HUMAN DIGESTIVE SYSTEM

KATEV SUMMER SEMINER-2010

Digestion

- The process of **breaking down** food into molecules the body can use is called digestion.

  Substance – *unit or monomer* – *usage*

- **Carbohydrates** – **monosaccharide** – as energy source
- **Proteins** – **amino acids** – as building material
- **Lipids** – **fatty acids** – as energy source and building material
- **Vitamins** – for body regulation

Although most foods contain a mix of nutrients, some foods are richer than others in a specific nutrient.

Carbohydrate-rich foods

(Carbohydrates contain 4 calories per gram.) **Breads, pasta, grains, cereals, potatoes, fruits**

Protein-rich foods

(Proteins contain 4 calories per gram.) **Fish, eggs, poultry, beef pork, nuts, legumes, milk, cheese, tofu**

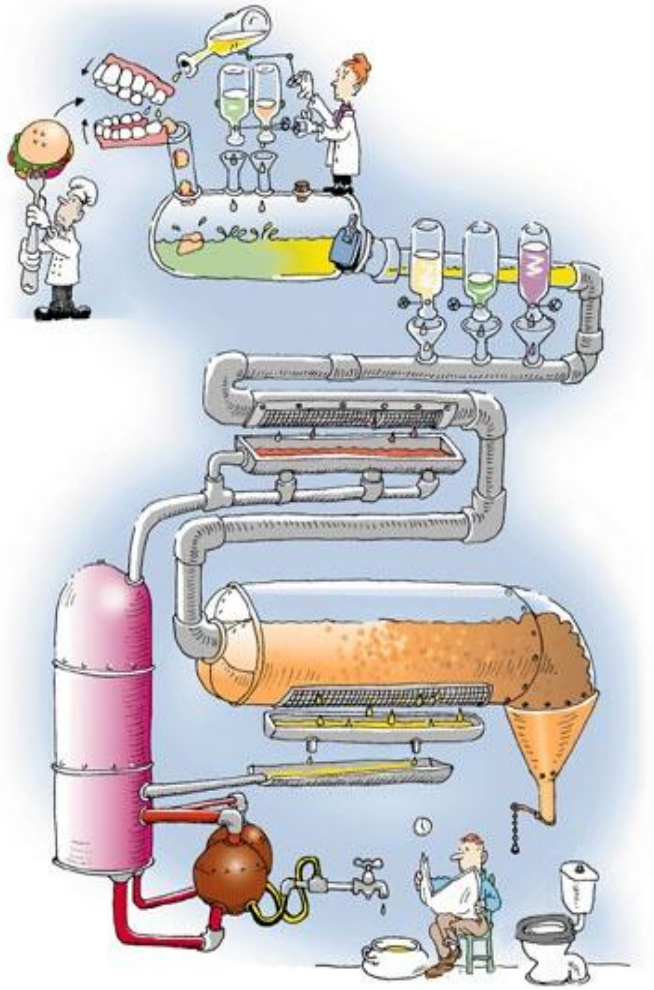
Fat-rich foods

(Fats contain 9 calories per gram.) **Milk, cheese, meats, butter, olives, avocados, fried foods, oils, chips**

