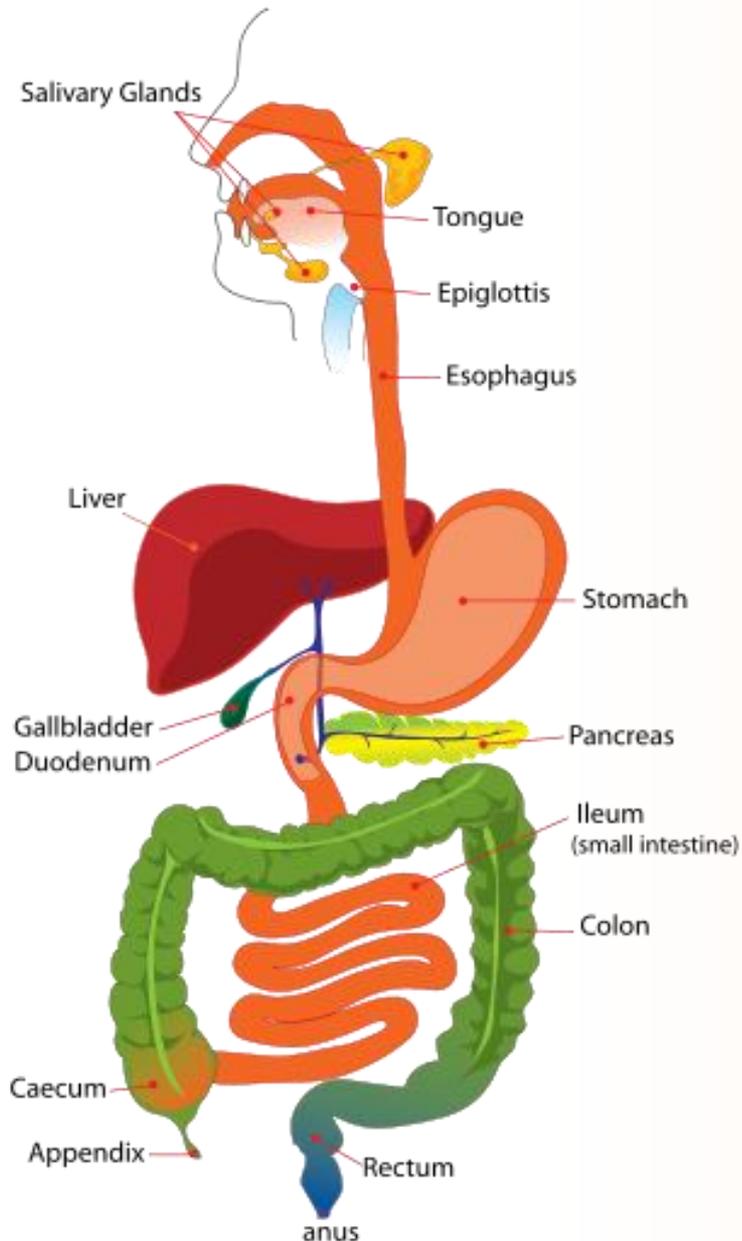


Digestive Tract

Also called **alimentary canal** or **gastrointestinal tract**

Mouth – pharynx-
epiglottis- esophagus –
stomach –small
intestine – large
intestine - anus

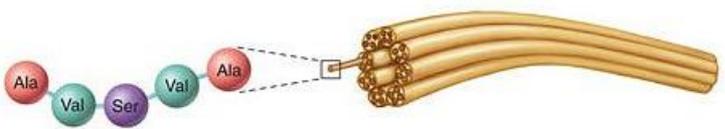
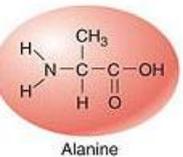
Digestive Tract



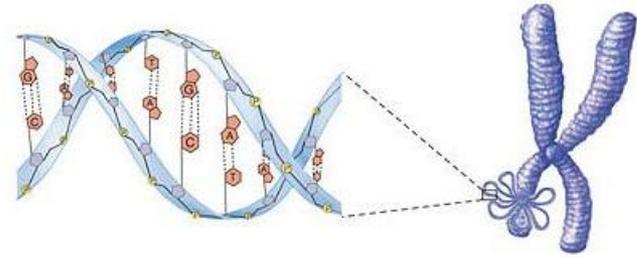
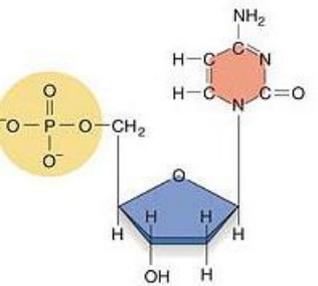
Digestion: *The **mechanical** and **chemical** breaking down of food into smaller components*

TABLE 4.1 MACROMOLECULES

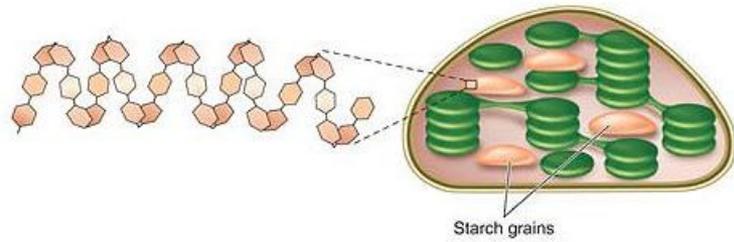
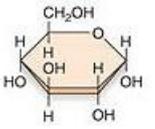
Monomer	Polymer	Cellular structure
Amino Acid	Polypeptide	Intermediate filament



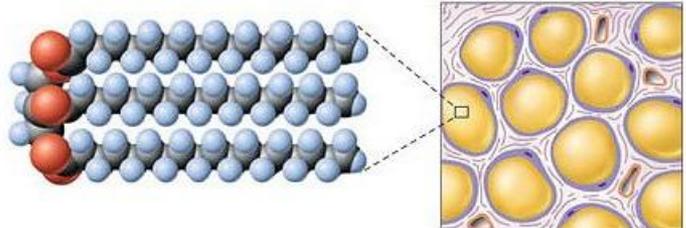
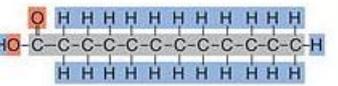
Nucleotide	DNA strand	Chromosome
------------	------------	------------



Monosaccharide	Starch	Starch grains in a chloroplast
----------------	--------	--------------------------------



Fatty acid	Fat molecule	Adipose cells with fat droplets
------------	--------------	---------------------------------

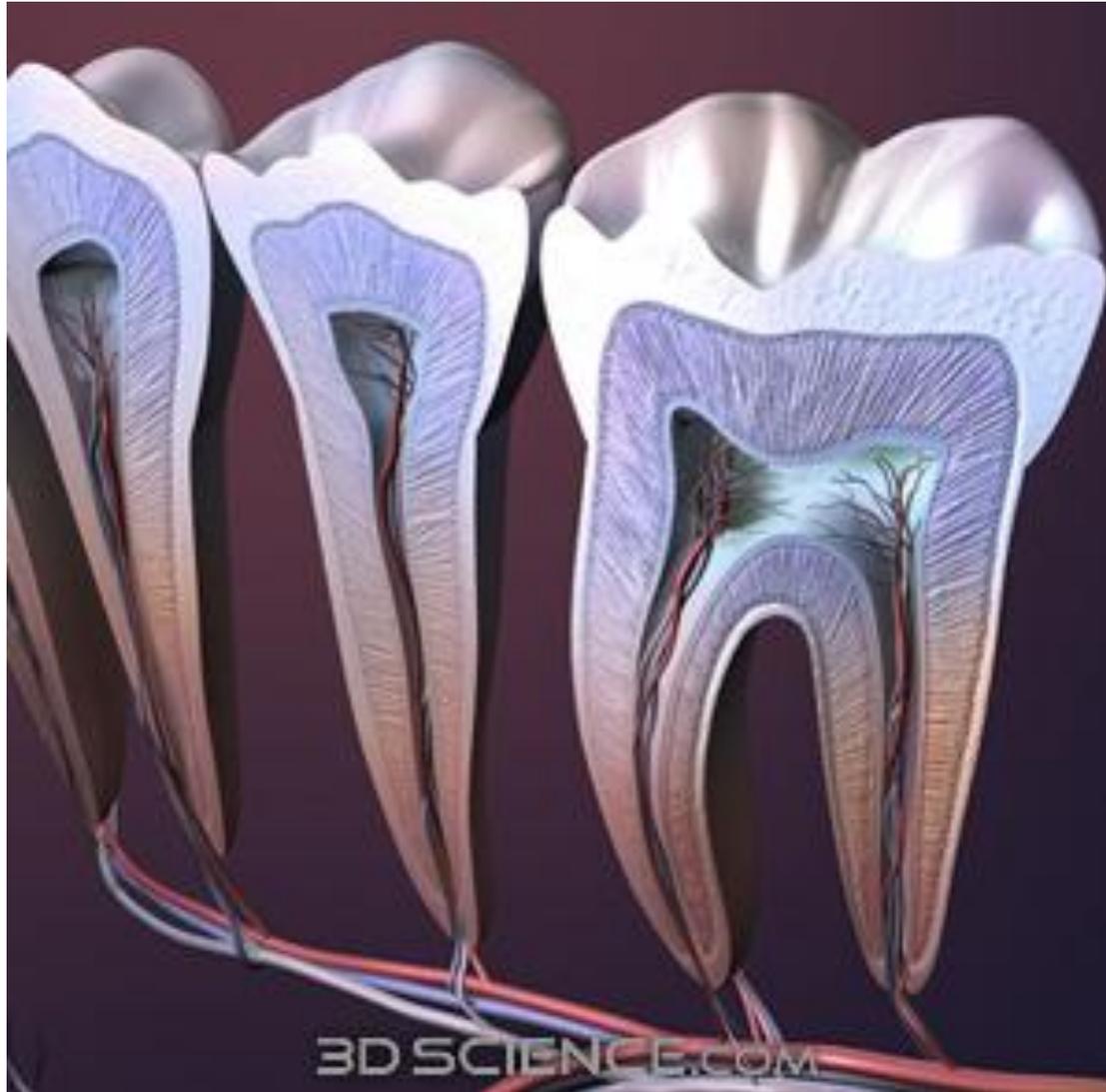


Digestive Tract

Macromolecules:
 Large molecules that provide nutrition (i.e. energy)

- Proteins
- Carbohydrates
- Fats
- *Nucleic acids do not provide energy

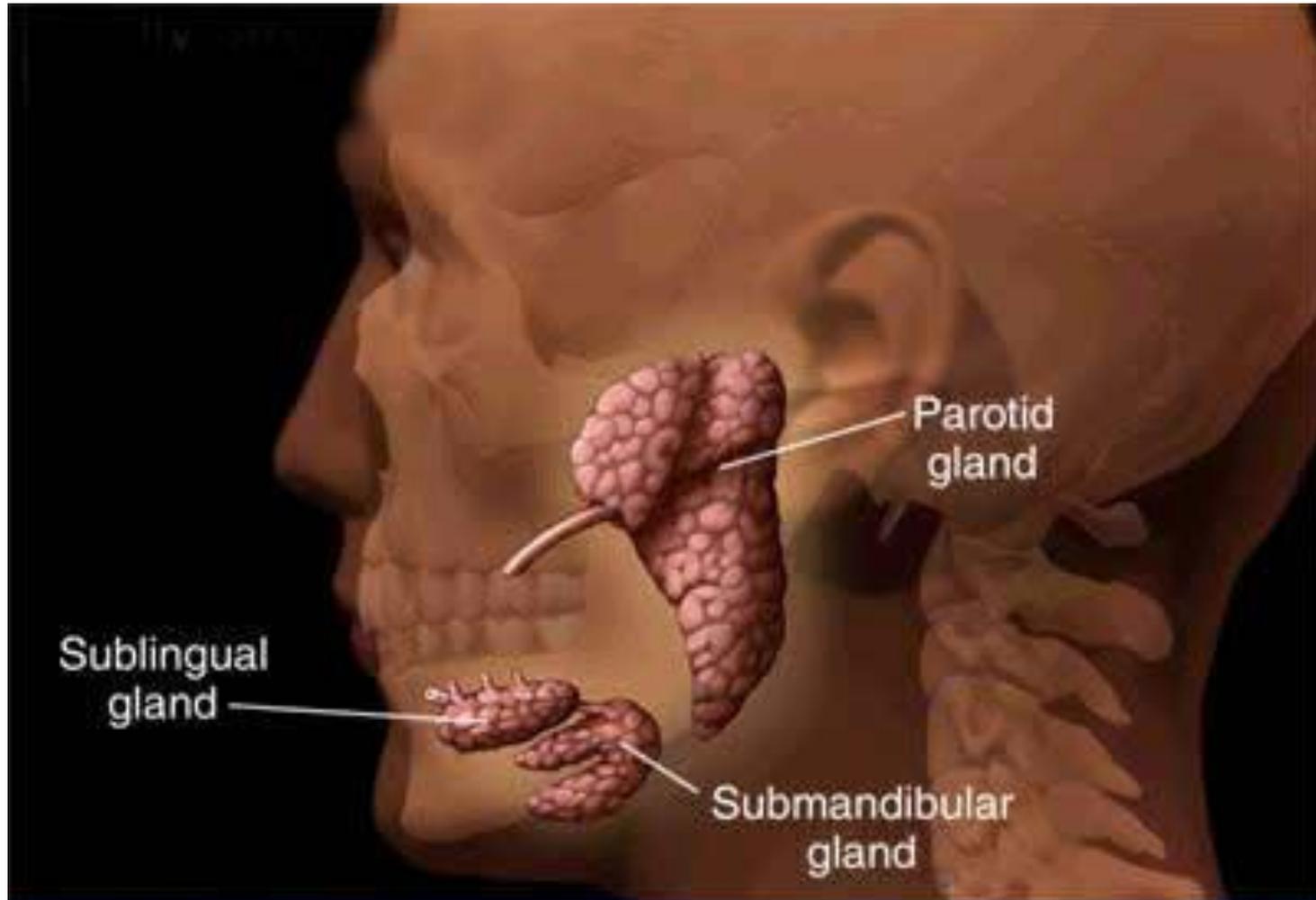
Teeth

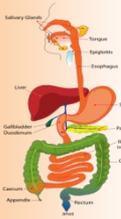


Uvula



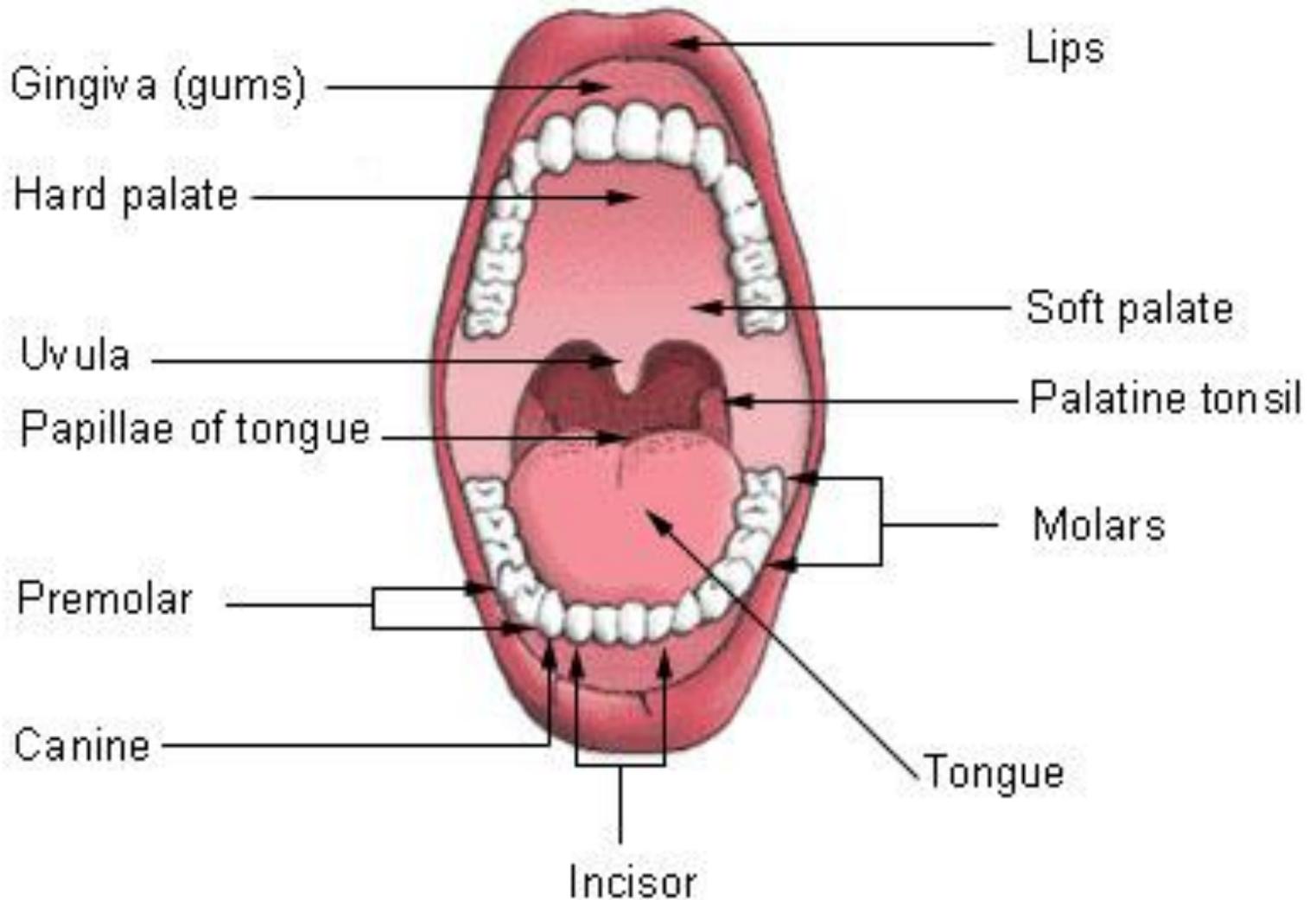
Salivary Glands

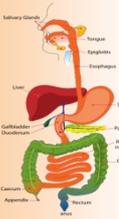




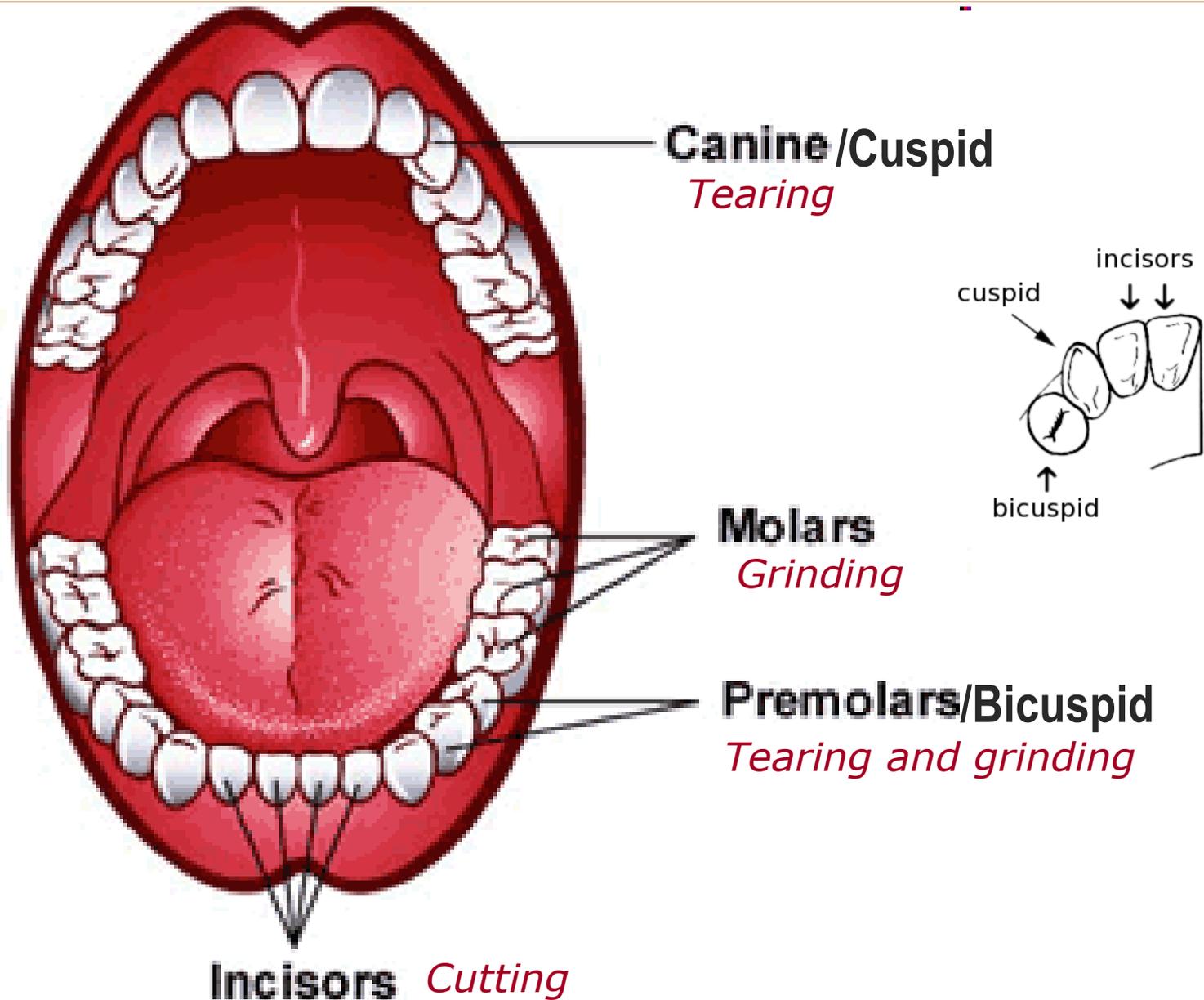
Digestive Tract: Mouth, Teeth, Tongue, and Glands

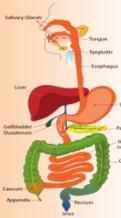
Mouth (Oral Cavity)





