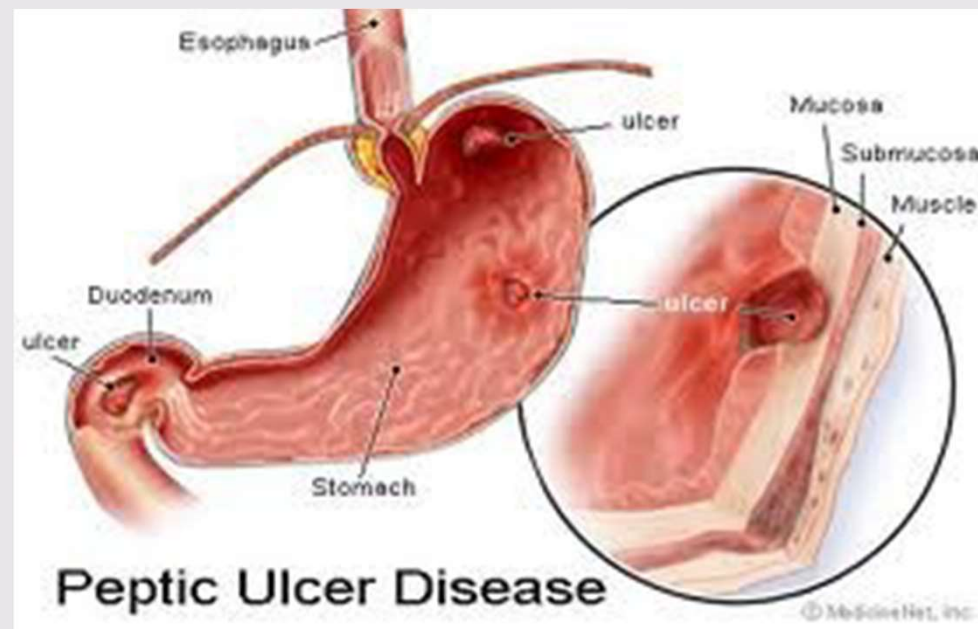


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## 2. GASTRIC ULCER

A well-defined round or oval ulcer, due to the action of the gastric juice upon some portion of the mucous membrane, which has been weakened by some impairment of nutrition. It penetrates the mucous membrane and sometimes the entire gastric wall.





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### 3. HYPERACIDITY

Increased activity of the secreting apparatus of the stomach, whereby an undue amount of hydrochloric acid, more than is required for the purpose of digestion, is secreted.

**Treatment:** The diet should consist of lean meats, eggs, milk, and whole wheat bread should be the principal bill of fare. Acid fruits should be restricted. With the exception of milk, the patient does better on a dry diet.







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## 4. DYSPEPSIA

It is also known as upset stomach or indigestion. Indigestion can be caused by various factors the most common being the abnormality of the pancreas or bile duct.

The symptoms can be fullness or a heavy stomach before and after a meal.





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# VI. OTHER DIGESTIVE DISEASES

## 1. HEPATITIS

**Hepatitis** is a viral infection in which the liver becomes inflamed and can lose its ability to function.

### TYPES

**Hepatitis A:** Hepatitis A is a virus that causes liver disease. It most commonly comes from contaminated food or water.

**Hepatitis B:** Hepatitis B is a virus that causes liver disease. It most commonly comes from contaminated food or water and can be treated through vaccination.

**Hepatitis C:** Patients with hepatitis C develop a chronic liver infection. It often does not show any symptoms. No vaccine is yet available to prevent hepatitis C.