4 STEPS OF DIGESTION

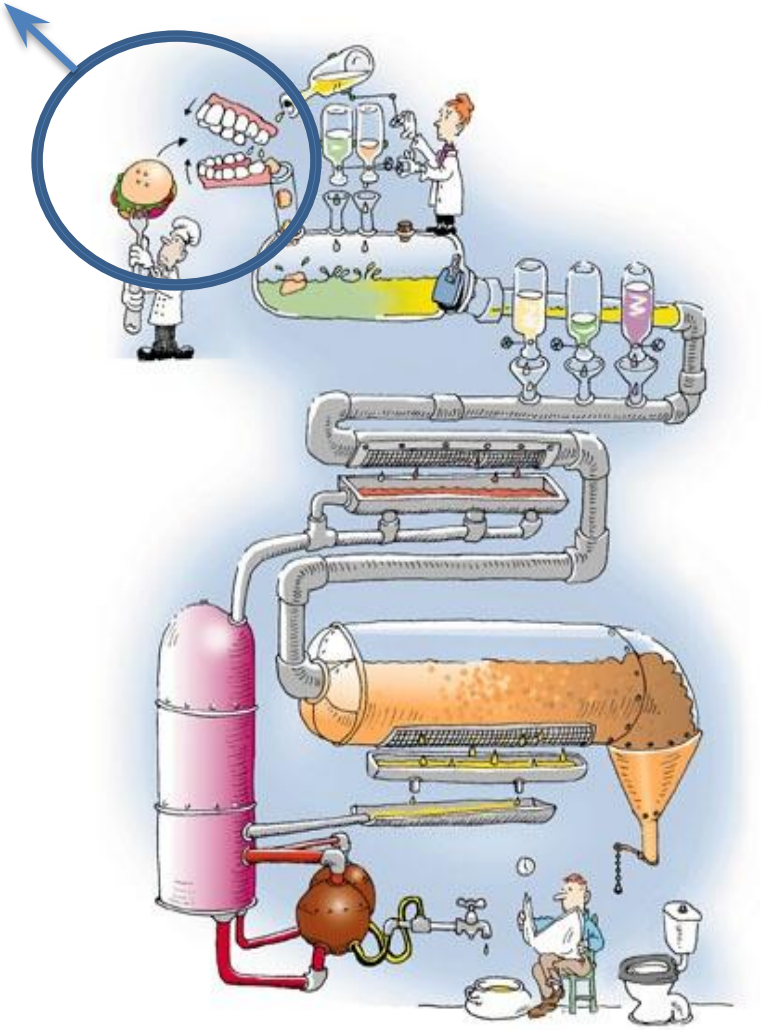
- **There are 4 main steps of digestion in human body:**

1. Ingestion of food
2. Digestion of polymers
   a. *Mechanical digestion*
   b. *Chemical digestion*
3. Absorption of monomers

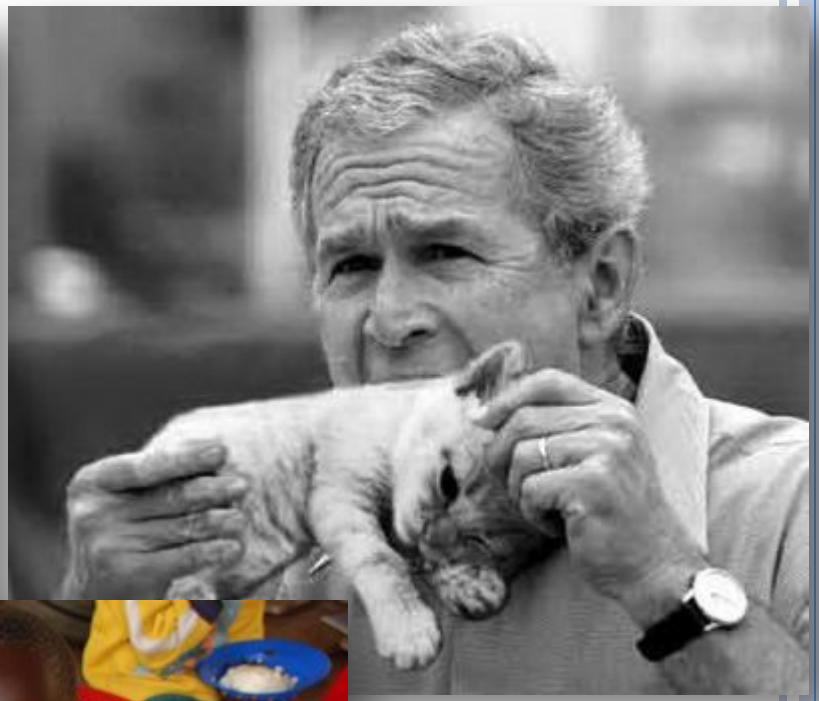


1. Ingestion

- Food enters our body, mouth, or simple eating




WING



2. Digestion of polymers

- **When polymers are broken down into simpler parts, into monomers**

1. Mechanical digestion:

- **Pieces of food are firstly cut, crushed, or broken into smaller particles without being changed chemically.**
- **Mechanical breakdown increases the surface area of the food particles.**