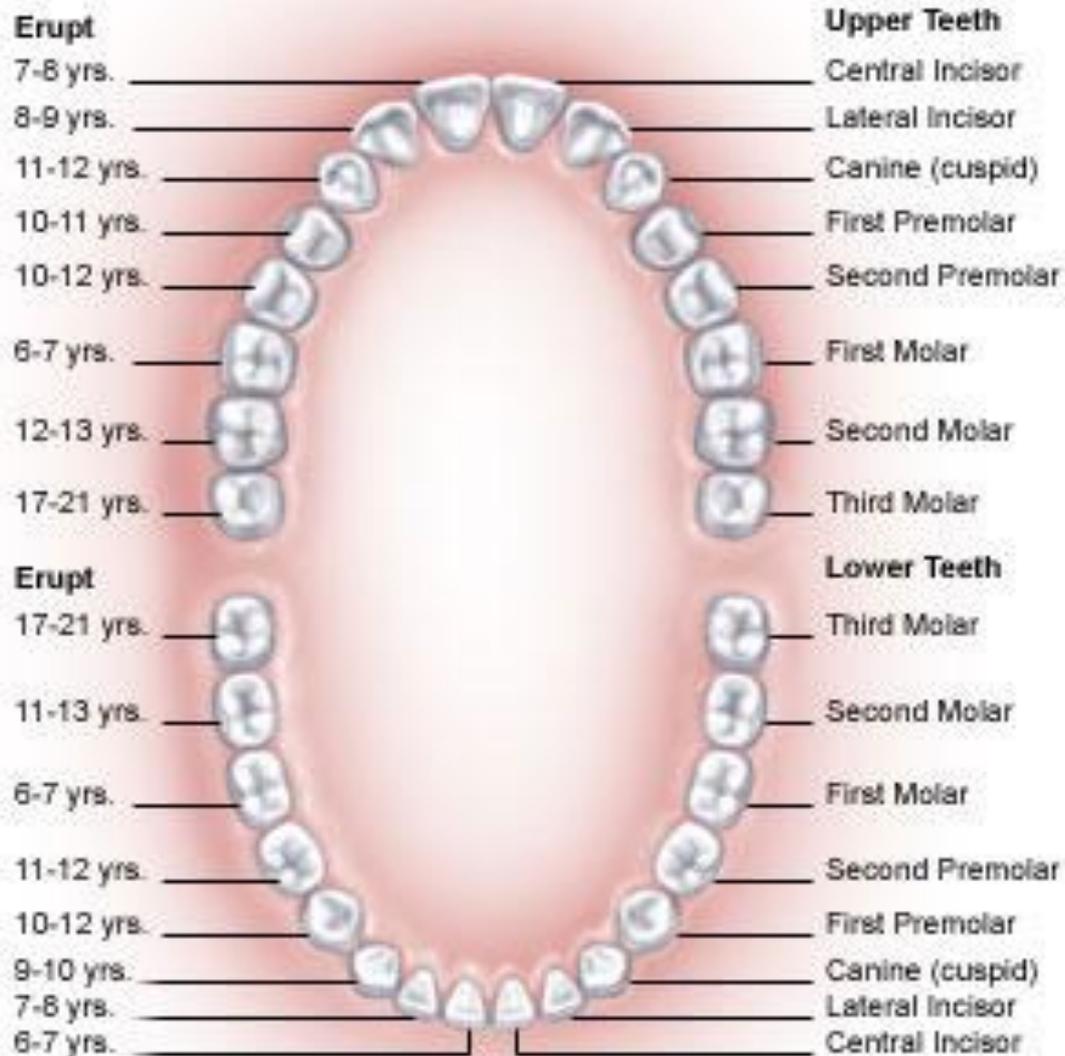
Digestive Tract: Mouth, Teeth, Tongue, and Glands

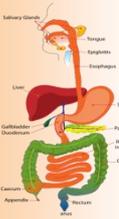




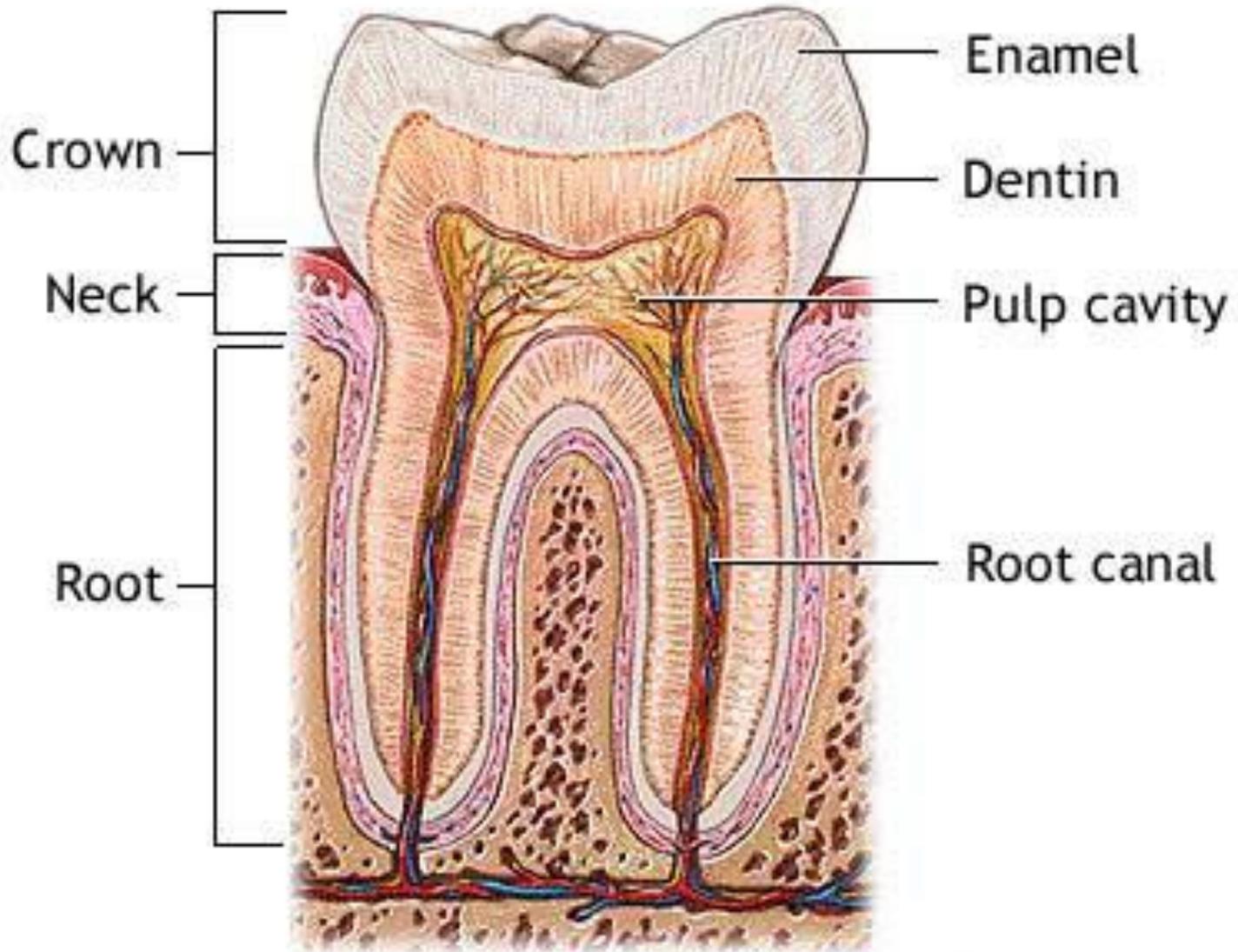
Digestive Tract: Mouth, Teeth, Tongue, and Glands

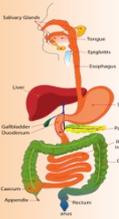
Tooth Development: Permanent Teeth



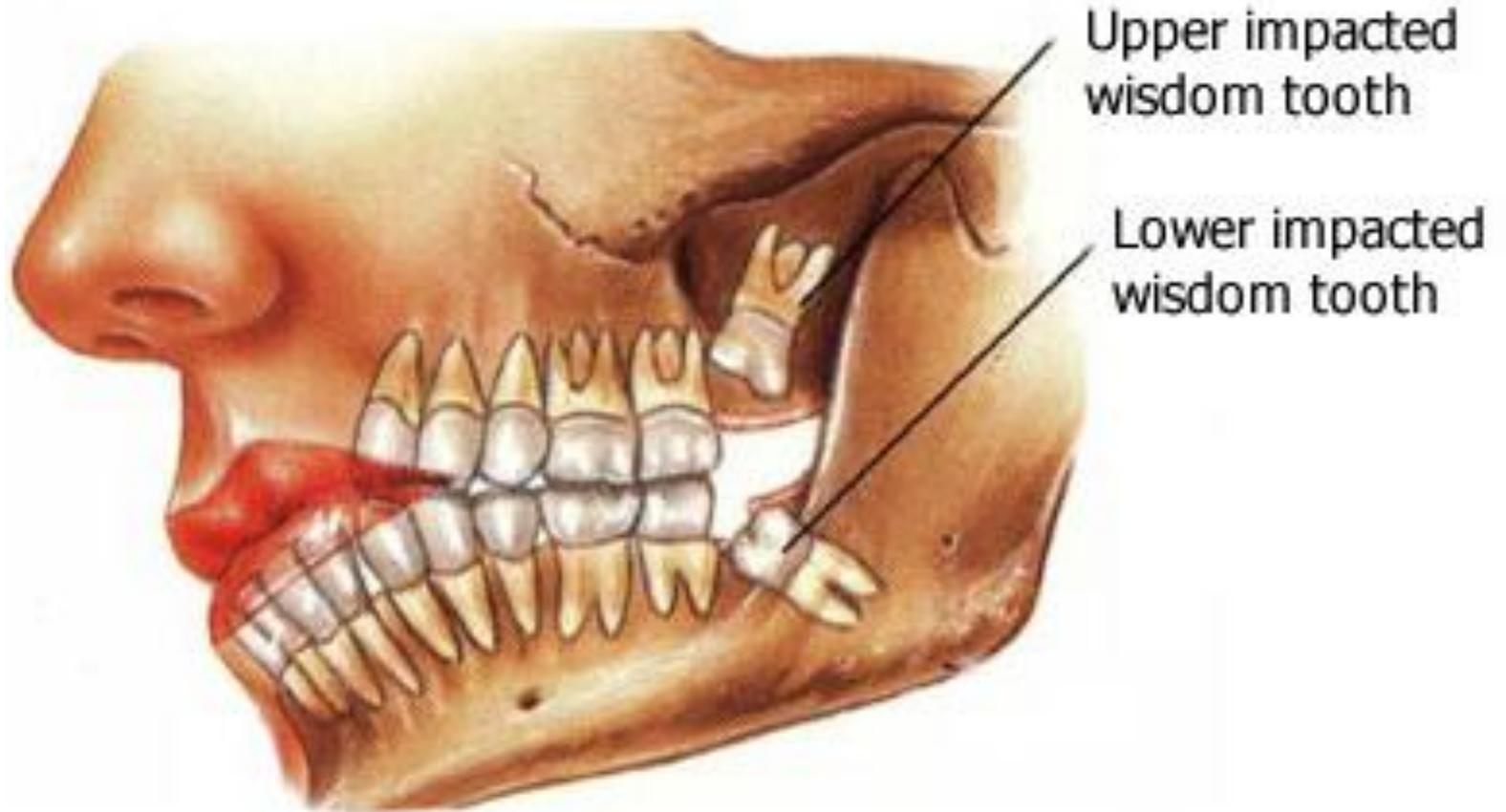


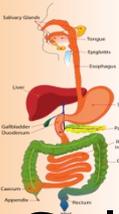
Digestive Tract: Mouth, Teeth, Tongue, and Glands





Digestive Tract: Mouth, Teeth, Tongue, and Glands



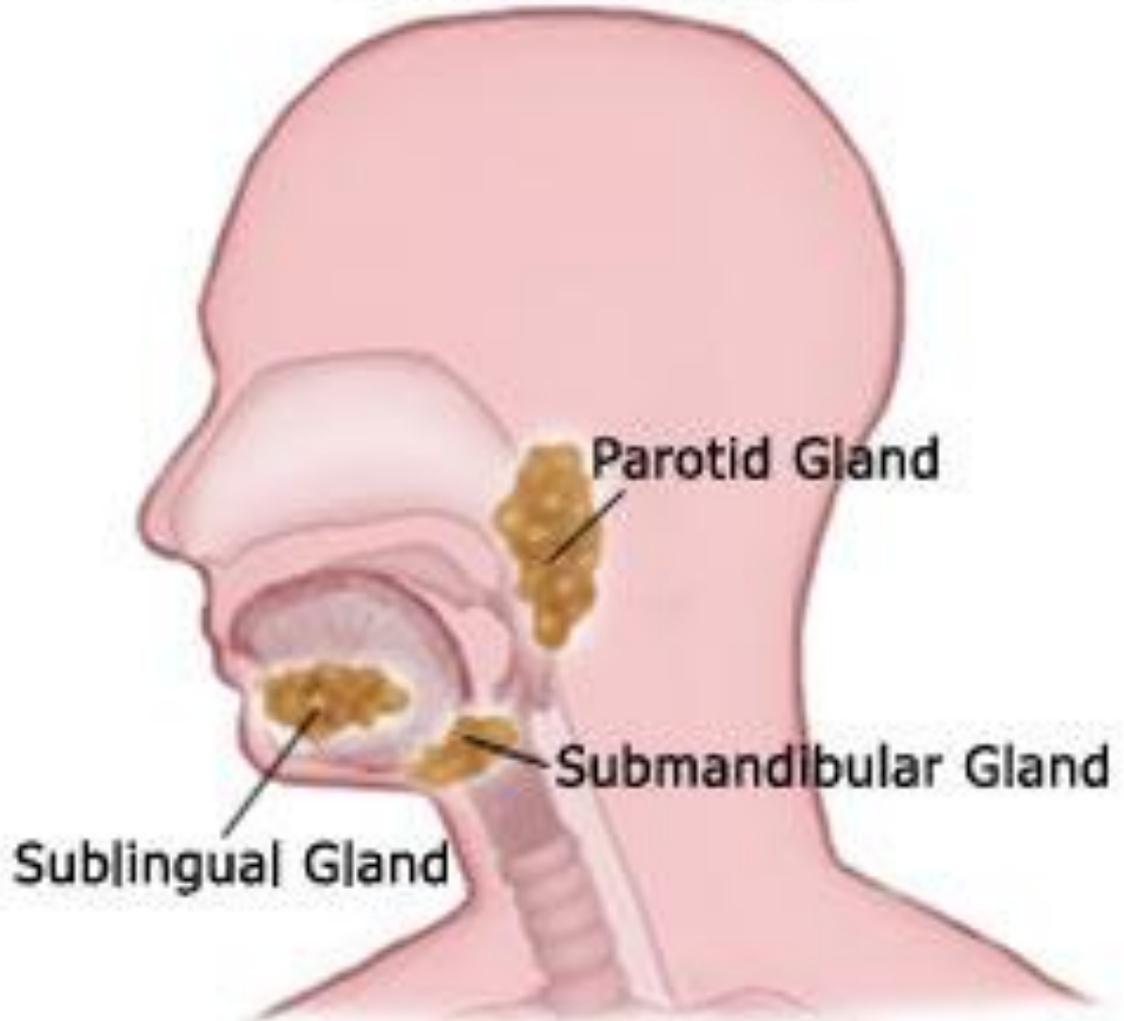


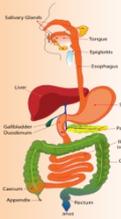
Digestive Tract: Mouth

Saliva contains mucus and **enzymes** (amylase -breaks down polysaccharides, maltase – breaks down maltose).

In other organisms like insects, salivary glands are often used to produce proteins like silk or glues

Salivary Glands

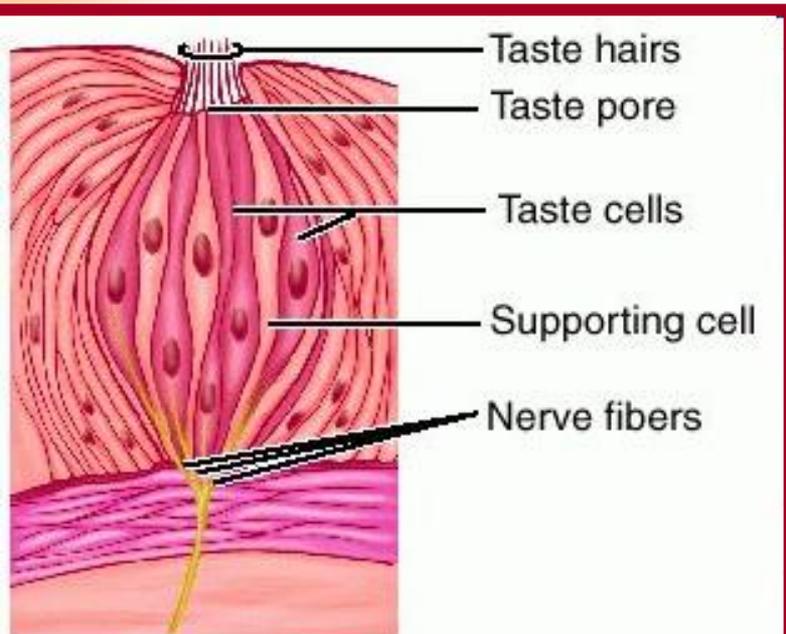
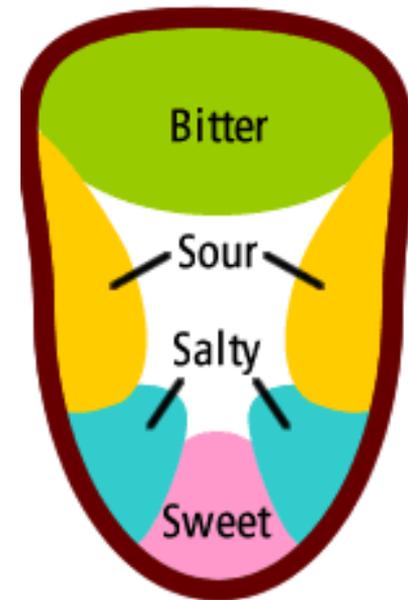
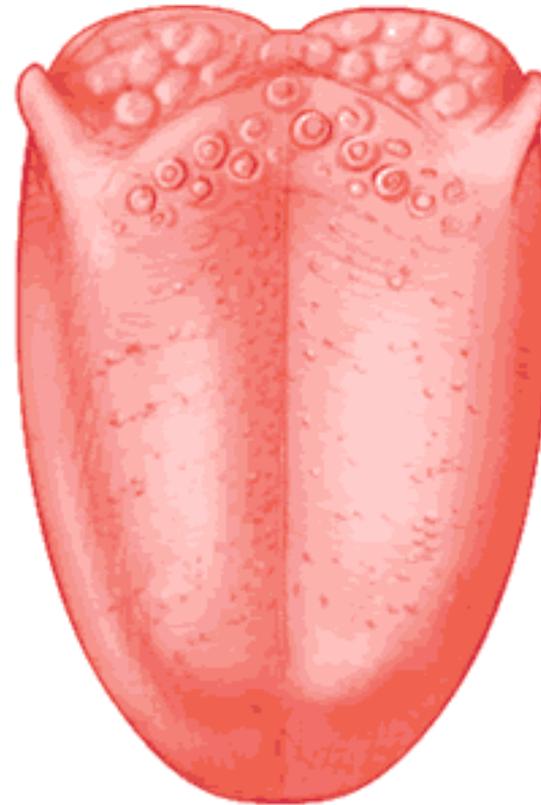


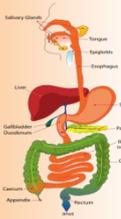


Digestive Tract: Mouth

Our tongues have several taste buds.

Taste buds are receptors that send messages to the brain





Digestive Tract: Mouth

Parotid salivary gland lies in front of the ear

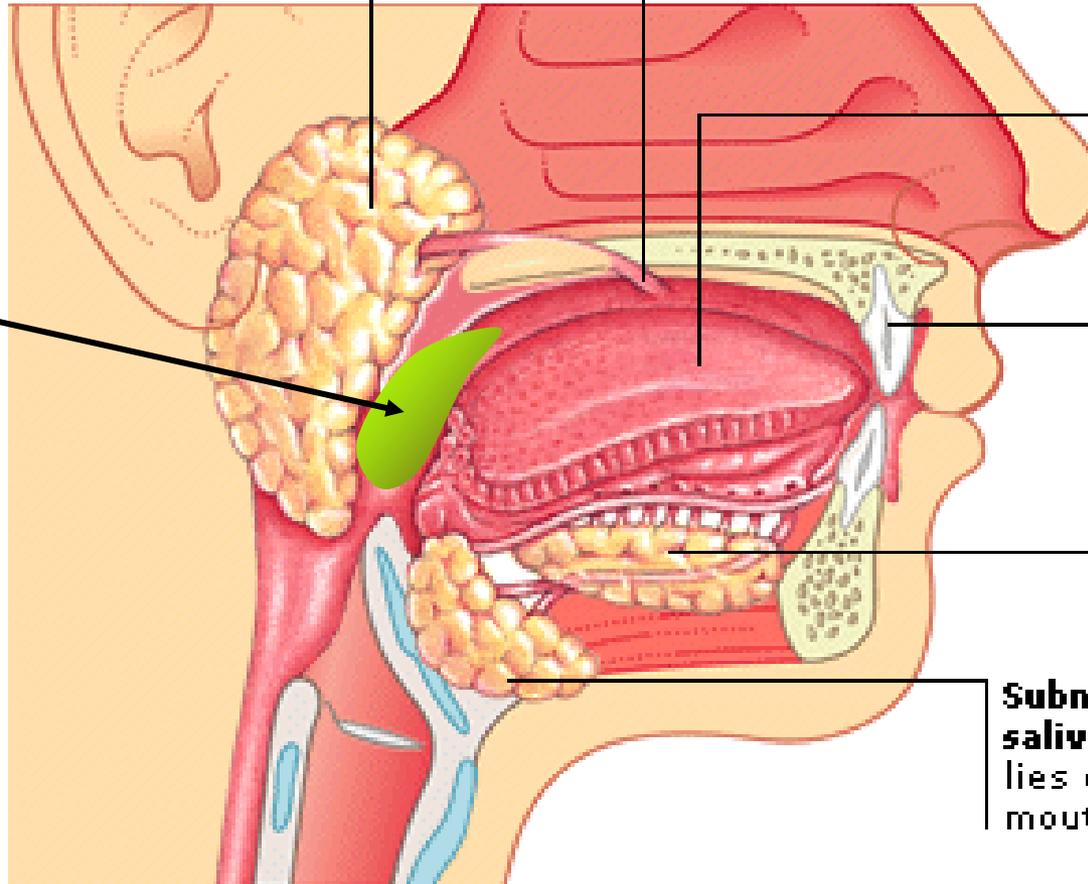
Salivary duct opens into the cheek

Tongue moves food during chewing and swallowing

Teeth cut and grind food

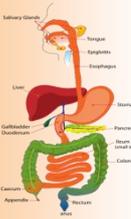
Sublingual salivary gland is located under the tongue

Submandibular salivary gland lies deep in the mouth



The saliva, teeth, mouth, and tongue form a **food bolus**

This bolus goes on into the next part of the digestive tract

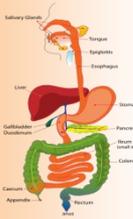


Digestive Tract: Pharynx and Epiglottis

The **pharynx** connects the oral cavity to the next part of the digestive system (the epiglottis and esophagus)