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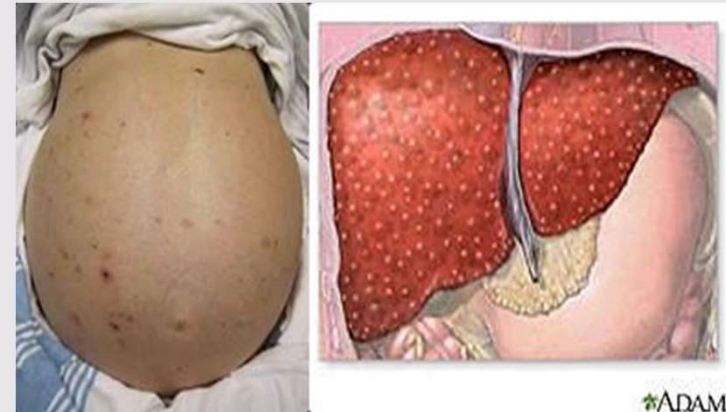
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## 2. DIARRRHEA

Diarrhea is the condition of having **three or more loose or liquid bowel movements per day**. It is a common cause of death in developing countries and the second most common cause of infant deaths worldwide. The loss of fluids through diarrhea can cause dehydration and electrolyte imbalances.

## 3. CIRRHOSIS

It is the condition in which the liver gradually deteriorates and starts to malfunction, blocking the flow of blood through the liver. Caused due to **obesity and excessive alcohol consumption**, cirrhosis, can be identified by **fatigue, vomiting, weight loss and loss of appetite**.







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## 4. LACTOSE INTOLERANCE

**Lactose, fructose and sucrose intolerance** is the body's inability to absorb these basic sugars. It is caused by deficiency in the enzyme **lactase**.

This enzyme is produced by the lining of the small intestine, and is responsible in breaking down sugars into absorbable forms.

Most common among Asians, African Americans, Native Americans and Hispanics.



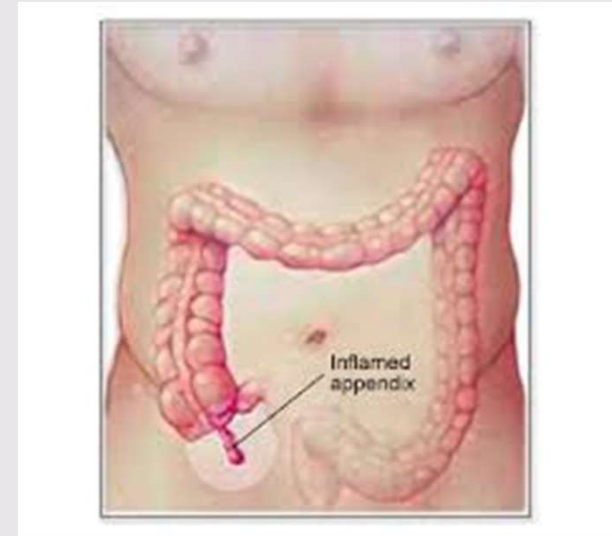


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## 5. APPENDICITIS

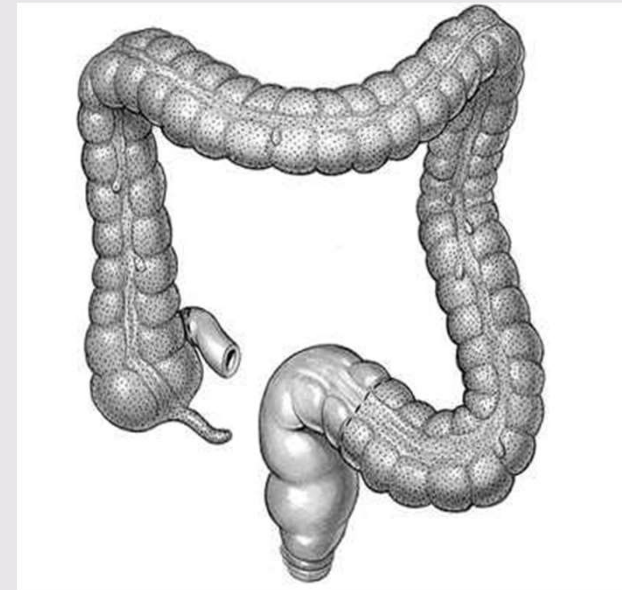
Appendicitis is a condition characterized by inflammation of the appendix.