2. Chemical digestion:

- **Foods are broken down into their monomers by enzymes and water.**

3. Absorption of monomers

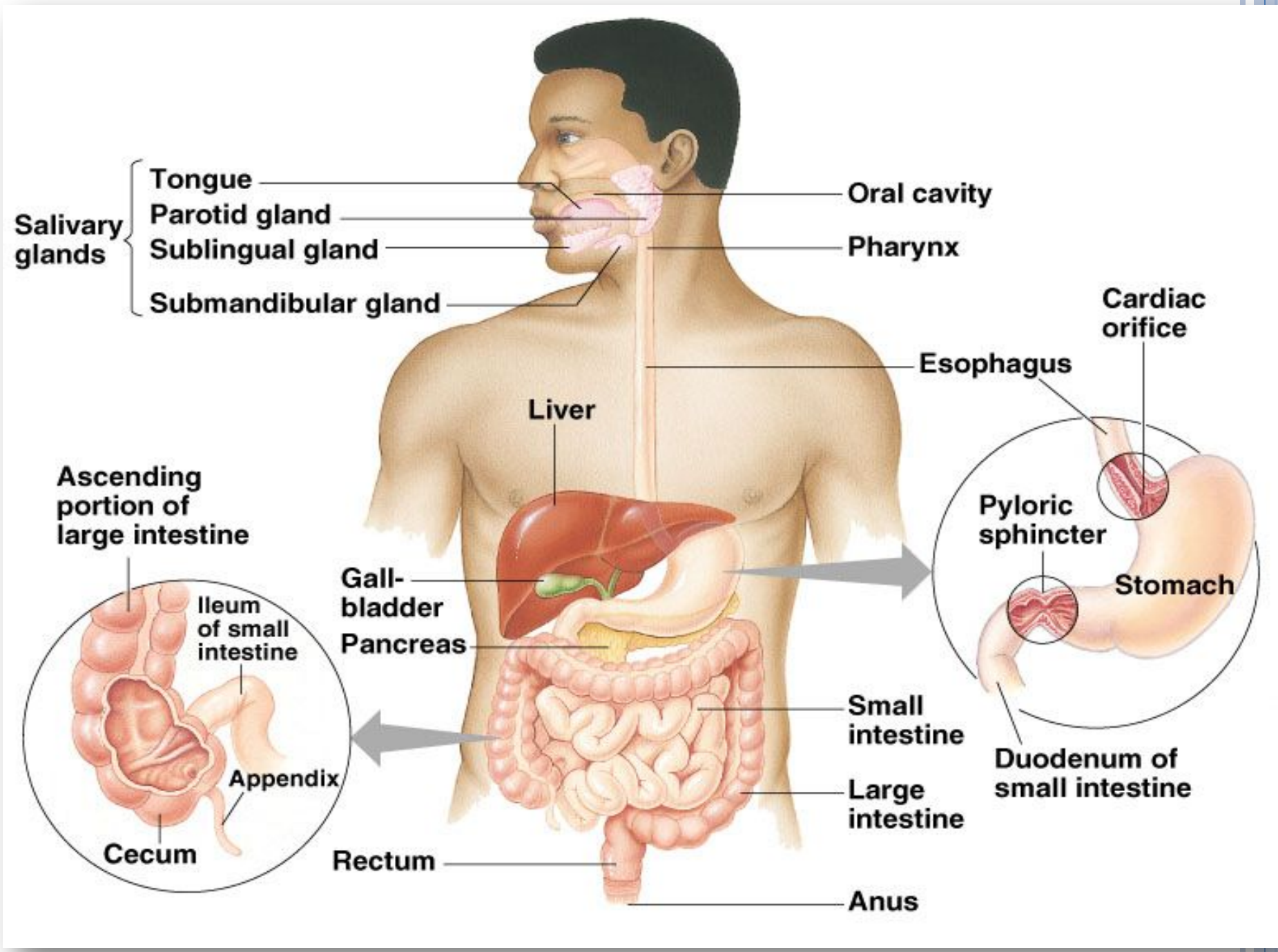
- After the food is digested, the human's cells **take up** small molecules such as amino acids and simple sugars from the small intestine, a process called absorption.
- **Vitamins** and **inorganic materials** pass into the blood without digestion.