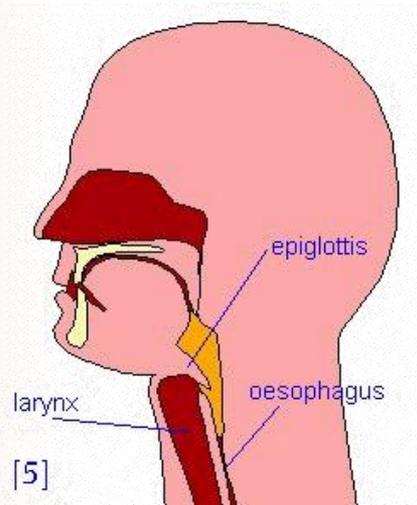
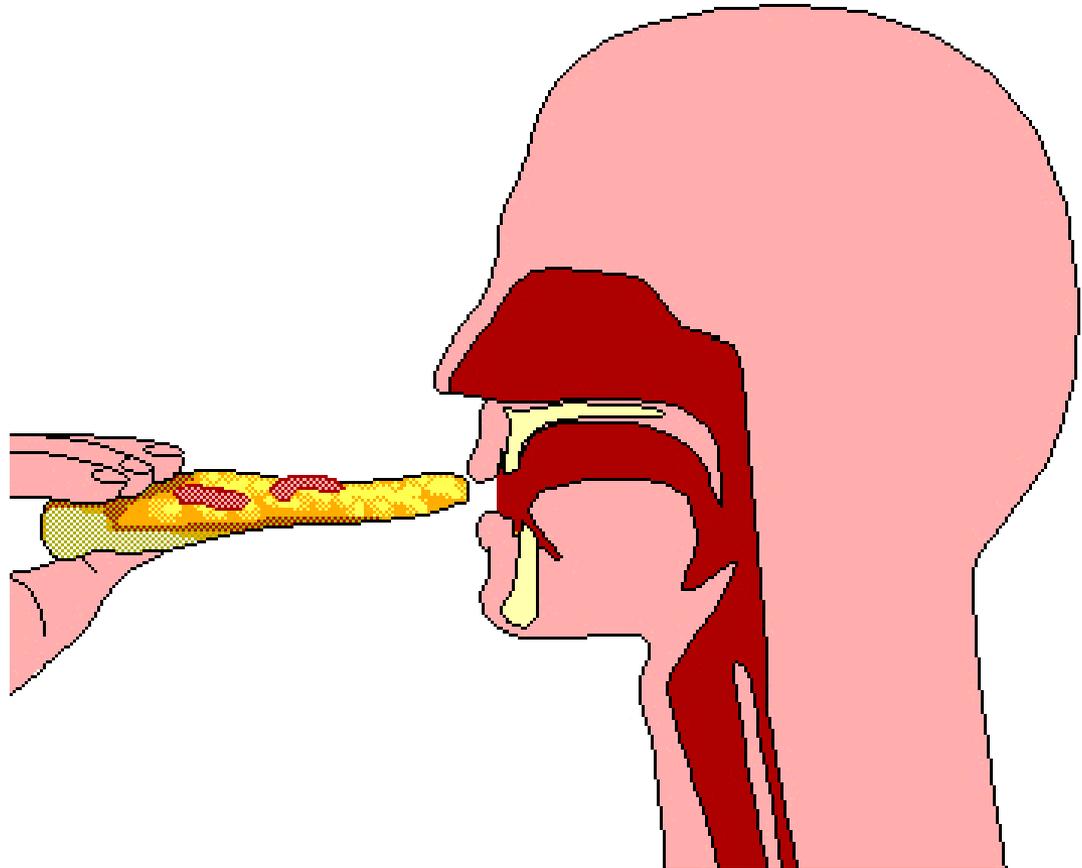
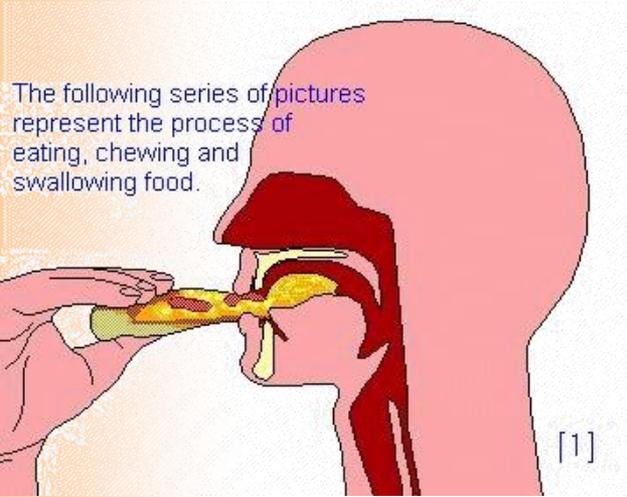
The **epiglottis** prevents food from going into your lungs through the larynx

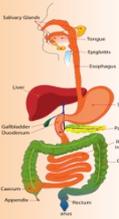




Digestive Tract: Pharynx and Epiglottis

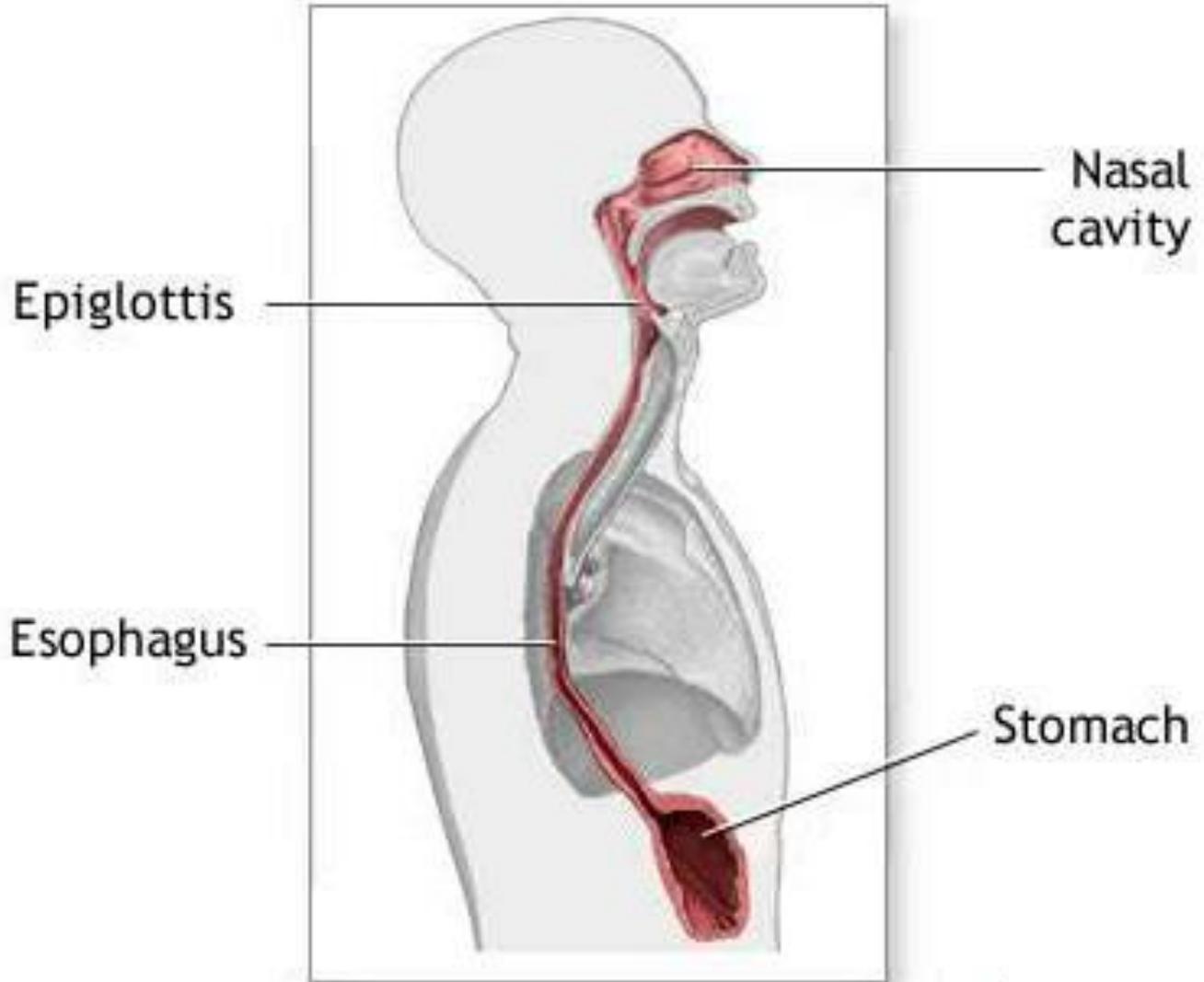
The following series of pictures represent the process of eating, chewing and swallowing food.

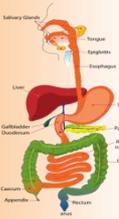




Digestive Tract: Esophagus

Esophagus:
Muscular tube through which food passes from the pharynx to the stomach , diameter 2cm

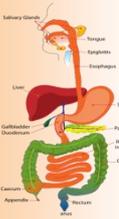




Digestive Tract: Esophagus

Peristalsis:
Radially
symmetrical
contraction of
muscles which
forms waves that
move the food
bolus along the
digestive tract.

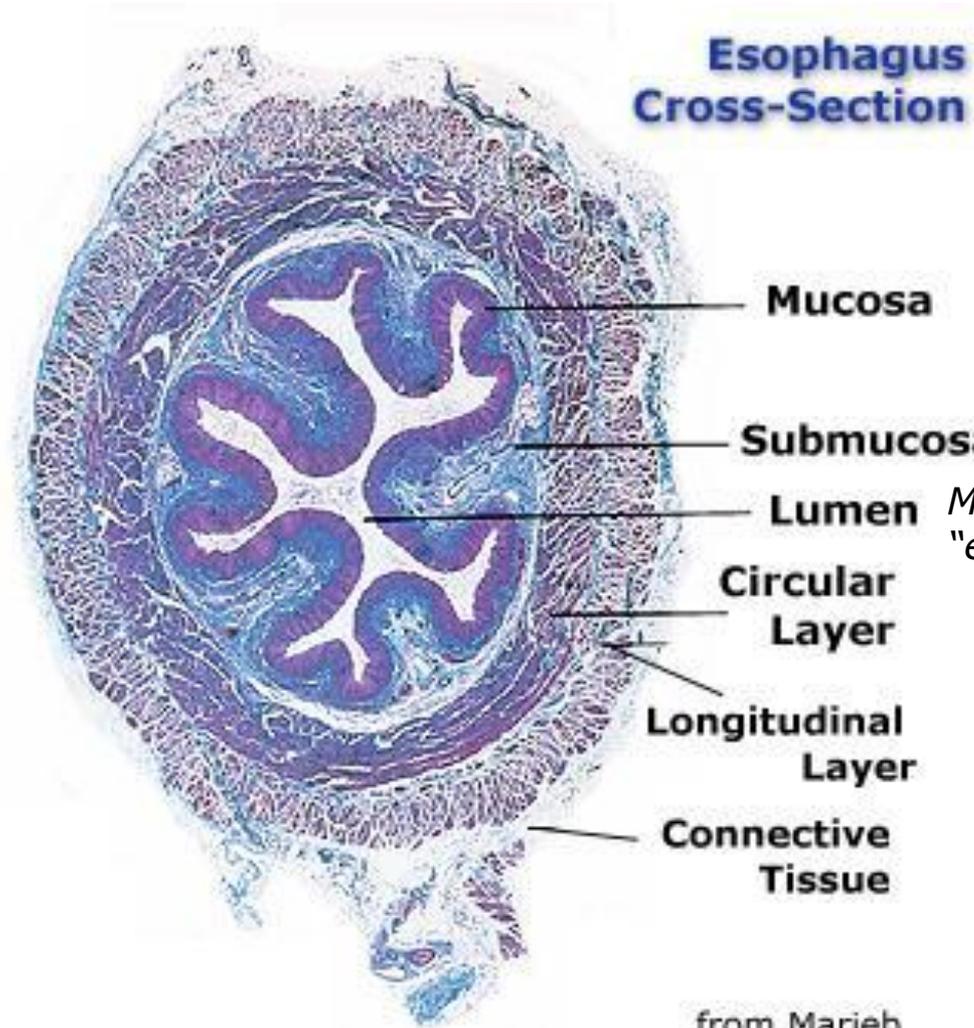




Digestive Tract: Esophagus

The esophagus is made up of **circular** and **longitudinal** layers.

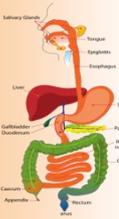
The inside is lubricated with mucous membranes



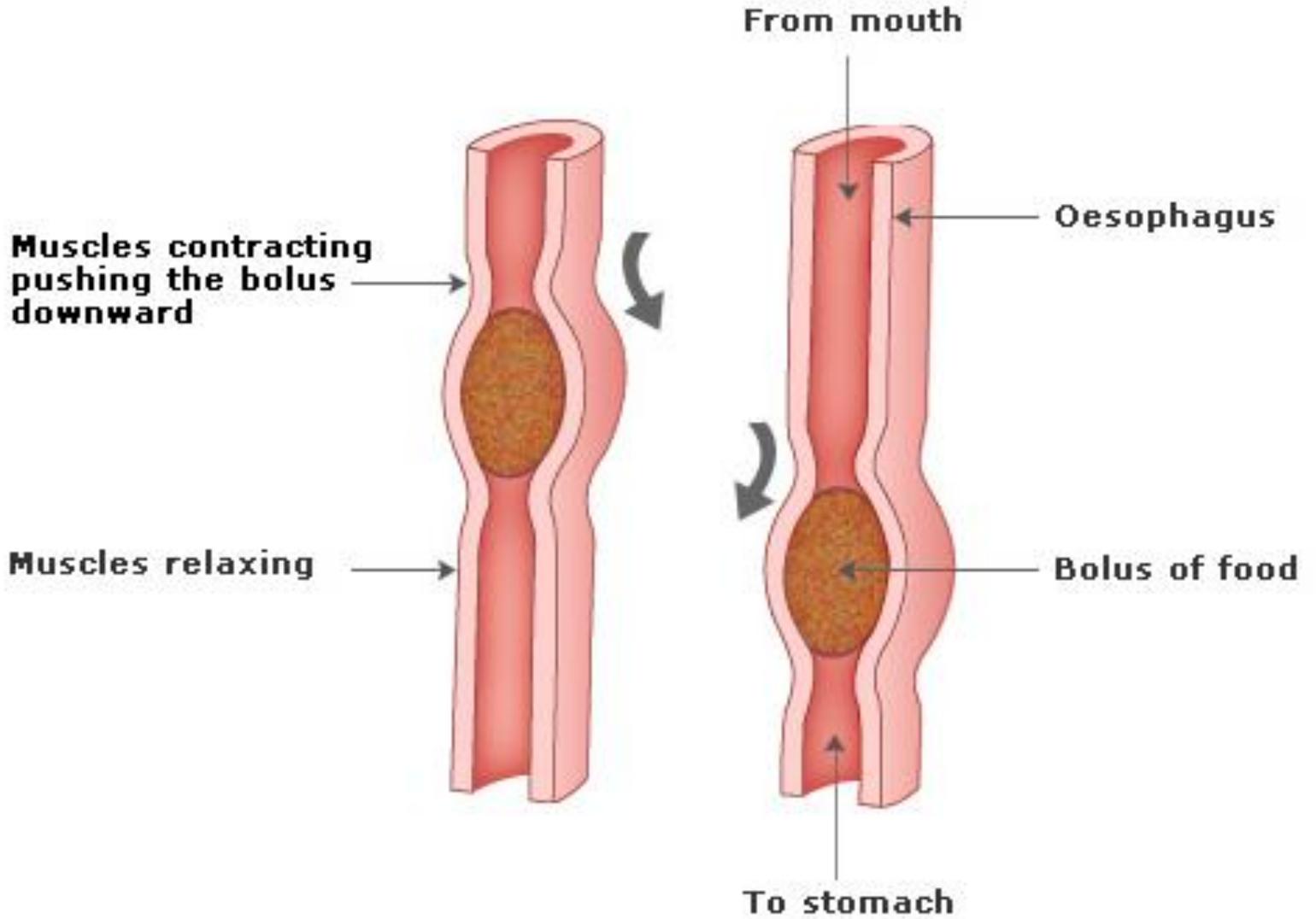
from Marieb

Peristalsis

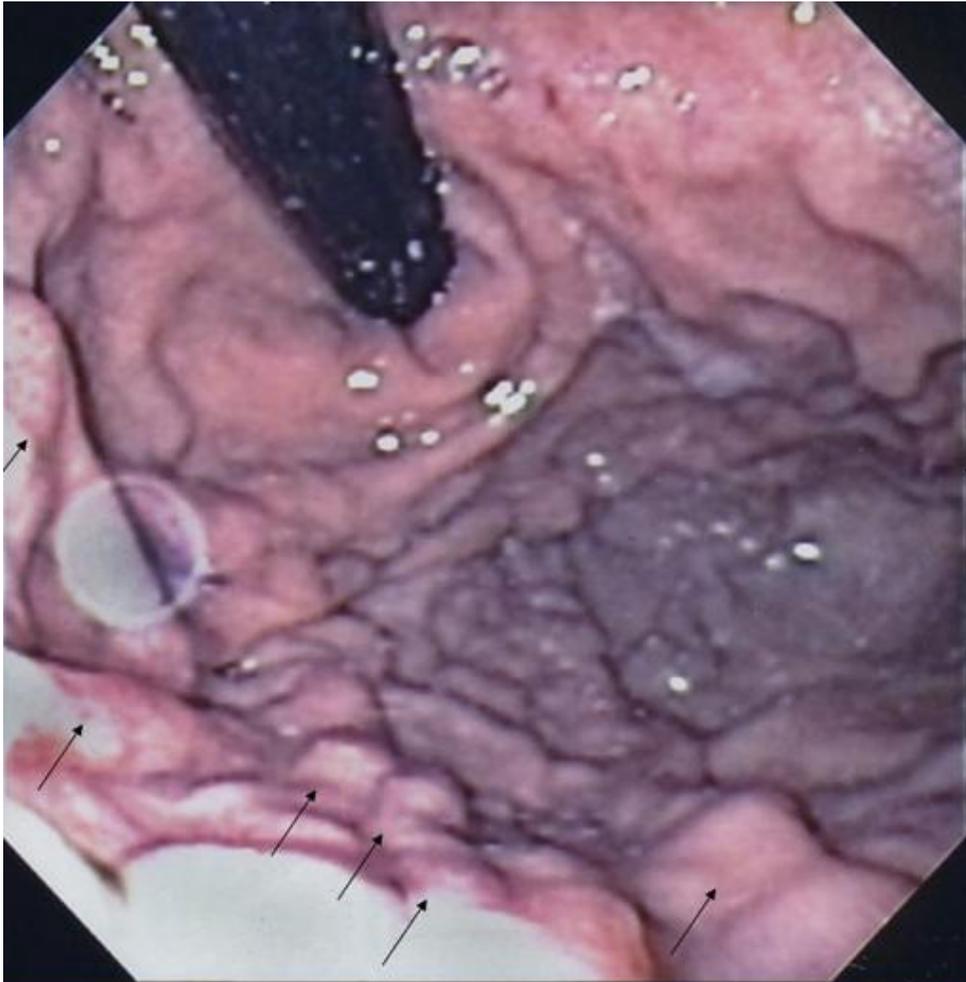
- **Circular muscles** -contract and narrow the passage behind the bolus and push it forward
- **Longitudinal muscles** – contract ahead of the bolus, causing the tube to shorten and slide the bolus



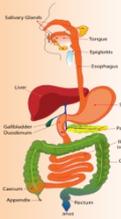
Digestive Tract: Esophagus



Stomach



- J-shaped
- Can hold up to 1.5 L of food
- **Rugae** – thick layers (folds) of smooth muscle lining the inner wall of the stomach, allowing it to stretch
- Mechanical digestion with muscle contractions → churning and mixing
- Chemical digestion with gastric juice



Digestive Tract: Stomach

Sometimes the acid does burn through...

The result is an **ulcer**

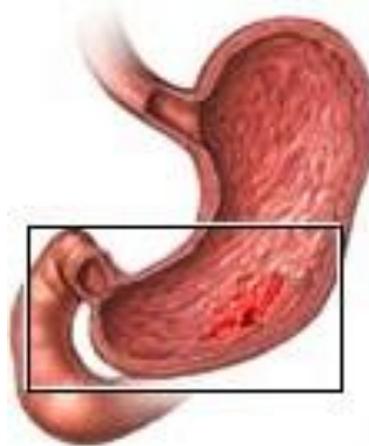
Can be caused by

- bacterial infection (i.e. Helicobacter Pylori)

- weakened mucosal lining

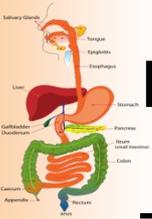
- anti-inflammatory medications (i.e. aspirin)

- smoking is associated as well



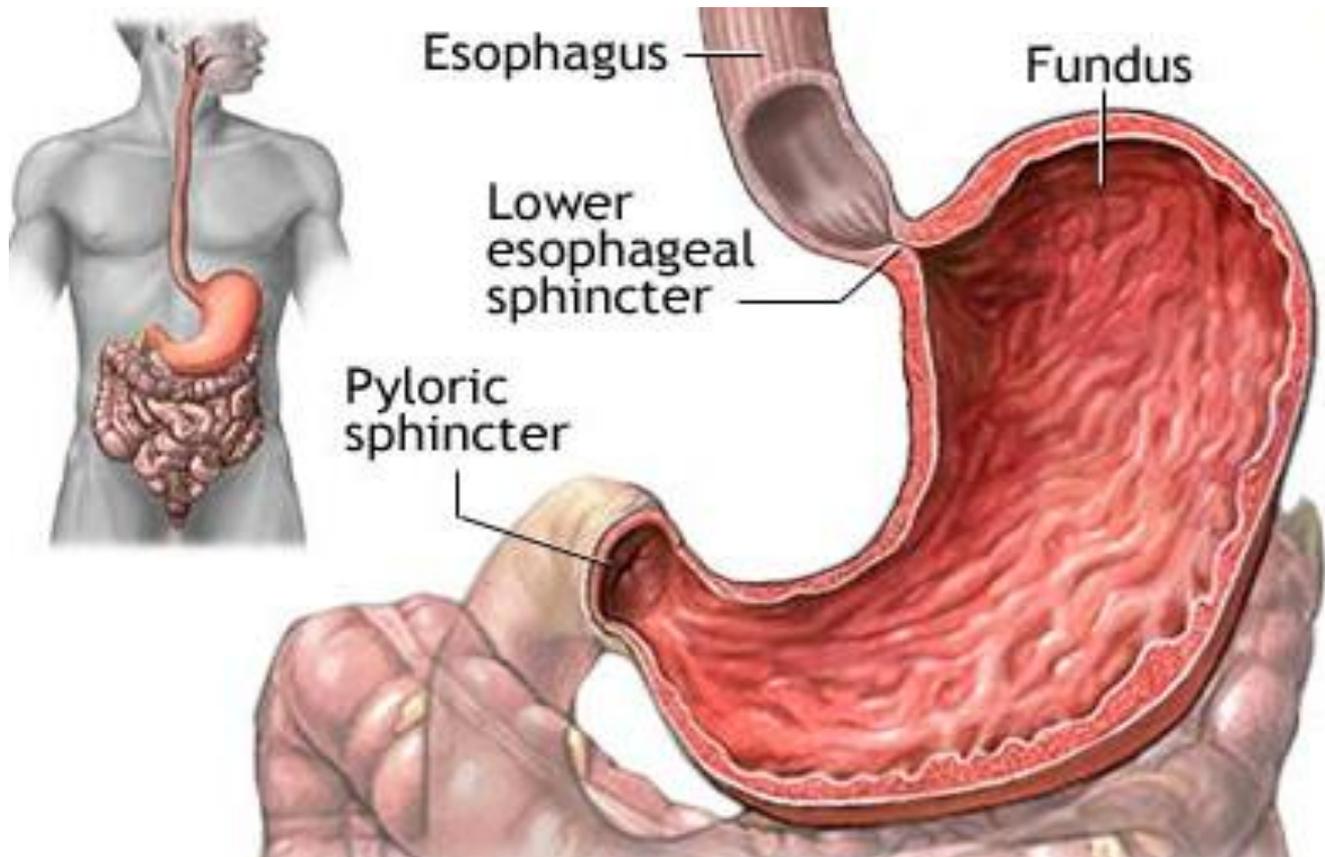
Peptic ulcers may lead to bleeding or perforation, emergency situations

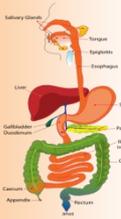




Digestive Tract: Stomach

Two muscle sphincters control the amount of food that enters (**lower esophageal sphincter** or **cardiac sphincter**) and exits (**pyloric sphincter**) the stomach.