## 6. CONSTIPATION

**Constipation** is a symptom, which almost every person experiences in his or her life.

The most common cause of constipation are lack of proper diet like not enough fiber, milk, dehydration, lack of physical exercise etc. It results in irregular and often painful bowel movements.





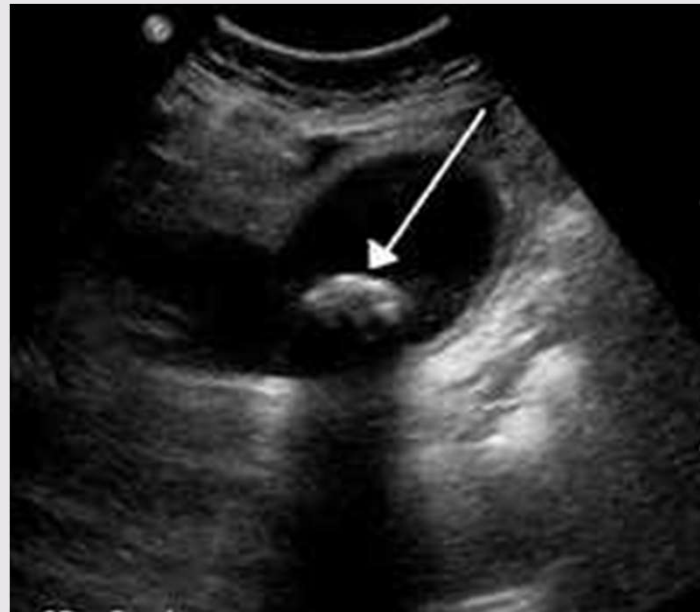
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## 7. GALLSTONES

Gallstones develop due to imbalances in the gall bladder due to **excess amount of cholesterol and too little of bile salts**. In addition, it can result when gall bladder cannot empty more often or completely.

Steady pain in the upper abdomen and between the shoulder blades can be due to the formation of gallstones.





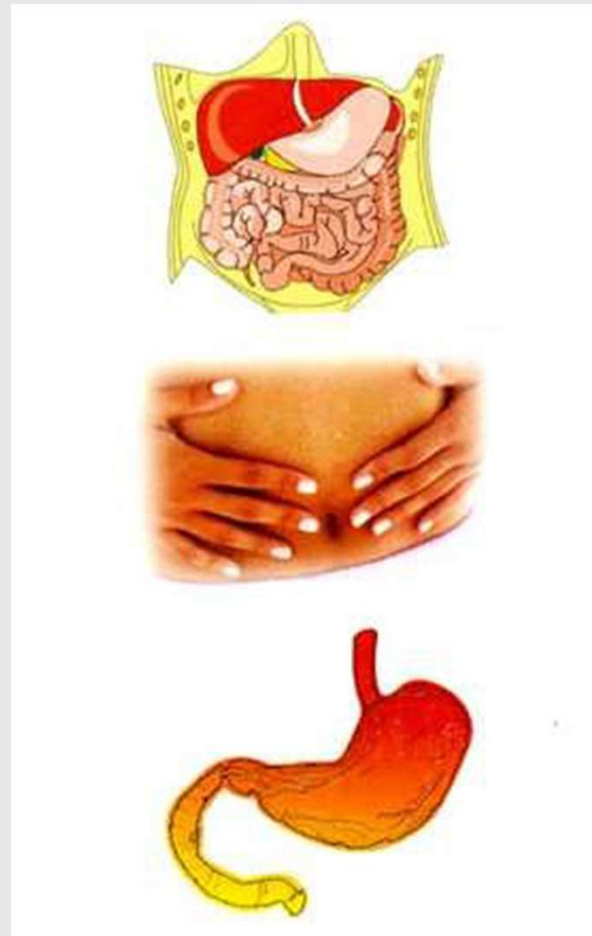


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## 8. FLATULENCE

Also known as gas in the digestive tract, it is caused by the breakdown of undigested food in the colon by bacteria and also through swallowing air. Gas results in **belching, flatulence, abdominal bloating, and pain.**





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