4. Elimination of waste

- Undigested material is removed from digestive tract and body

Human digestive system

- The digestive system **takes in food**, **breaks it down** into molecules small enough for the body to absorb, and **gets rid** of undigested molecules and waste.
- Food travels **more than 8 m** through the human digestive tract.


Salivary glands
Tongue
Parotid gland
Sublingual gland
Submandibular gland
Oral cavity
Pharynx
Cardiac orifice
Esophagus
Liver
Ascending portion of large intestine
Pyloric sphincter
Stomach
Gall-bladder
Pancreas
Ileum of small intestine
Small intestine
Duodenum of small intestine
Appendix
Large intestine
Cecum
Rectum
Anus

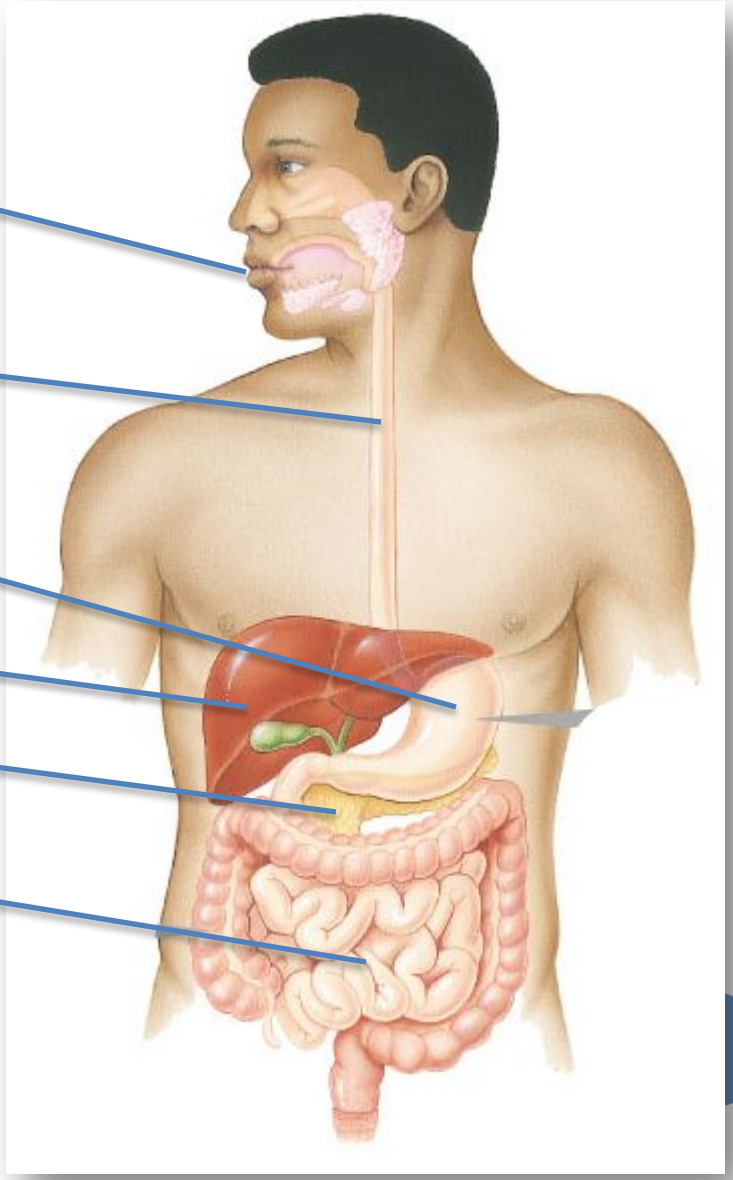
HUMAN DIGESTIVE SYSTEM PARTS

- Mouth

  teeth – salivary glands – tongue

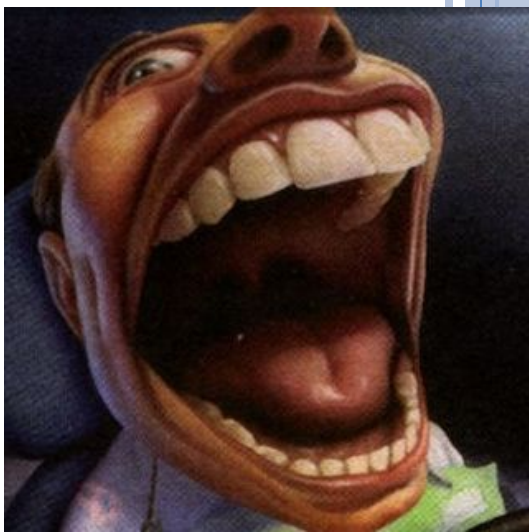
- Esophagus
- Stomach
- Liver
- Pancreas
- Intestine