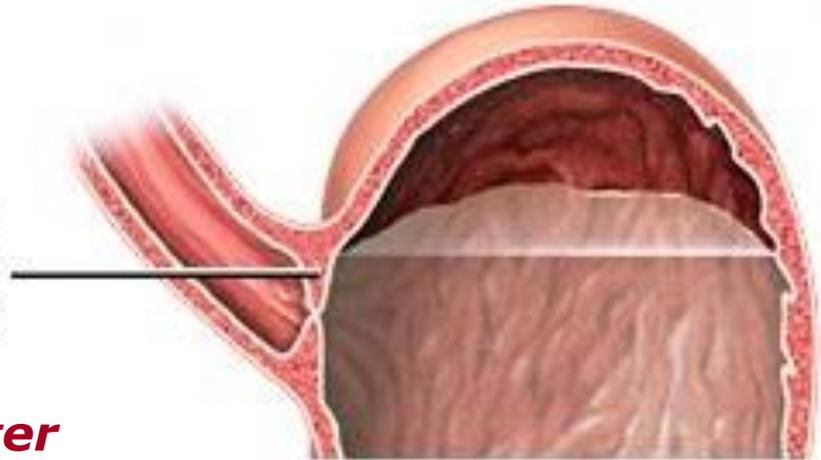
Digestive Tract: Stomach

Lower esophageal sphincter:

If the lower esophageal sphincter is not closed properly, stomach acid enters the esophagus and causes **heartburn**

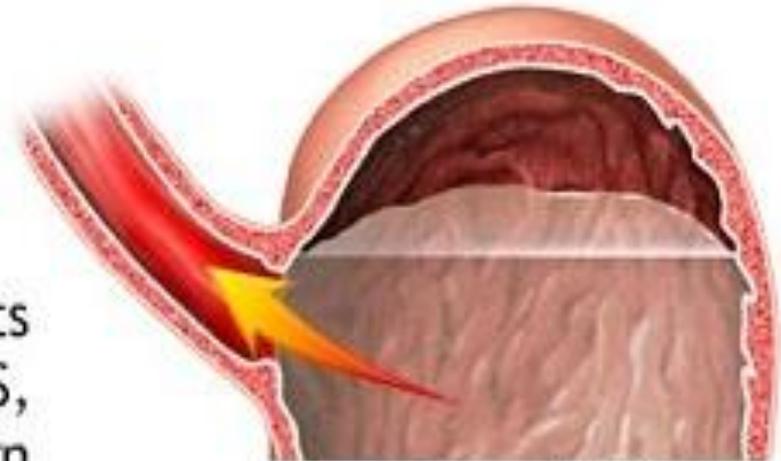
Lower esophageal sphincter (LES)

Also known as cardiac sphincter

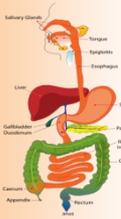


Closed LES

Stomach contents pass through the LES, causing heartburn



Open LES

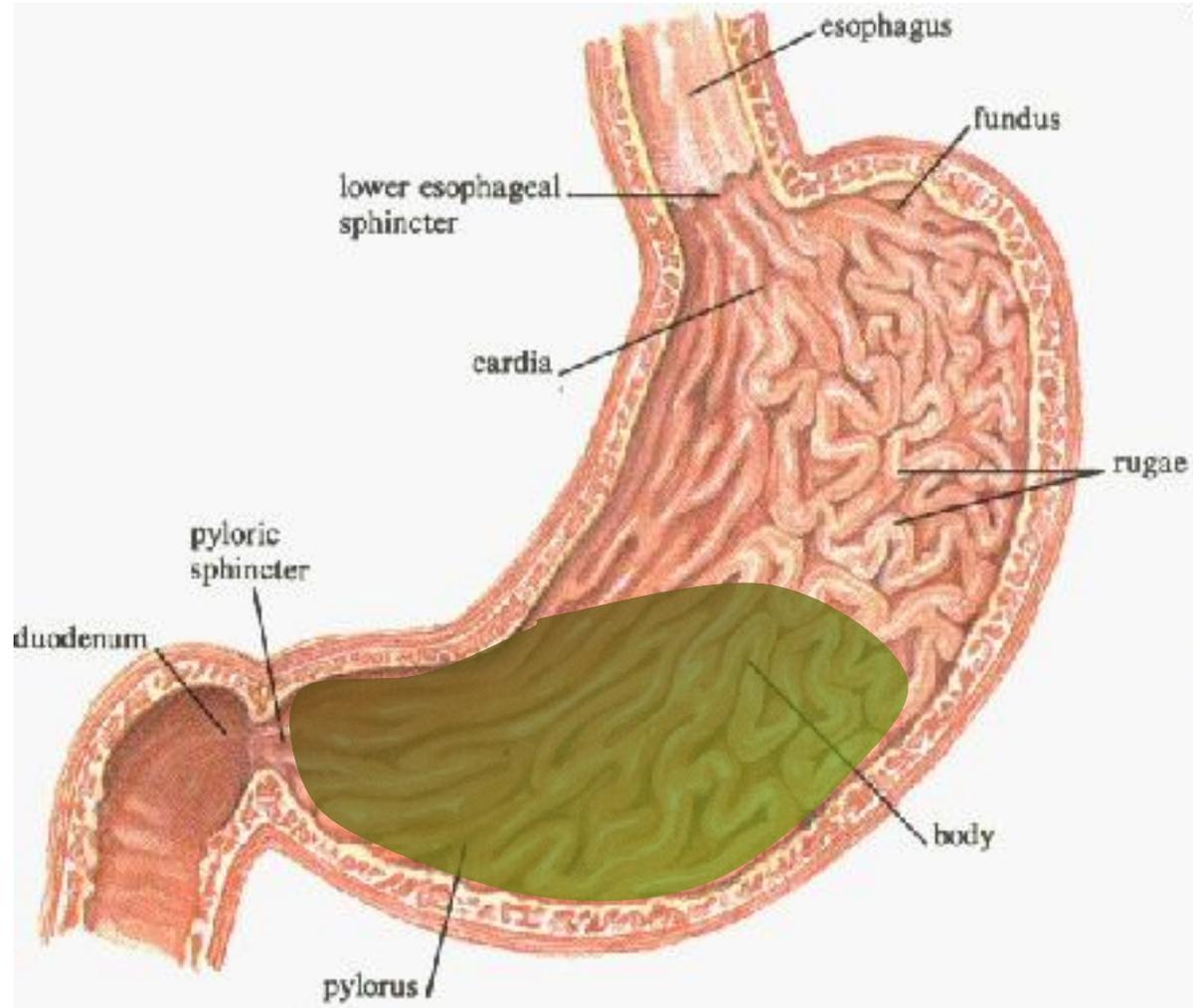


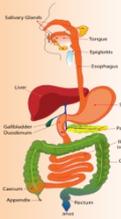
Digestive Tract: Stomach

Pyloric Sphincter:

Strong ring of smooth muscle which connects stomach to small intestines.

Enables **chyme** (semi-digested food from stomach) to enter the duodenum.





Digestive Tract: Stomach

Gastric Juice is produced in the gastric glands located in the lining of the stomach. It contains:

1) hydrochloric acid (HCl)

- pH of 2 (approximately)
- destroys invading microbes
- breaks down food bolus
- converts pepsinogen to pepsin

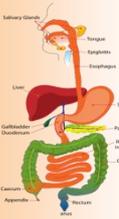
2) Pepsinogen (**enzyme**, inactive form)

- Is converted to pepsin, active form, in acidic environment
- **Pepsin** breaks down **polypeptides** to **dipeptides**

3) Mucus

- protective coating for the stomach wall against HCl

4) lipases – enzymes that break down lipids, but are not very active due to the acidic environment

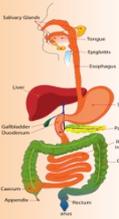


Digestive Tract: Stomach

Why doesn't the acid burn through the stomach?

The rugae lining the stomach continuously secretes mucus to protect the stomach





Digestive Tract: Stomach

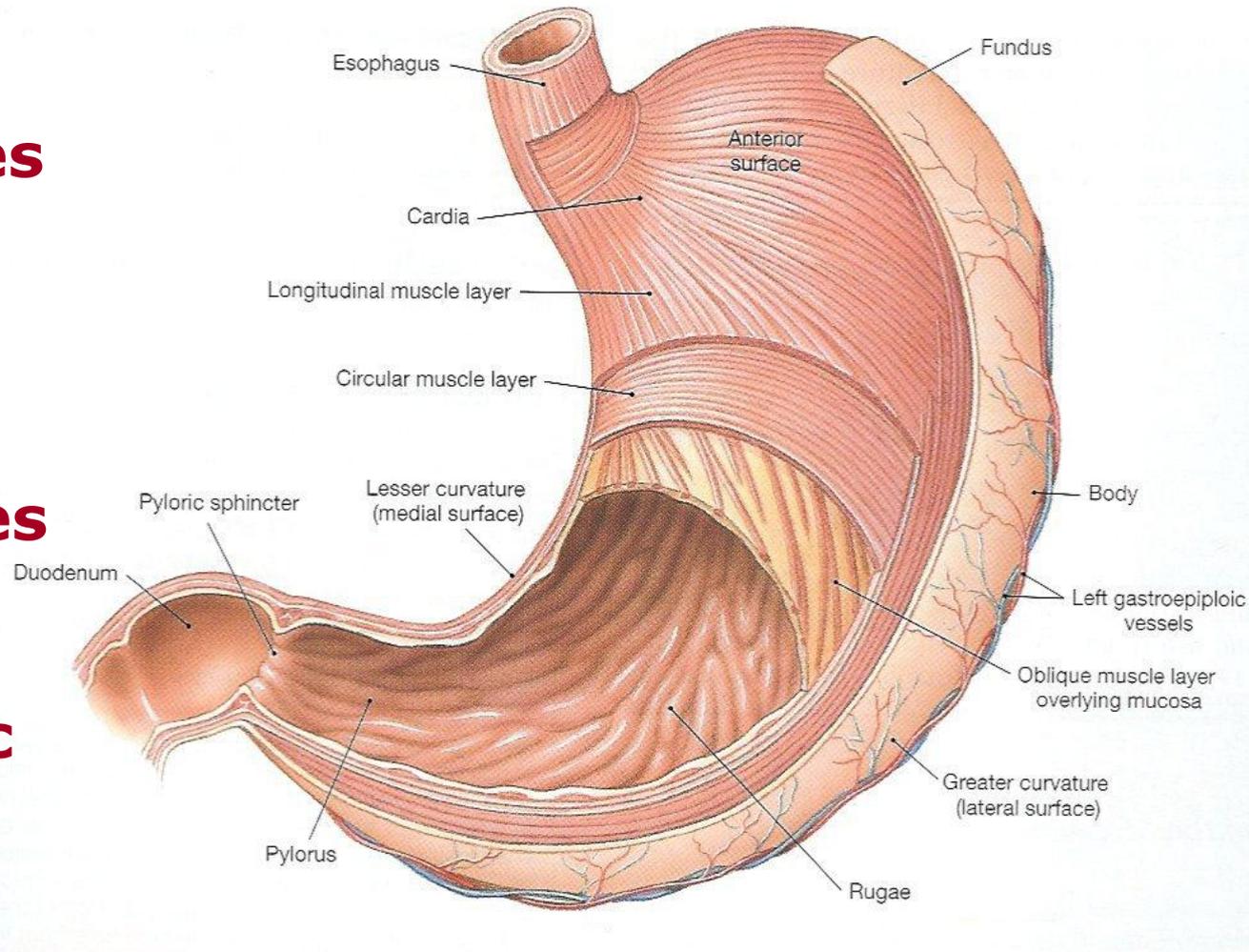
Stomach has layers of muscles:

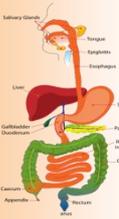
-Oblique muscles

-Longitudinal muscles

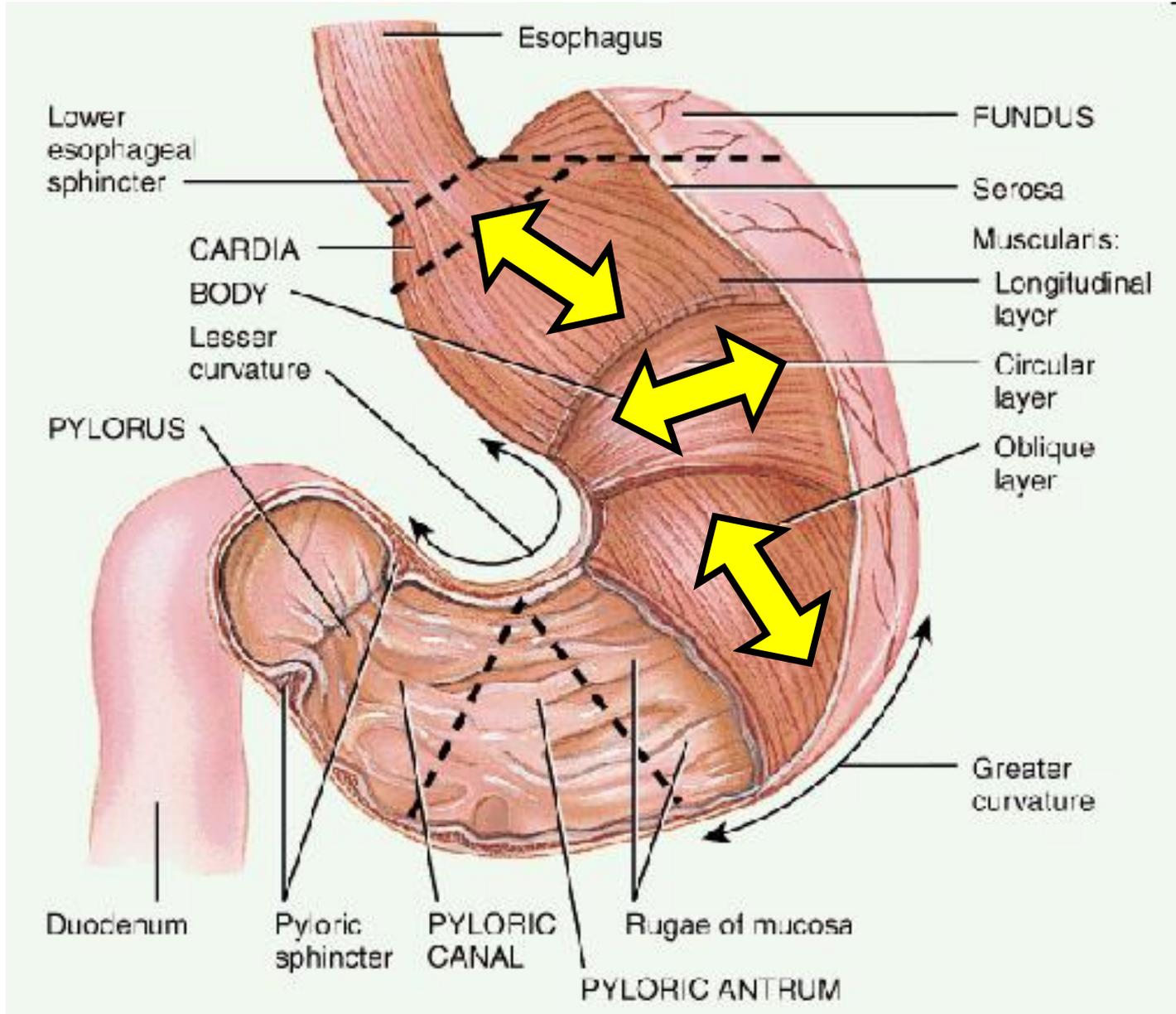
-Circular muscles

Helps mix **gastric juice** with food





Digestive Tract: Stomach

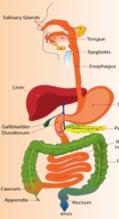


Chyme



Small Intestine





Digestive Tract: Small Intestines

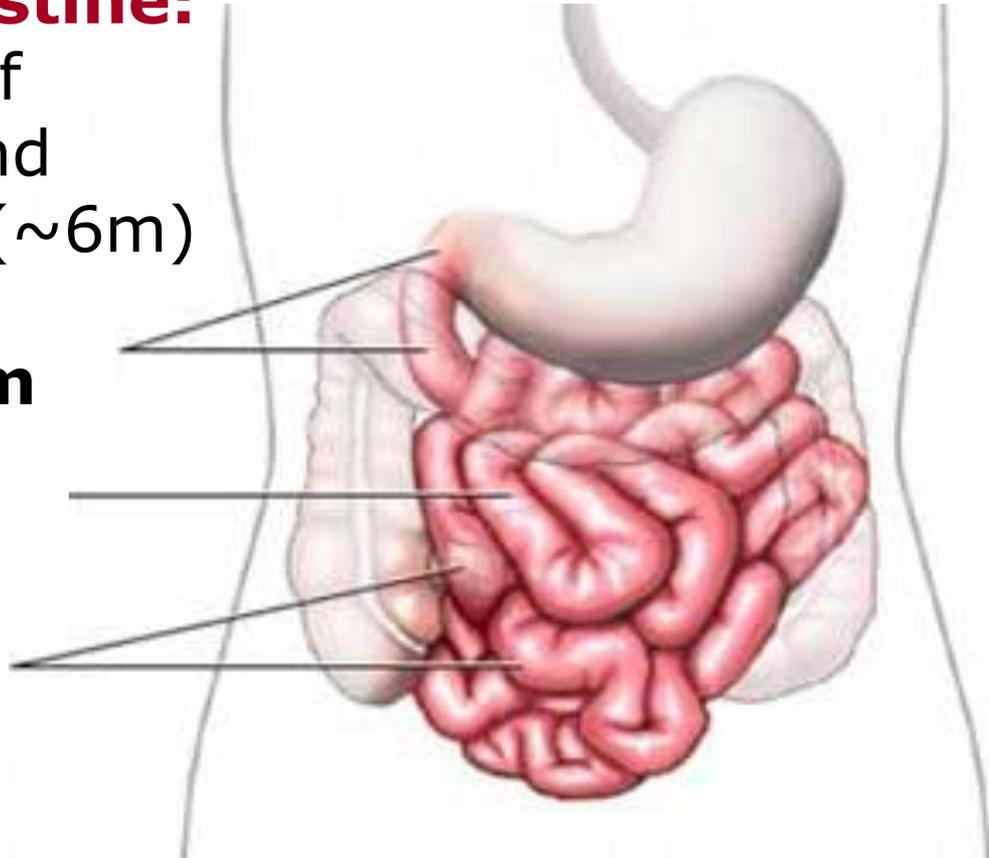
Small Intestine:

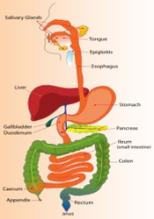
Major site of digestion and absorption (~6m)

-Duodenum

-Jejunum

-Ileum



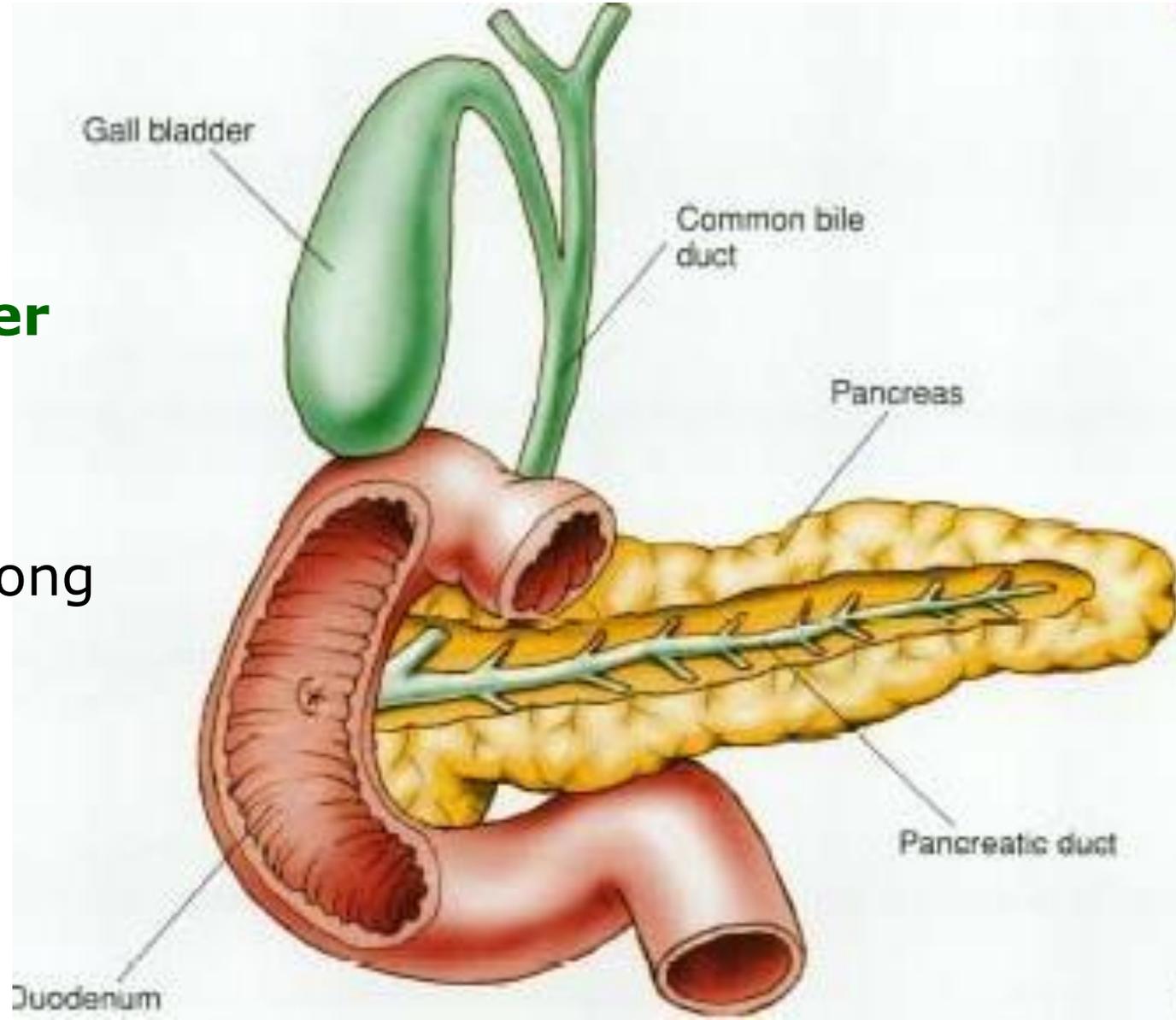


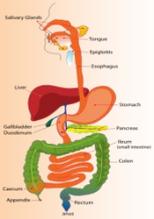
Duodenum:

-Receives secretions from the **gall bladder** and **pancreas** through ducts

-10-12 inches long

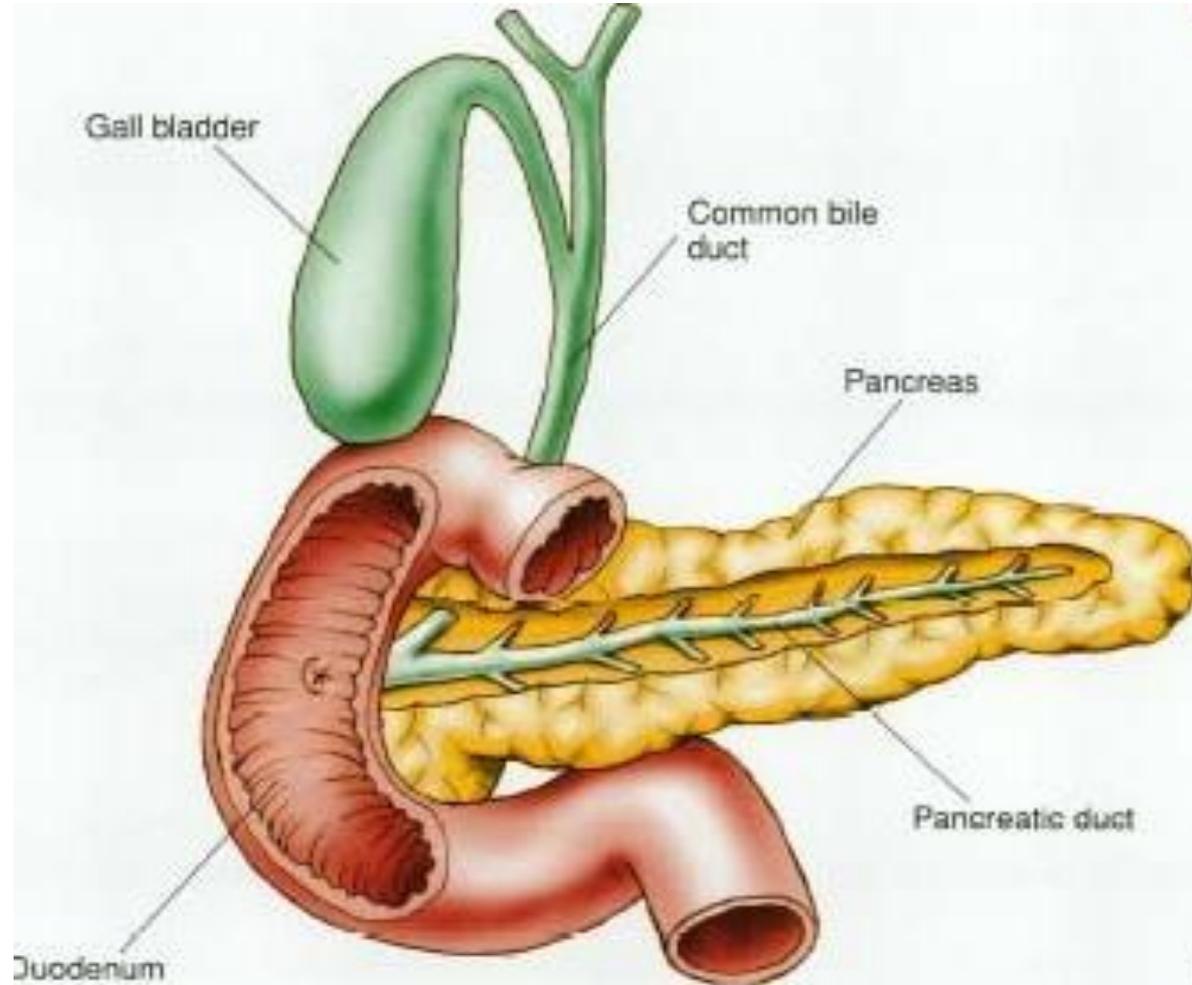
-most chemical digestion takes place here

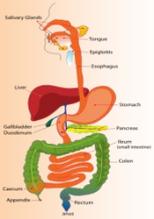




Duodenum:

- Cells in the duodenum secrete the hormone cholecystikinin (CCK)
- CCK signals the pancreas to secrete a variety of substances
- CCK also signals the stomach to slow down digestion so that the duodenum can effectively digest fats

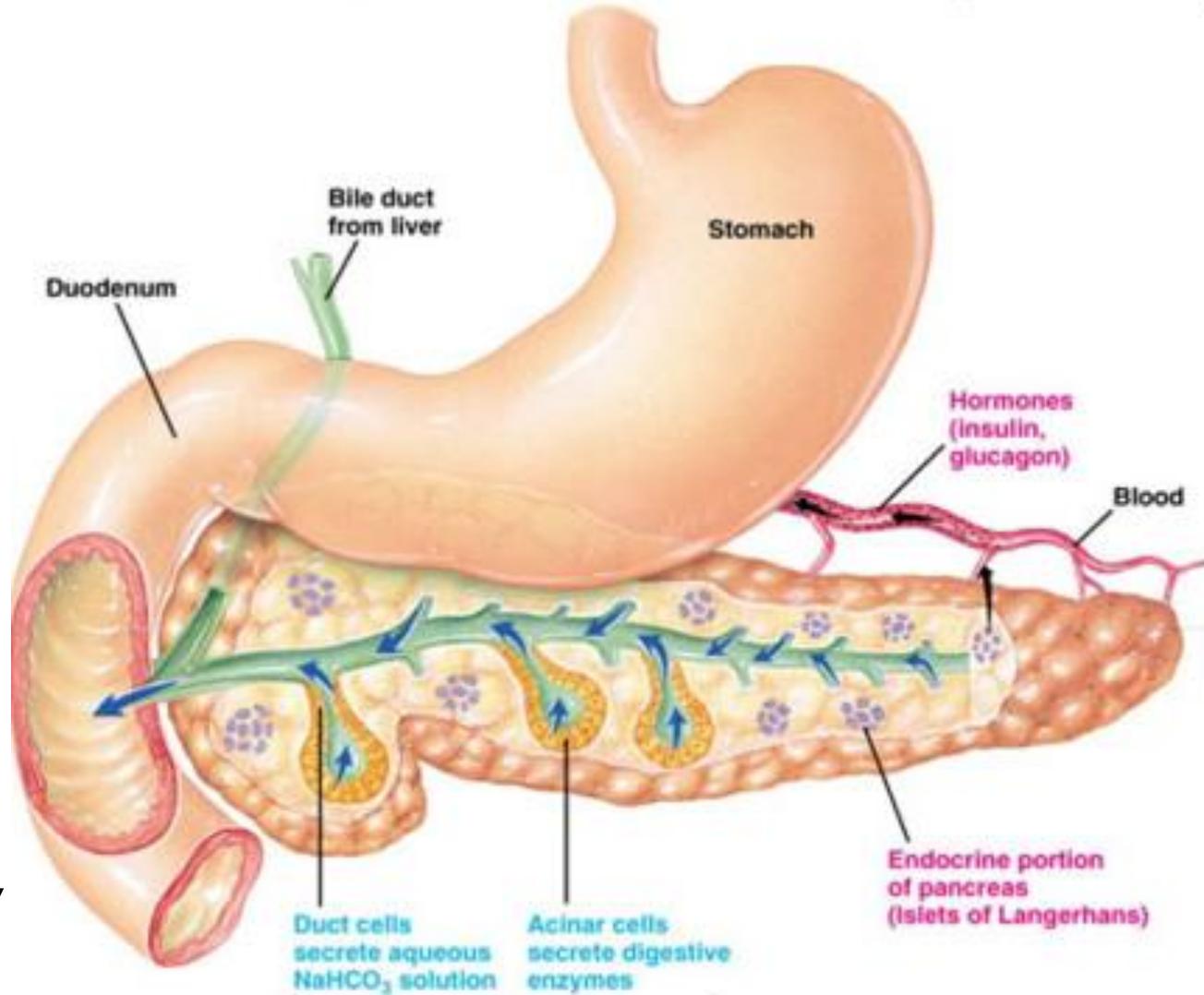


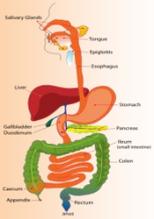


Pancreas:

-Secretes **bicarbonate ions** to neutralize stomach acid and inactivate pepsin, makes the **duodenum alkaline (pH 9)**

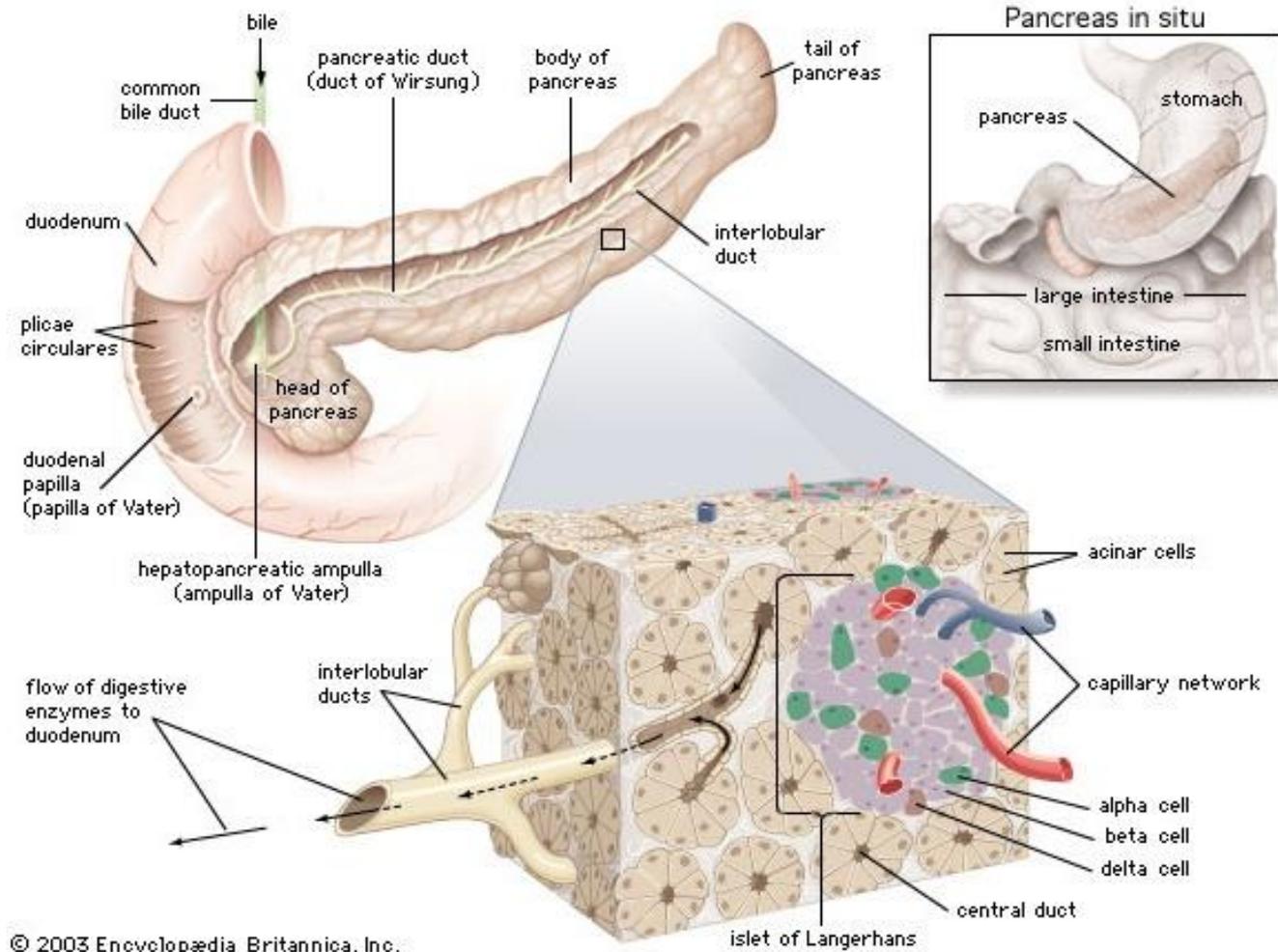
-Secretes **pancreatic juice**, a mixture of enzymes like **trypsin**, **pancreatic lipase**, **pancreatic amylase**

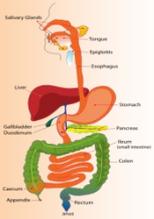




Pancreas:

Also produces **insulin** and **glucagon** from the *Islets of Langerhans*

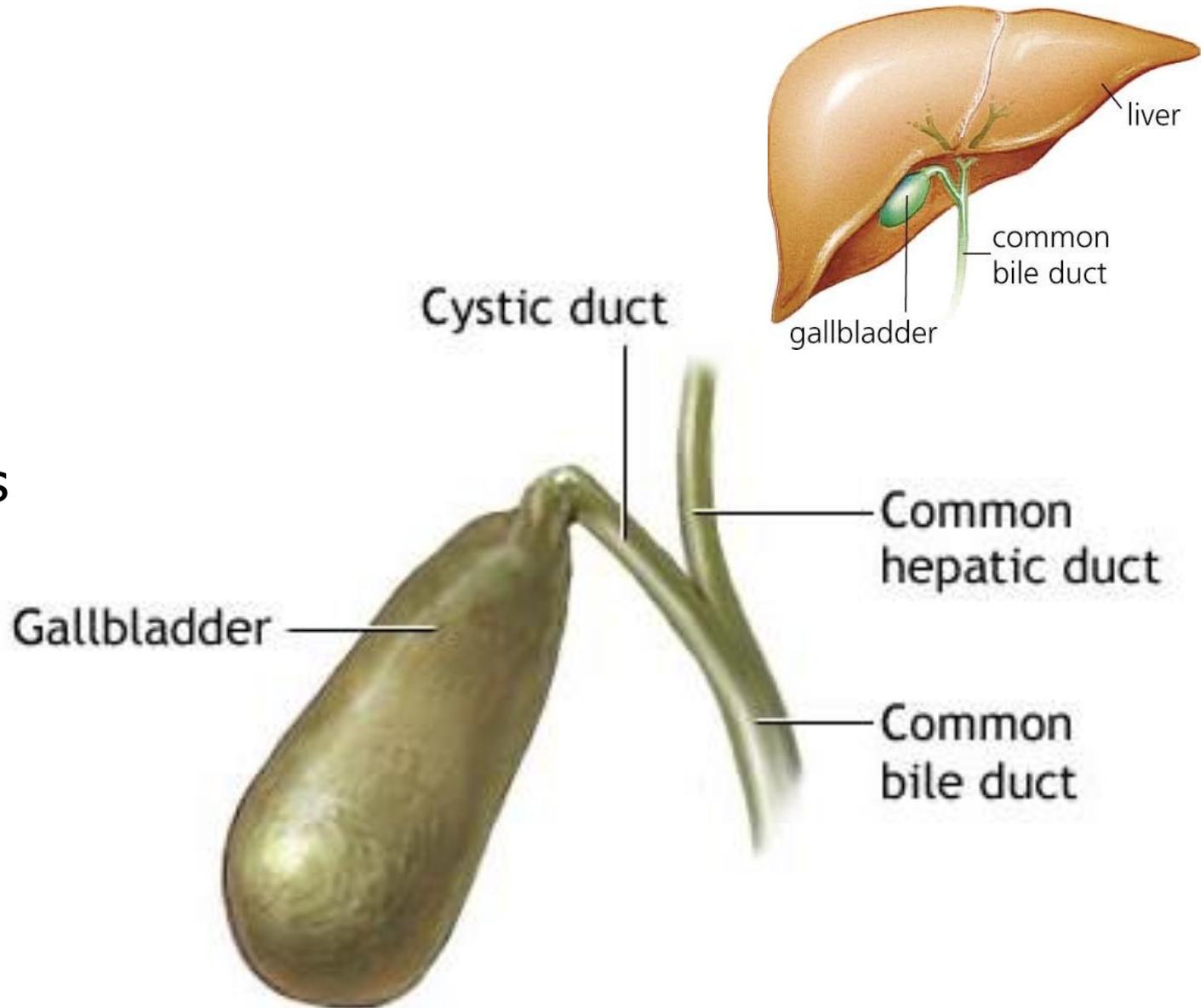


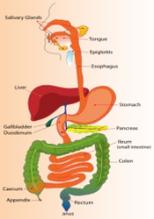


Gall Bladder:

Stores **bile** produced by the **liver**.

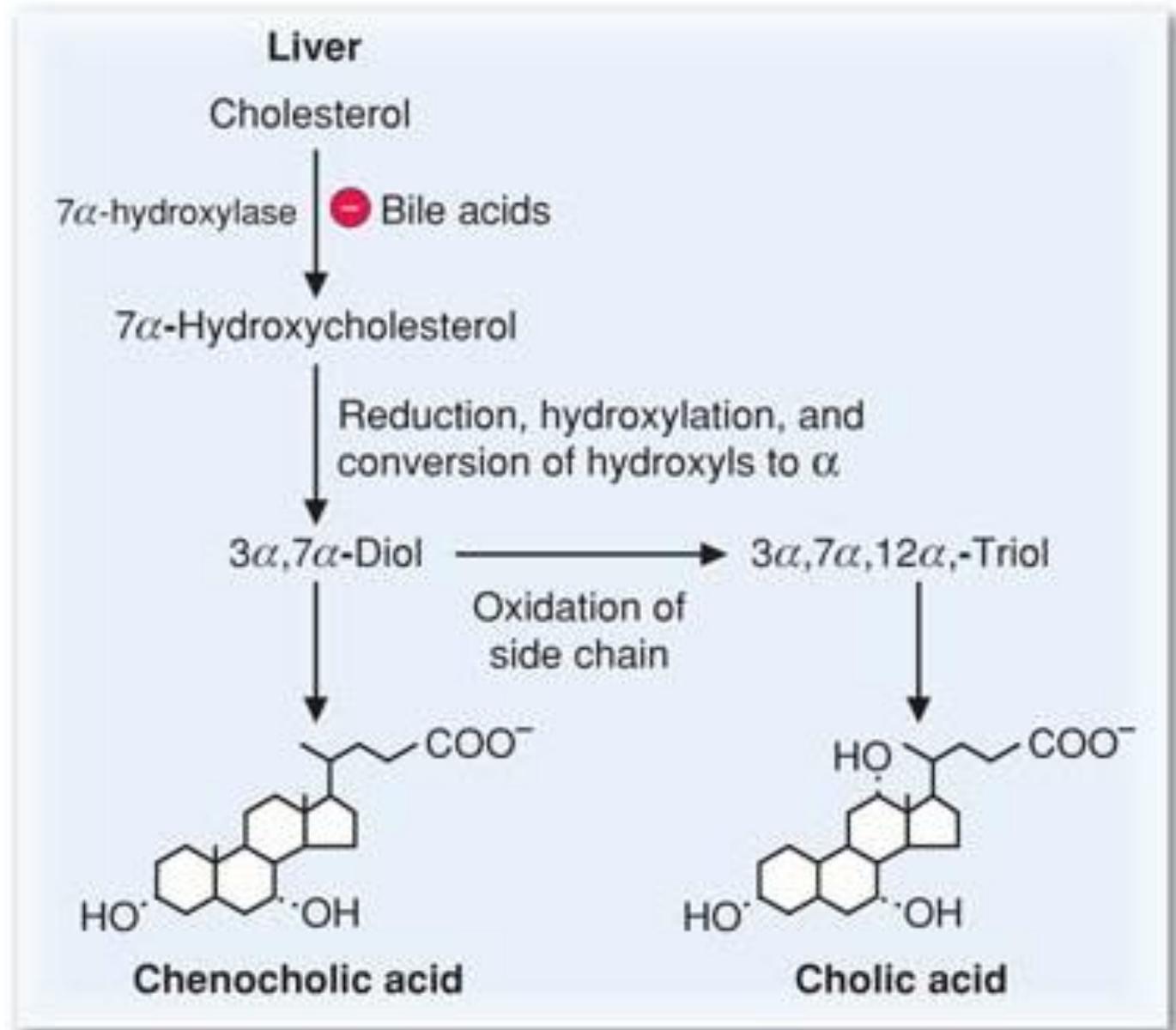
Bile emulsifies fats to allow greater surface area for fat enzymes (**lipases**) to work

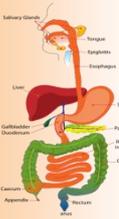




Bile is made from cholesterol and bile salts

The resulting molecule is like dish detergent





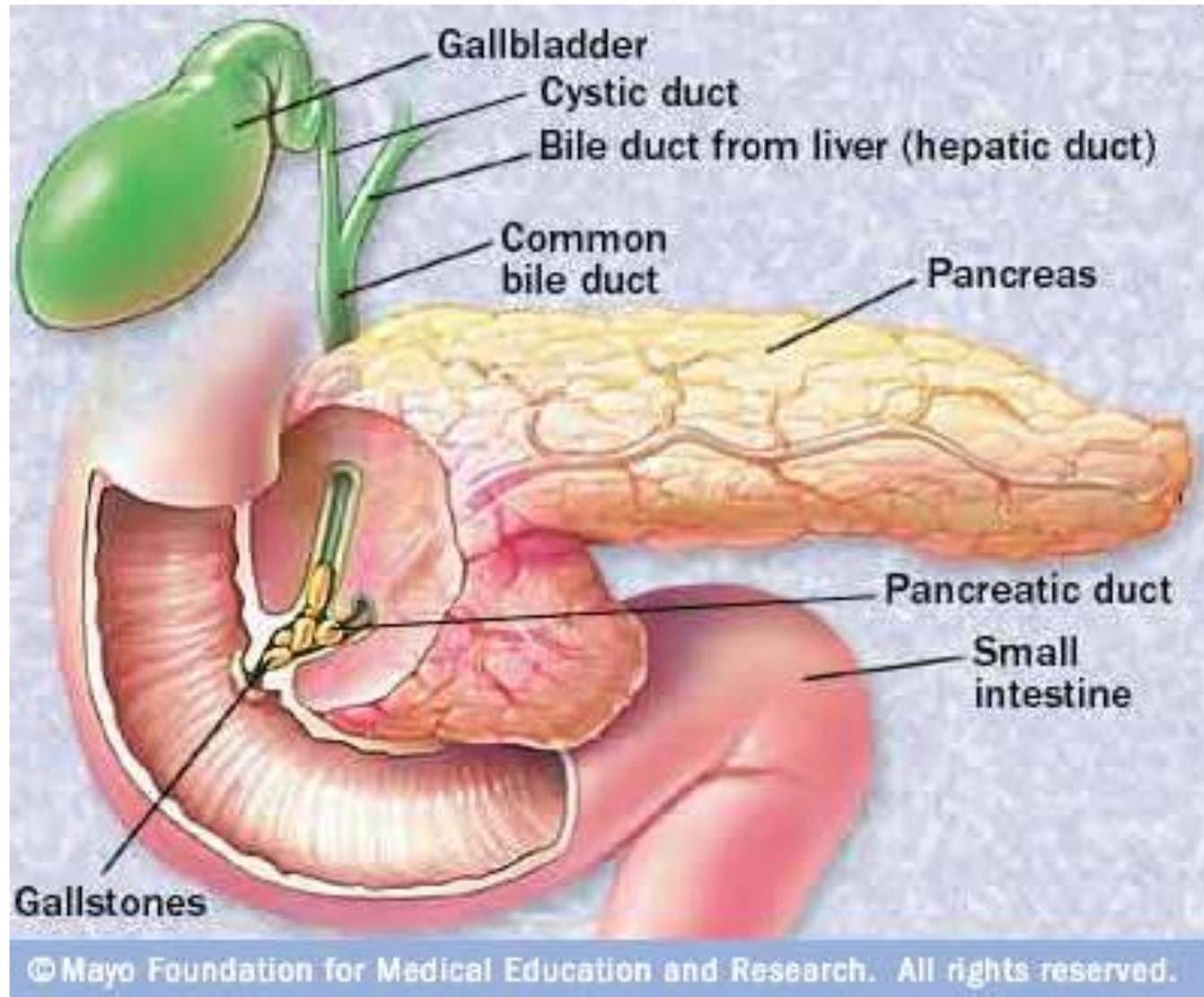
Digestive Tract: Duodenum, Pancreas, & Gall Bladder

Gallstones:

Crystallization of bile components (primarily cholesterol).

Causes:

- diet
- body weight
- bile duct motility
- gall bladder motility



Gallstones



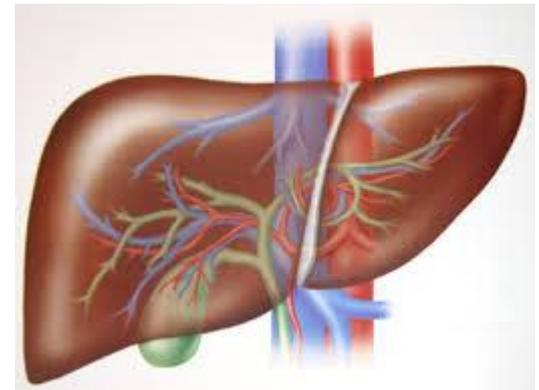
Gallstones



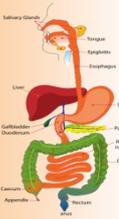
Gallstones



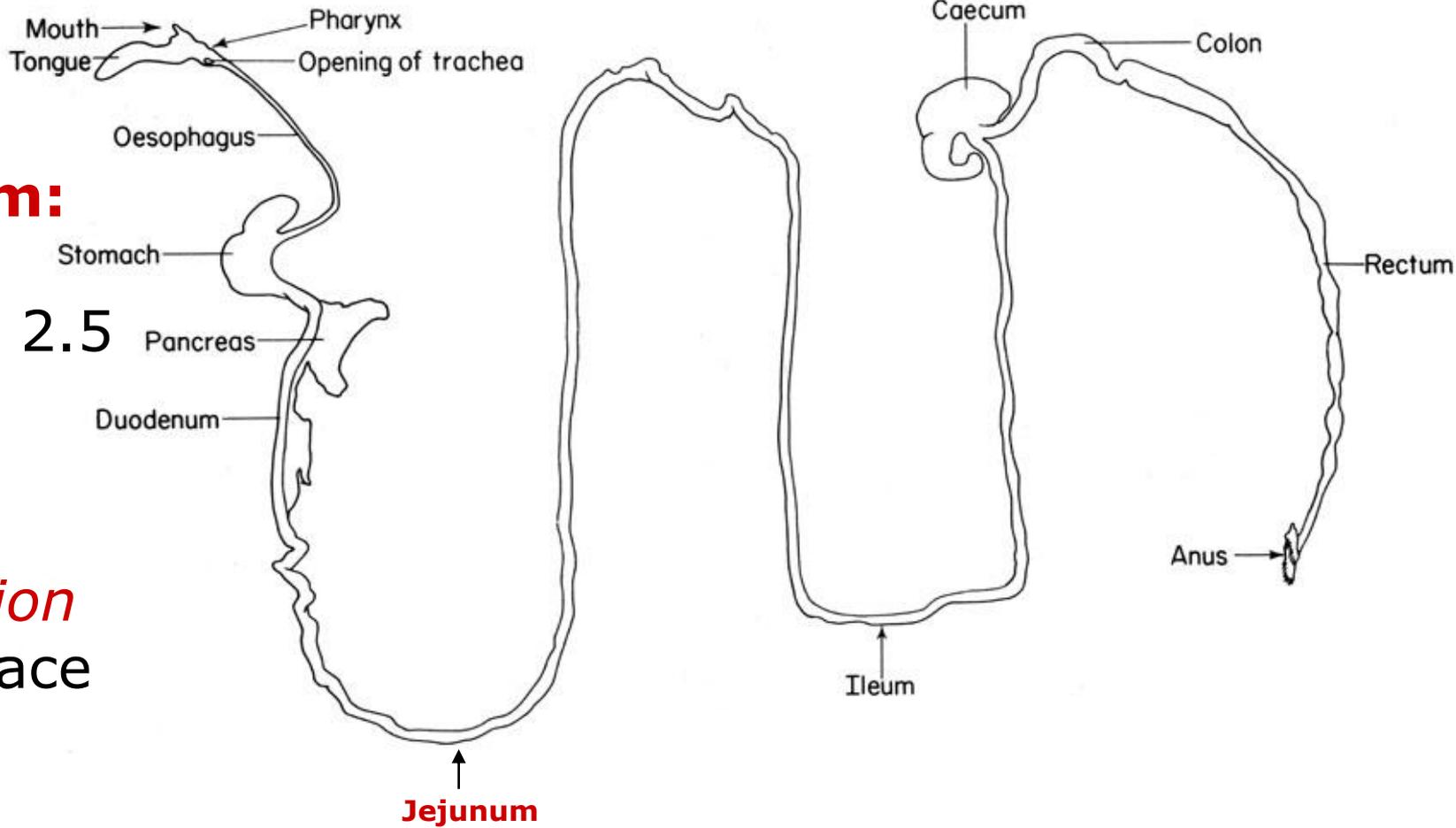
Liver



- - Produces bile and cholesterol
- - Breaks down old red corpuscles, recycles parts of hemoglobin to make bile salts
- - Converts excess glucose and stores as glycogen, converts it back to glucose when needed
- - excess glucose can be converted to fat stored in adipose tissues
- - Stores fat-soluble vitamins K, E, D, A
- - Detoxifies various poisons like alcohol and medicines



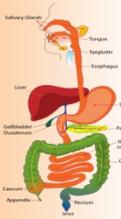
Digestive Tract: Jejunum



Jejunum:

Roughly 2.5 meters long.

Absorption takes place here

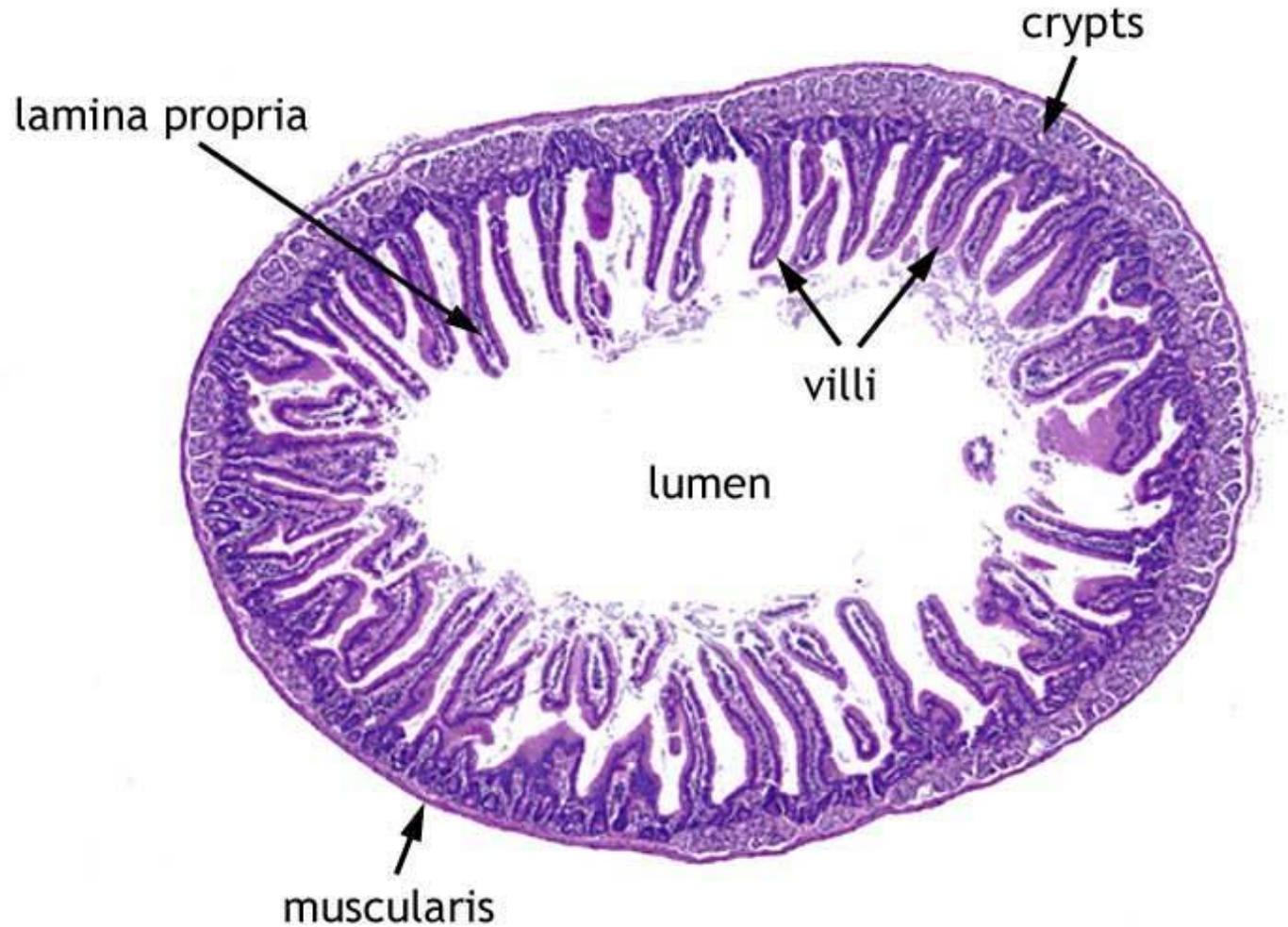


Digestive Tract: Jejunum

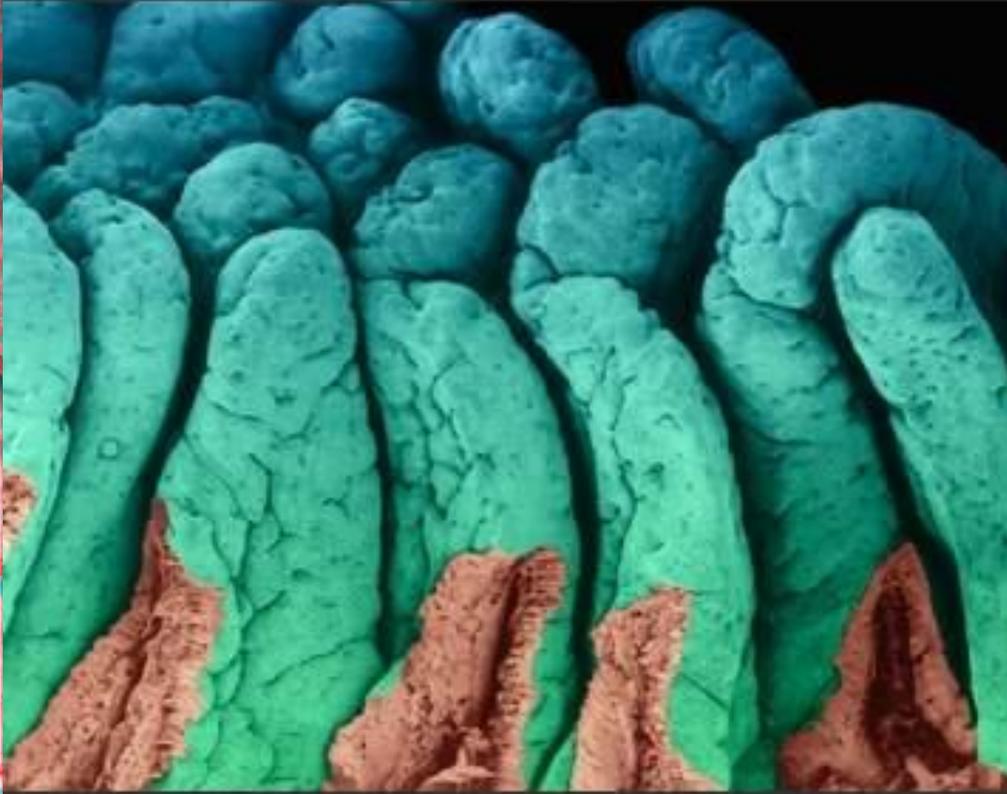
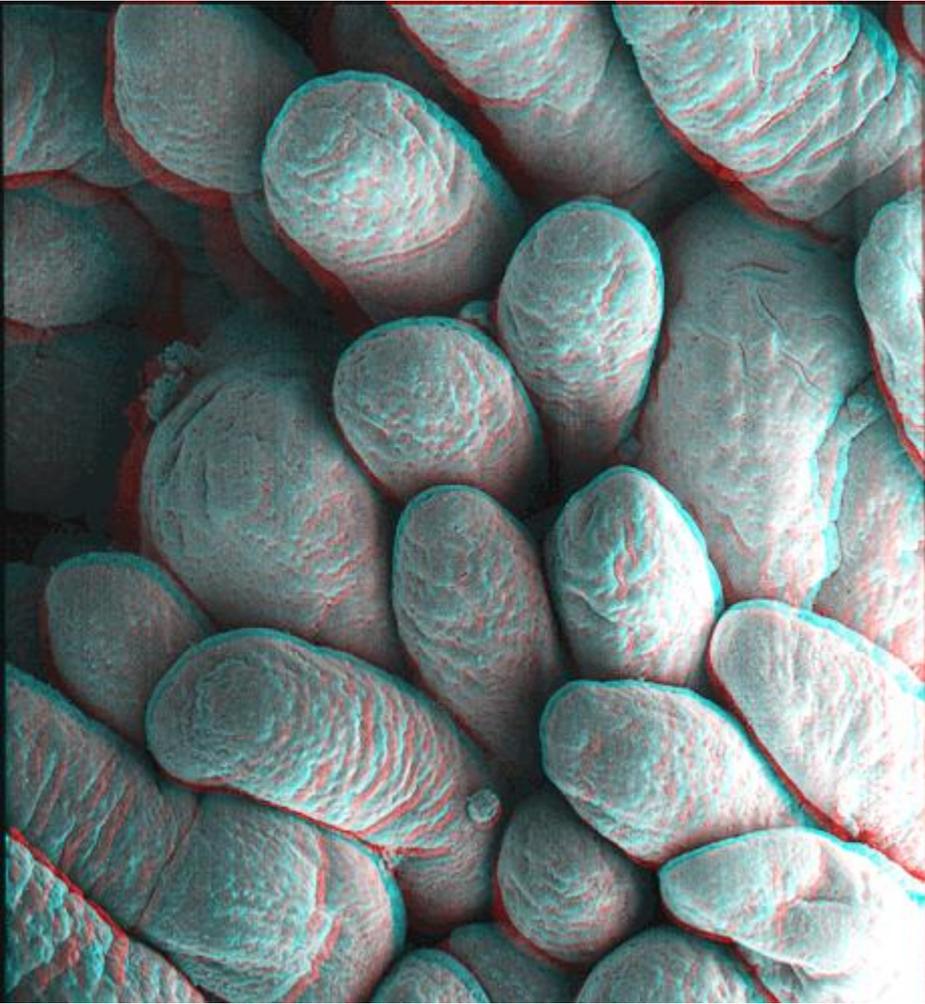
Jejunum:

Lined with longitudinal and circular muscles to perform *peristalsis*.

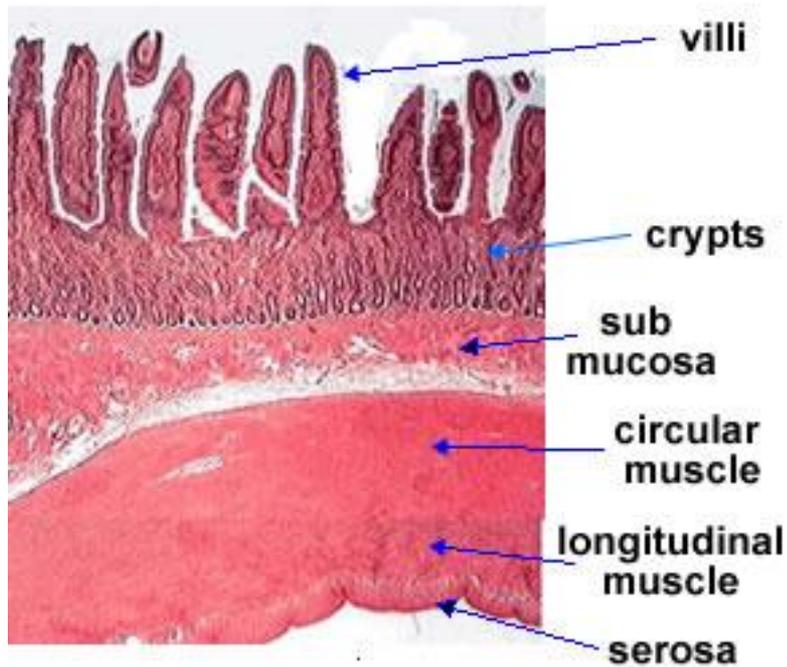
Has structures called **villi**.



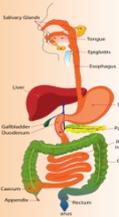
Villi



Jejunum Structure



- Crypts:
 - glands that produce enzymes maltase, sucrase, lactase and lipases
 - located in the epithelial lining



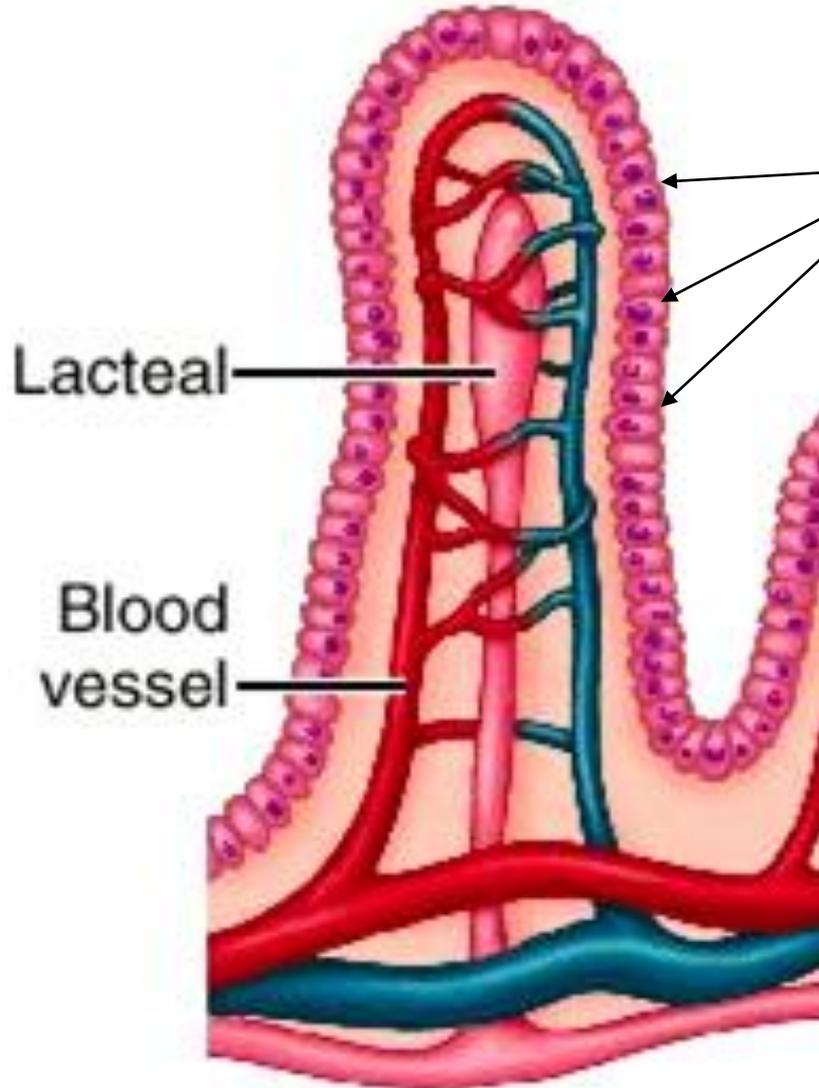
Digestive Tract: Jejunum

Villi:

-finger-like projections of the small intestine lining

-More surface area to absorb nutrients.

-Each epithelial cell has **microvilli** on its surface that increase surface area even more



The cells lining each villus can perform

-Passive transport
(transport of nutrients not requiring energy)

-Active transport
(transport of nutrients requiring energy)

Absorption

- 1) **Water-soluble nutrients:**
 - **-Minerals, vitamins, monosaccharide's, amino acids**
 - -absorbed through the mucosal epithelium passively or actively
 - -flow into the blood capillaries of the villi
 - -transported to the liver and body cells
 - * water is absorbed by osmosis (follow the movement of nutrients)

- 2) **Fat-soluble nutrients:**
 - **-fatty acids, cholesterol, fat-soluble vitamins**
 - -absorbed through the mucosal epithelium by membrane transport
 - -absorbed into the lacteals (lymphatic vessels)
 - -transported in lymphatic system

Simple Diffusion (Passive Transport)

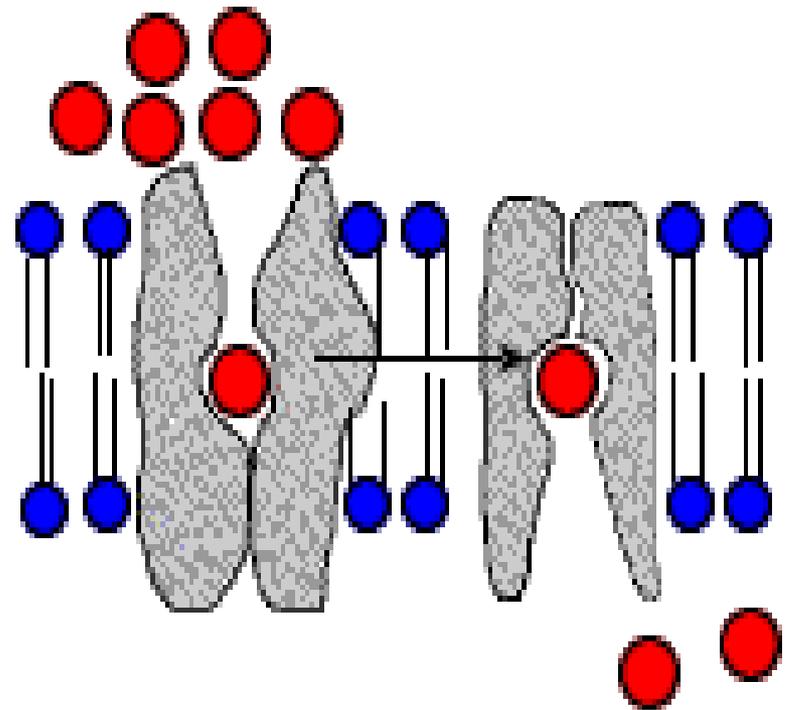
- Simple ions are absorbed through simple diffusion
- They move from a high concentrated area (in the lumen) to a low concentrated area (in the epithelium cell of the intestinal wall), **according to the concentration gradient**

Facilitated diffusion (passive transport)

- water soluble minerals and vitamins

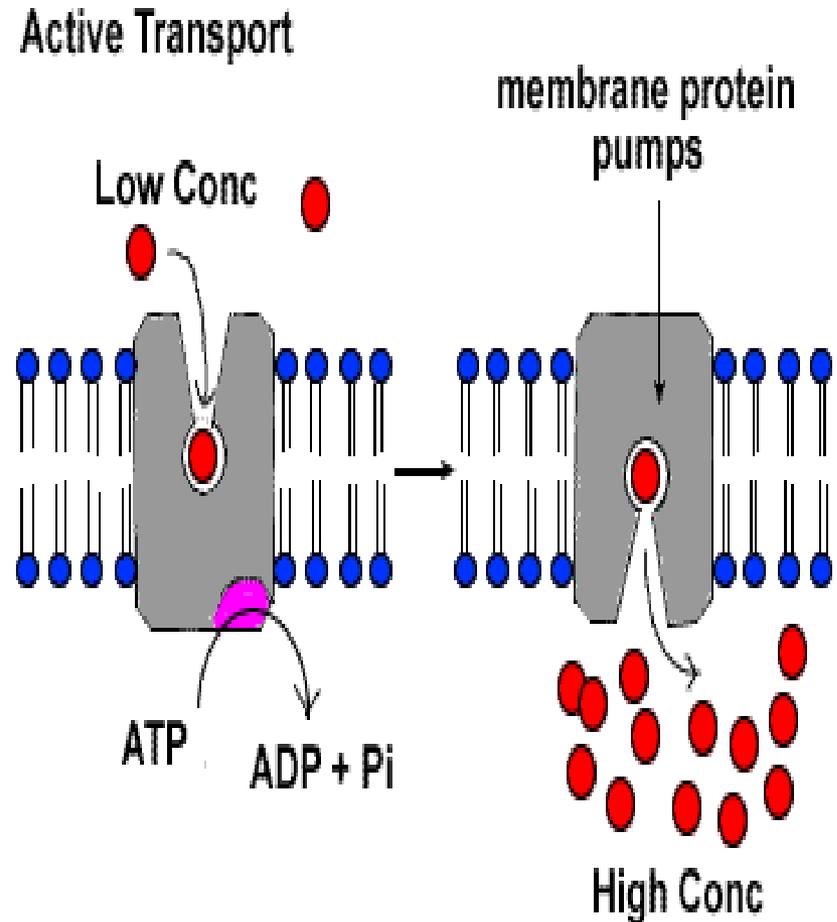
- Larger molecules move passively through the membrane via **channel proteins**
- According to the concentration gradient

Facilitated Diffusion



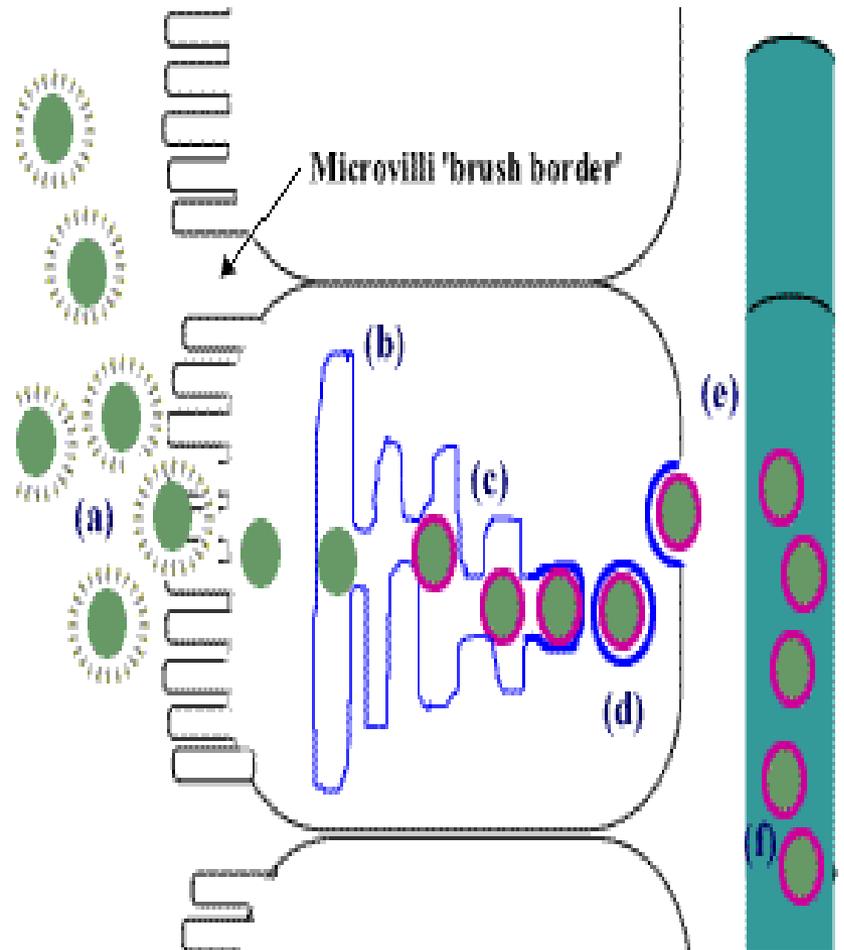
Active Transport - monosaccharides & amino acids

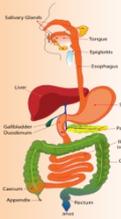
- membrane protein 'pump' requires energy to function
- The source of energy is ATP from respiration
- This moves the molecules from **low to high concentration against the concentration gradient**
- The energy causes a shape change in the protein that allows it to move the molecule to the other side of the membrane.



Membrane Transport –fatty acids, cholesterol & fat-soluble vitamins

- a) Bile salts form a micelle around fatty acids. It fuses with the cell membrane and the fatty acid molecules to pass into the epithelial cells of a small intestine villus (endocytosis).
- b) The fatty acids and glycerol recombine in the endoplasmic reticulum to form lipid.
- c) Protein is added to the lipid to form lipoprotein. This is how lipid is transported around the body.
- d) The lipoprotein is formed into small vesicles
- e) Exocytosis of the vesicles releases the lipoprotein from the cell
- f) The lipoprotein is taken up in the lacteal vessel and eventually enters the general circulation.





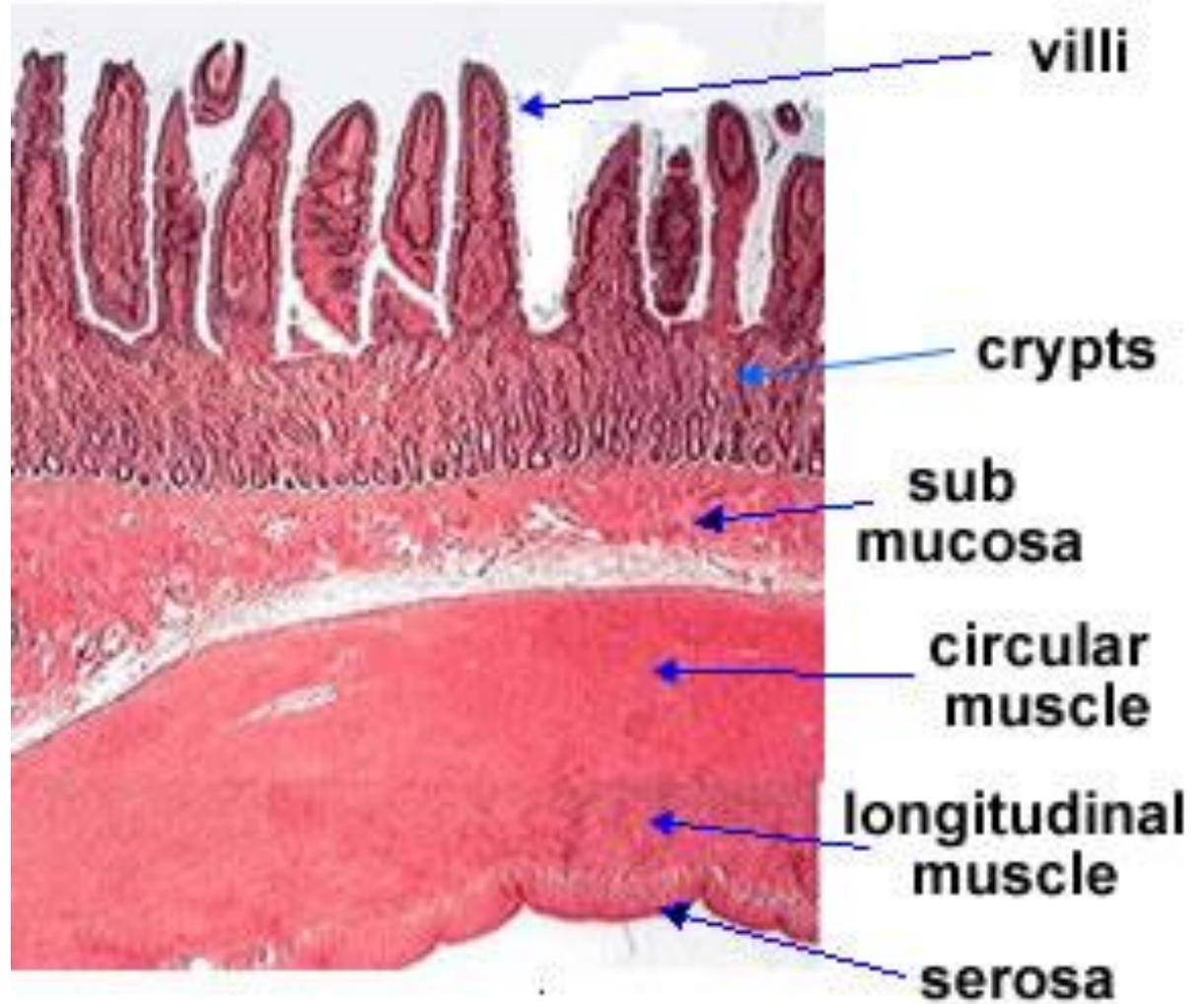
Digestive Tract: Ileum

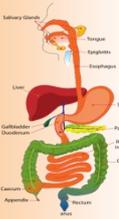
Ileum:

-2.4 meters long

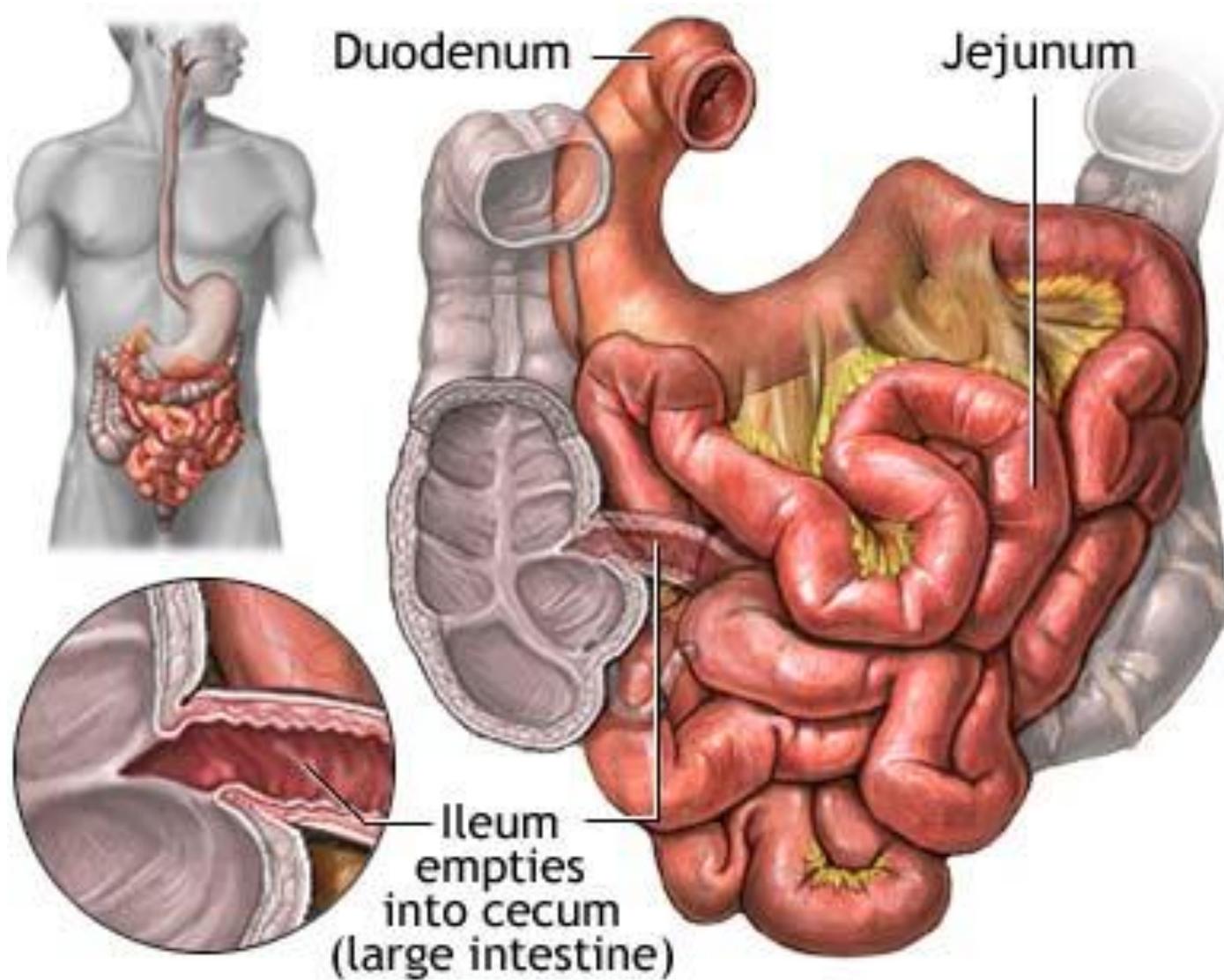
-absorption (has villi)

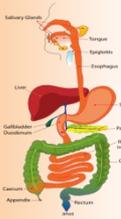
-also absorbs vitamin B12 and bile salts





Digestive Tract: Ileum

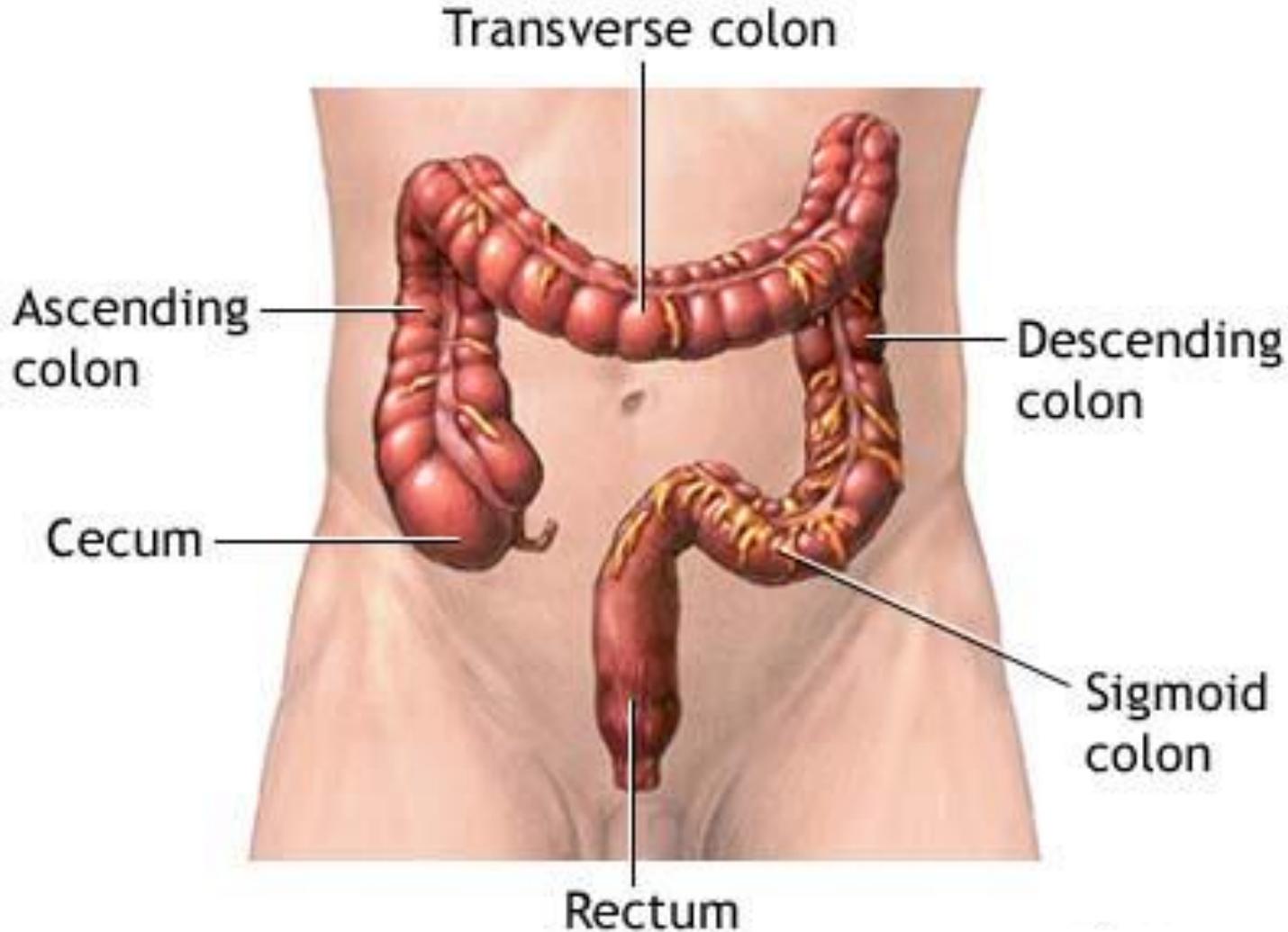


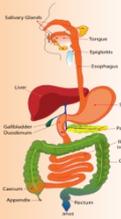


Digestive Tract: Caecum & Appendix

Caecum:

- first part of the large intestine
- Attached to the appendix

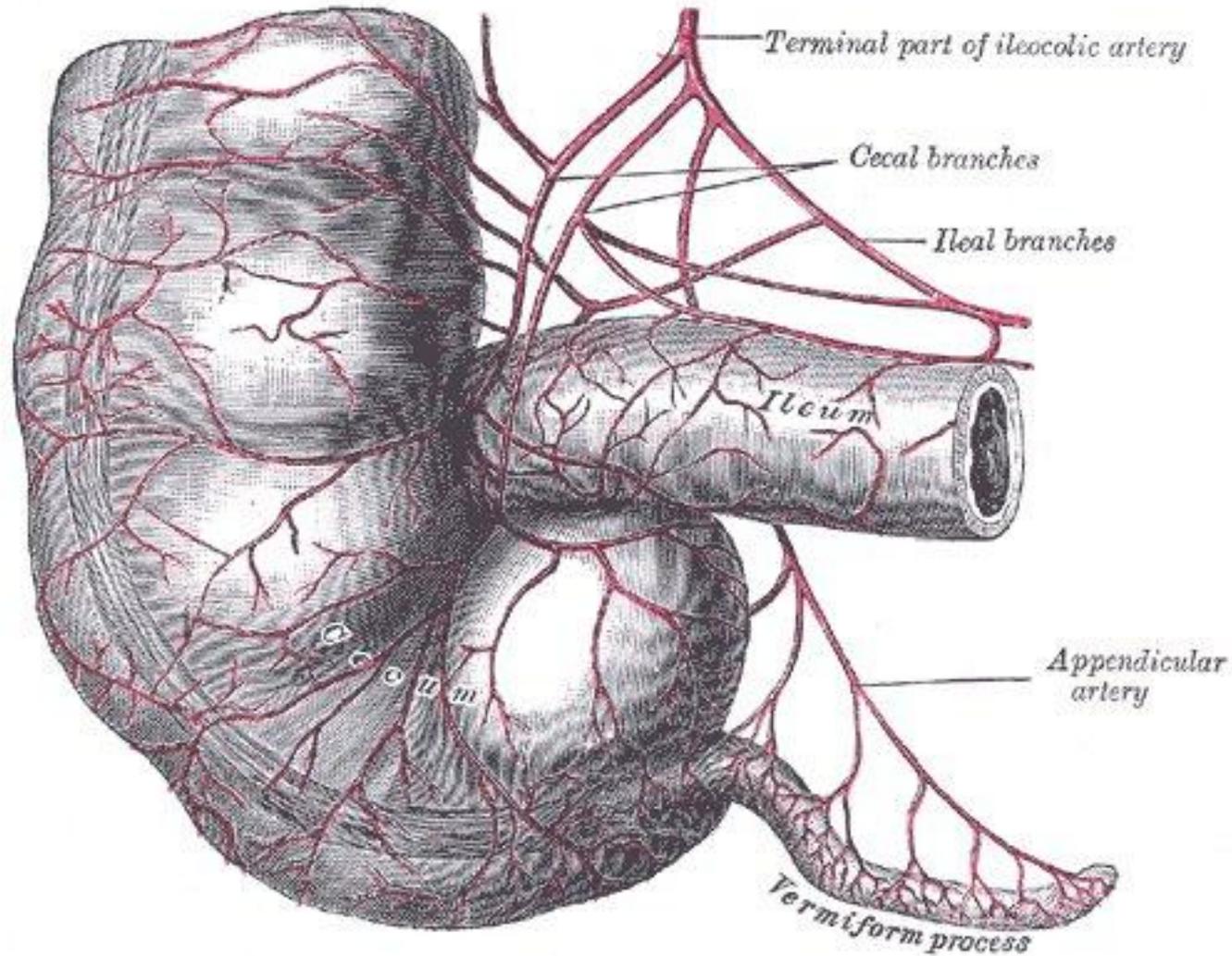


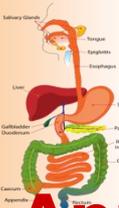


Digestive Tract: Caecum & Appendix

Caecum:

-separated from the ileum by the **ileocaecal valve**.



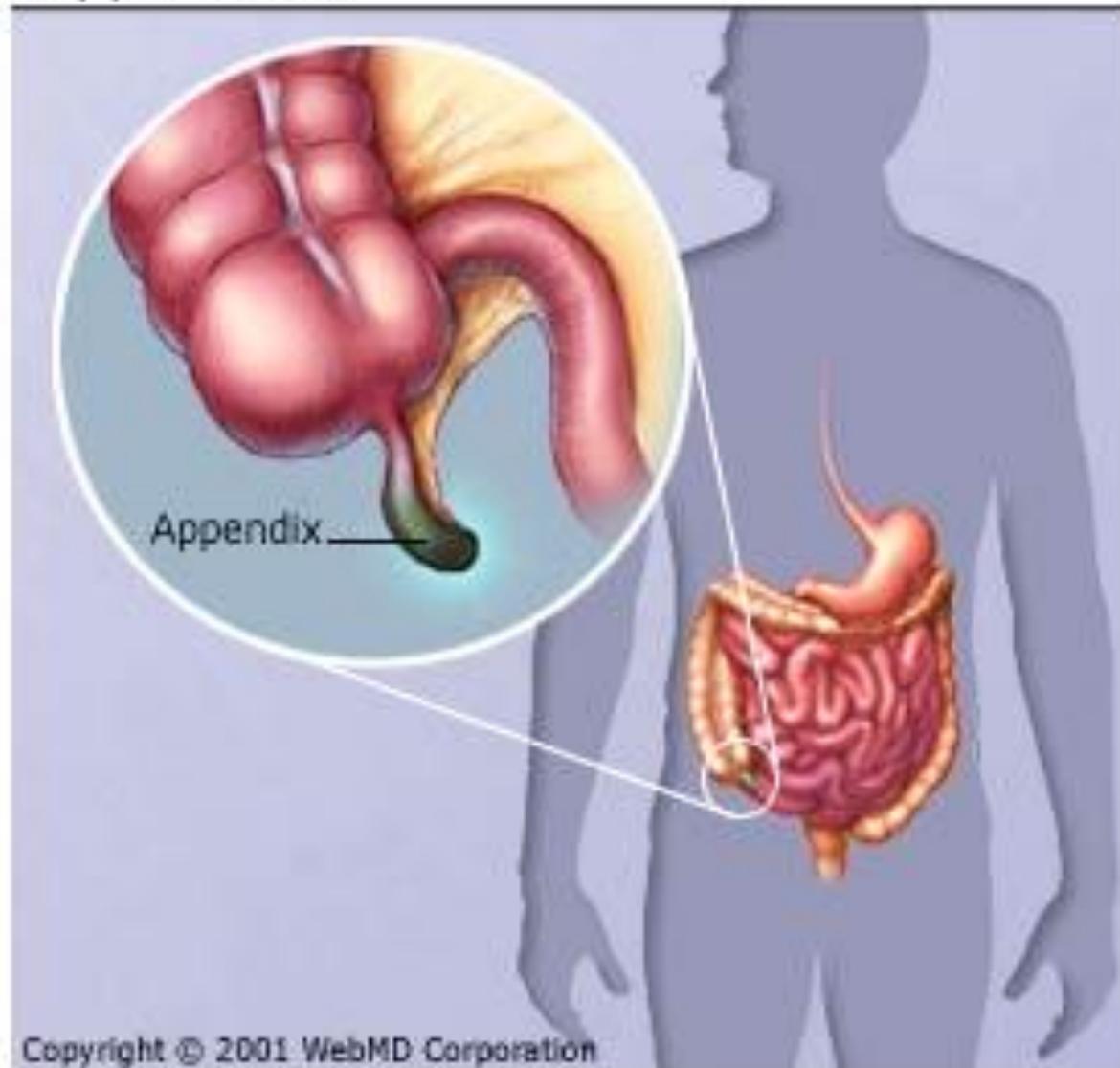


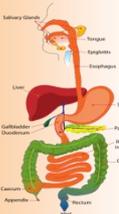
Digestive Tract: Caecum & Appendix

Appendix:

- blind-ended tube
- believed to shelter beneficial bacteria for digestion
- has lymphoid tissue
- can become infected (**appendicitis**)

Appendicitis

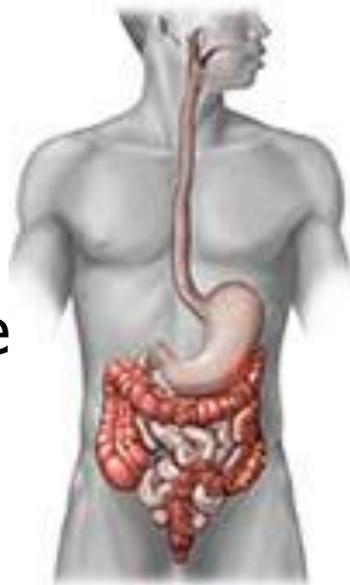




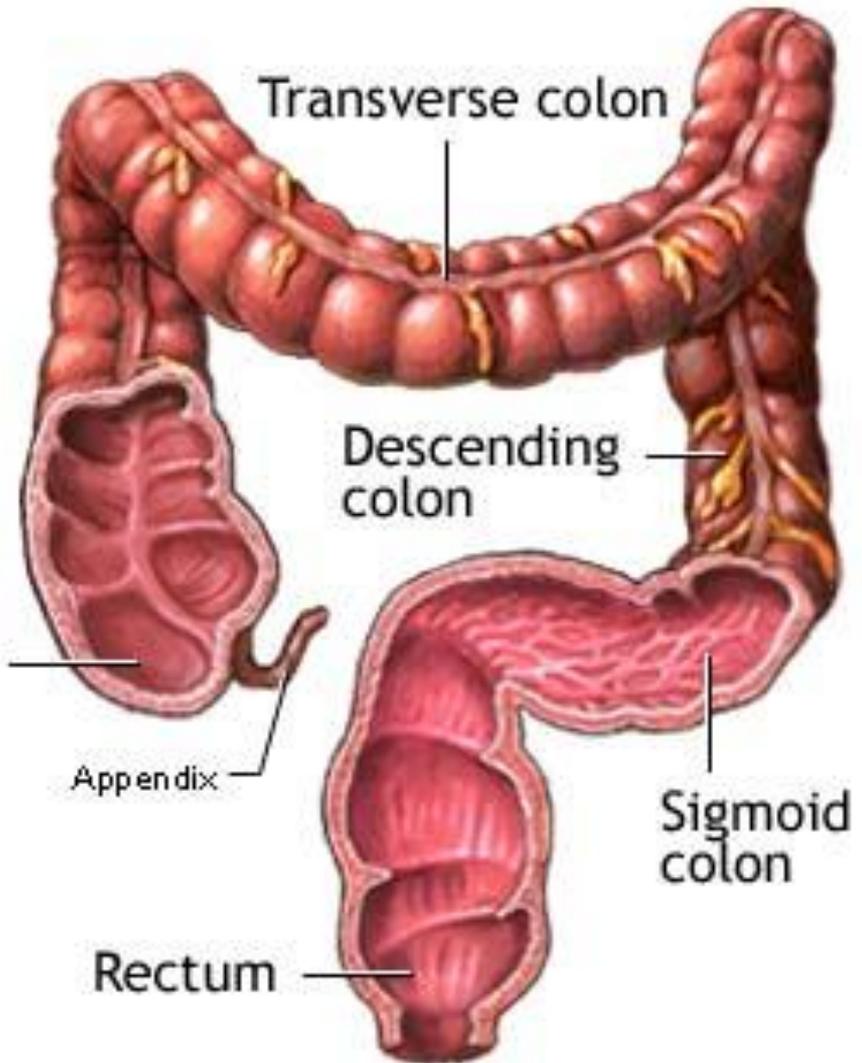
Digestive Tract: Large Intestines

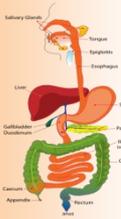
Colon:

- Absorbs water
- Pass waste material from the body
- Contains colonic bacteria which produce **vitamin K**, **vitamin B12**, **thiamine**, and **riboflavin** (*mutualistic relationship*)



Ascending colon



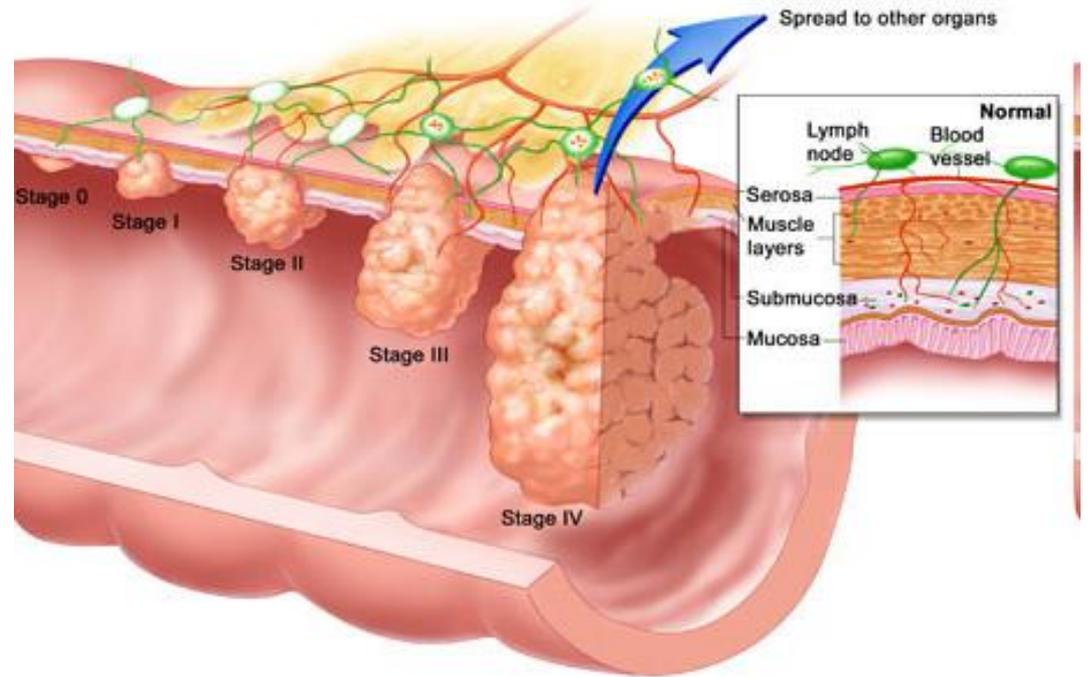


Digestive Tract: Large Intestines

Colon Cancer:

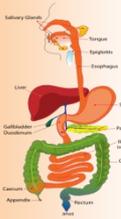
-4th most common type of cancer (3rd most common death-causing cancer)

-Starts with **benign** tumours (polyps), which become **malignant**



Causes range from genetics and/or viral infections (i.e. HPV) to lifestyle causes (diet low in vegetables and fruit, and smoking*)

*smoking is correlated



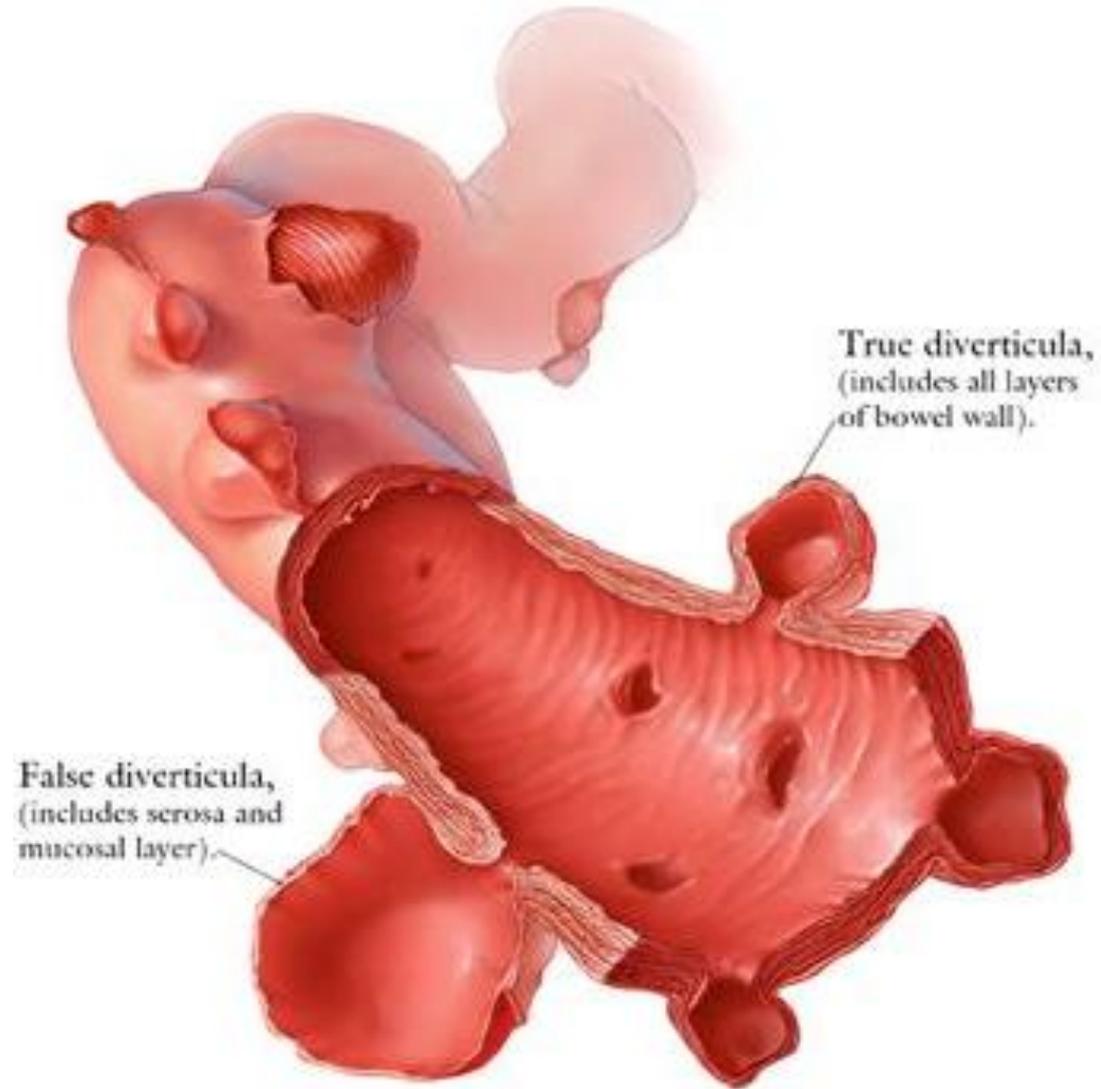
Digestive Tract: Large Intestines

Diverticula:

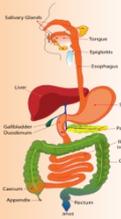
-Small pouches in the lining of colon, causing the condition

diverticulosis

-Pouches get inflamed and swells (diverticulitis)



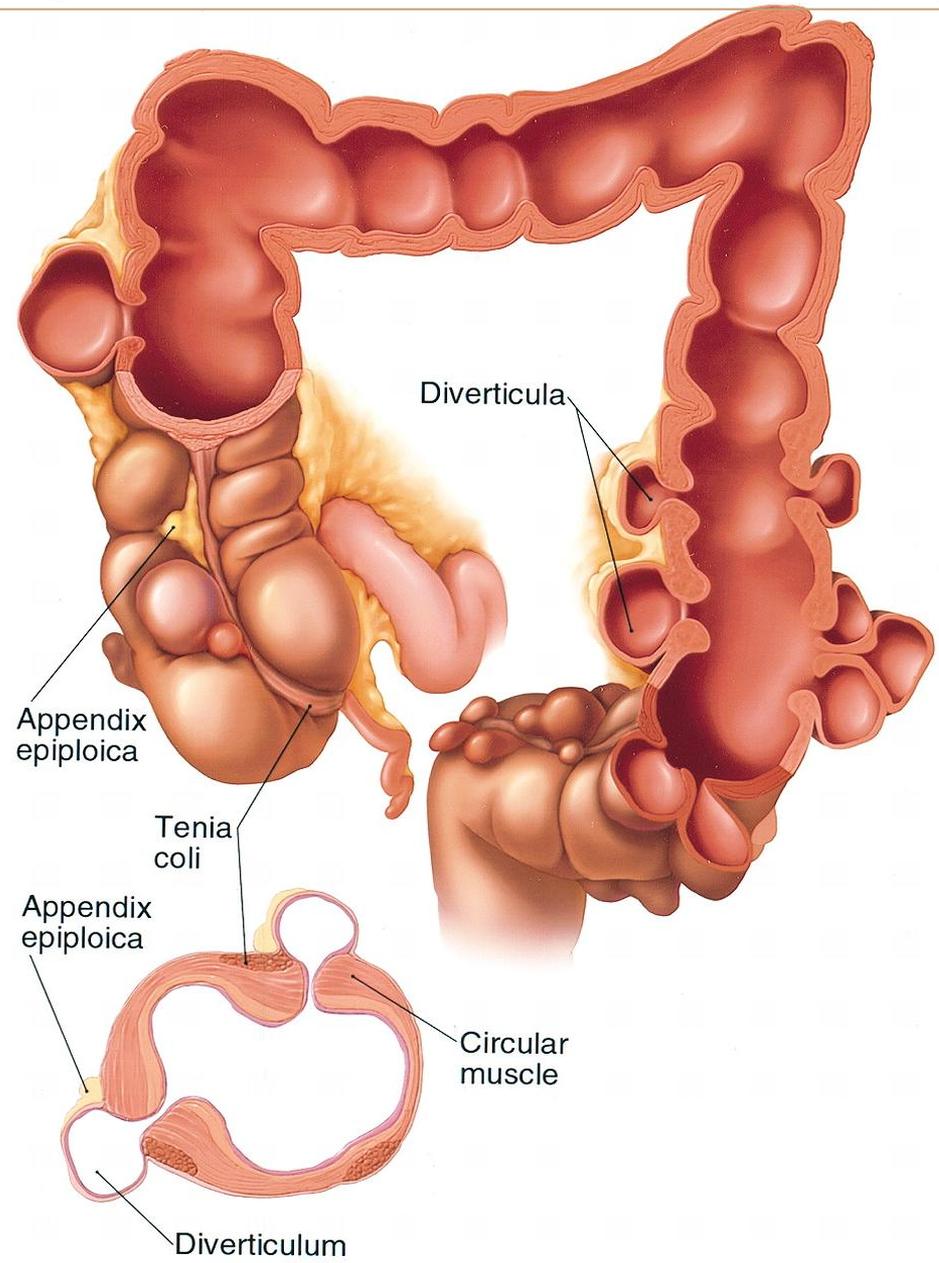
Diverticulosis

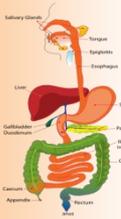


Digestive Tract: Large Intestines

Diverticulosis:

- Caused by **low fibre diet**
- Lack of exercise** associated
- Muscles in colon wall weaken if feces are hard to push downward, and eventually bulge outward



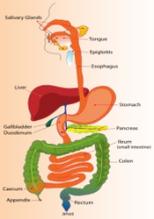


Digestive Tract: Large Intestines

Diagnostic: Barium Enema

- Barium solution is inserted into rectum, to provide contrast for the X-ray
- An X-ray is taken to see how barium fluid moves through the large intestine (checks for blockages, leaks, abnormal structures)





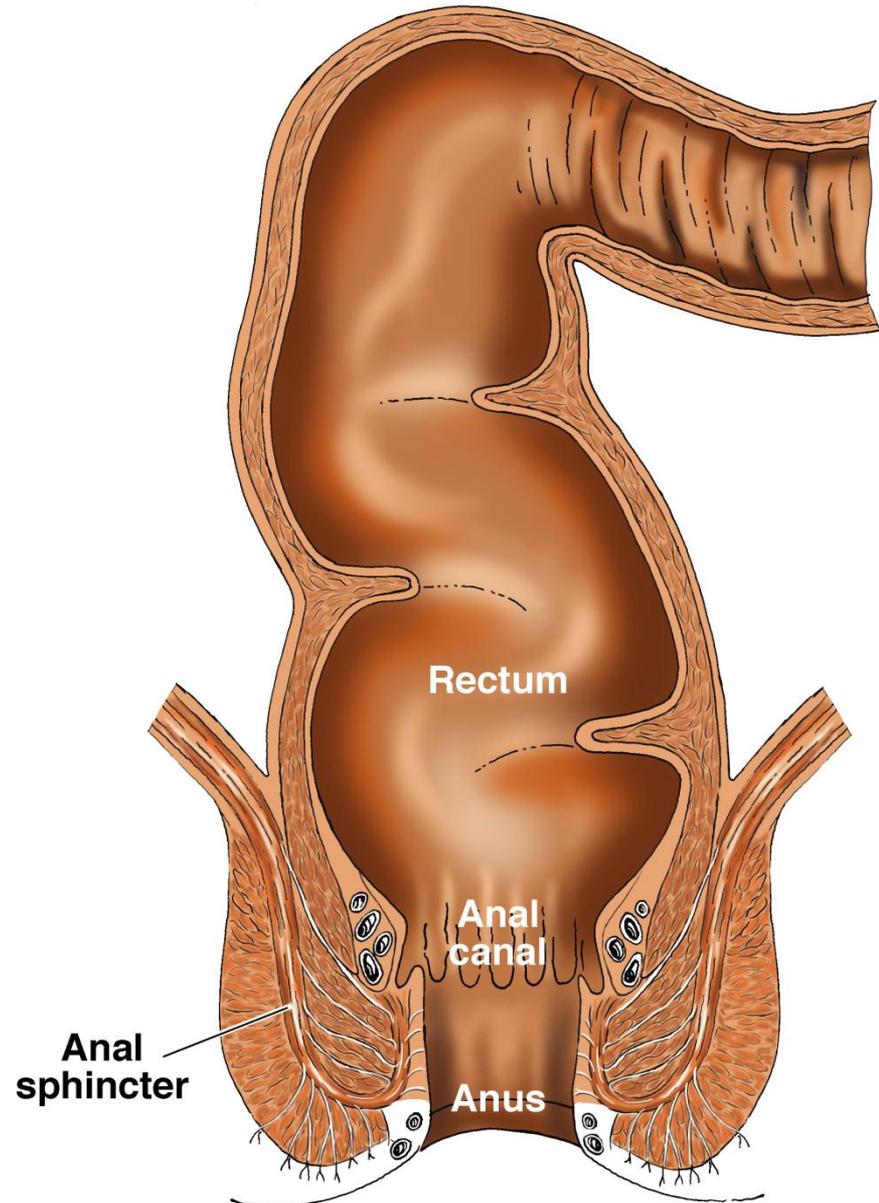
Digestive Tract: Rectum, Anal Canal, Anus

Rectum:

- Forms peristaltic waves to expel feces through the anal canal
- Stretch receptors trigger contractions when rectum is full

Anal sphincter:

Exterior and interior sphincters pull the anus up over the exiting feces



Intestines