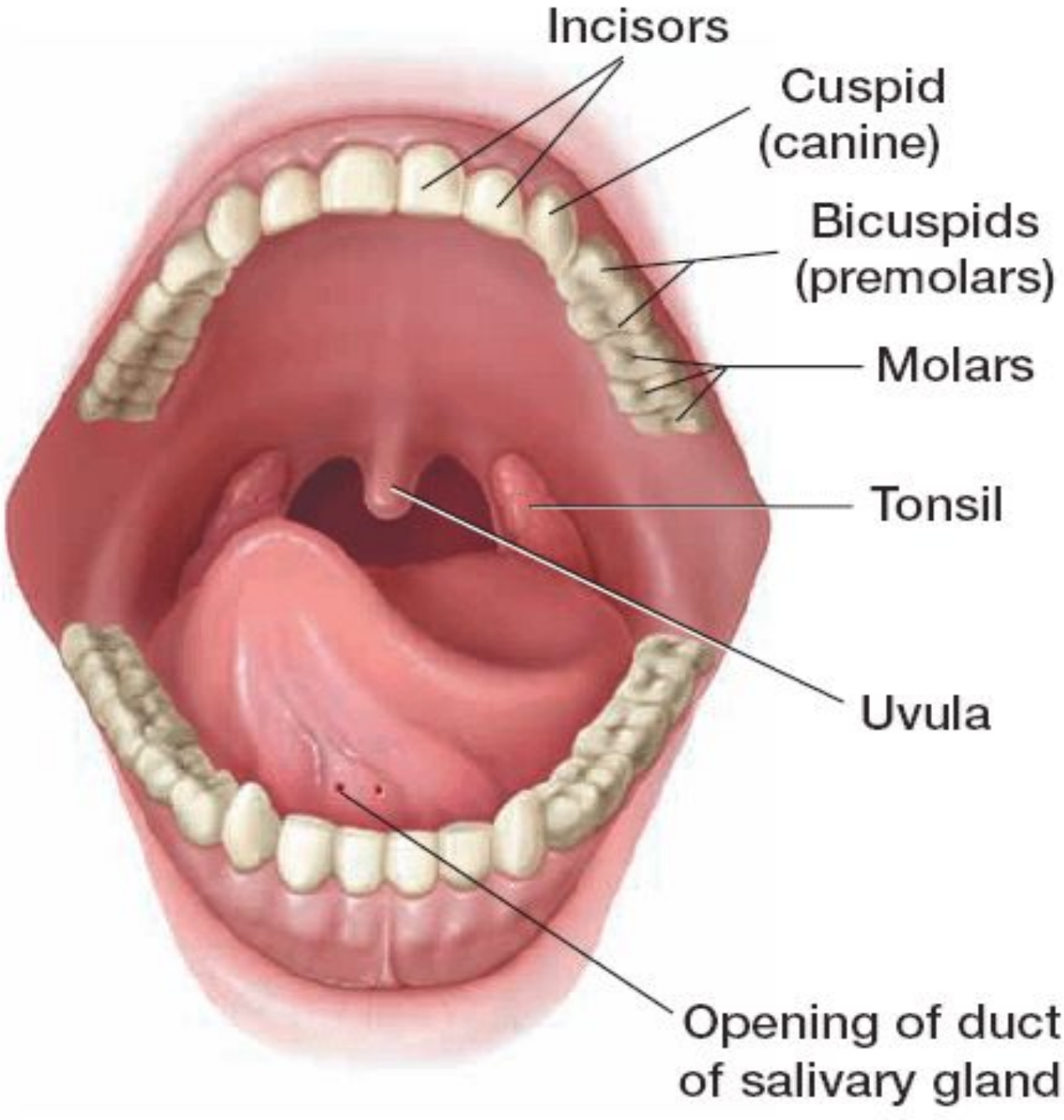
  small intestine – large intestine - rectum



MOUTH

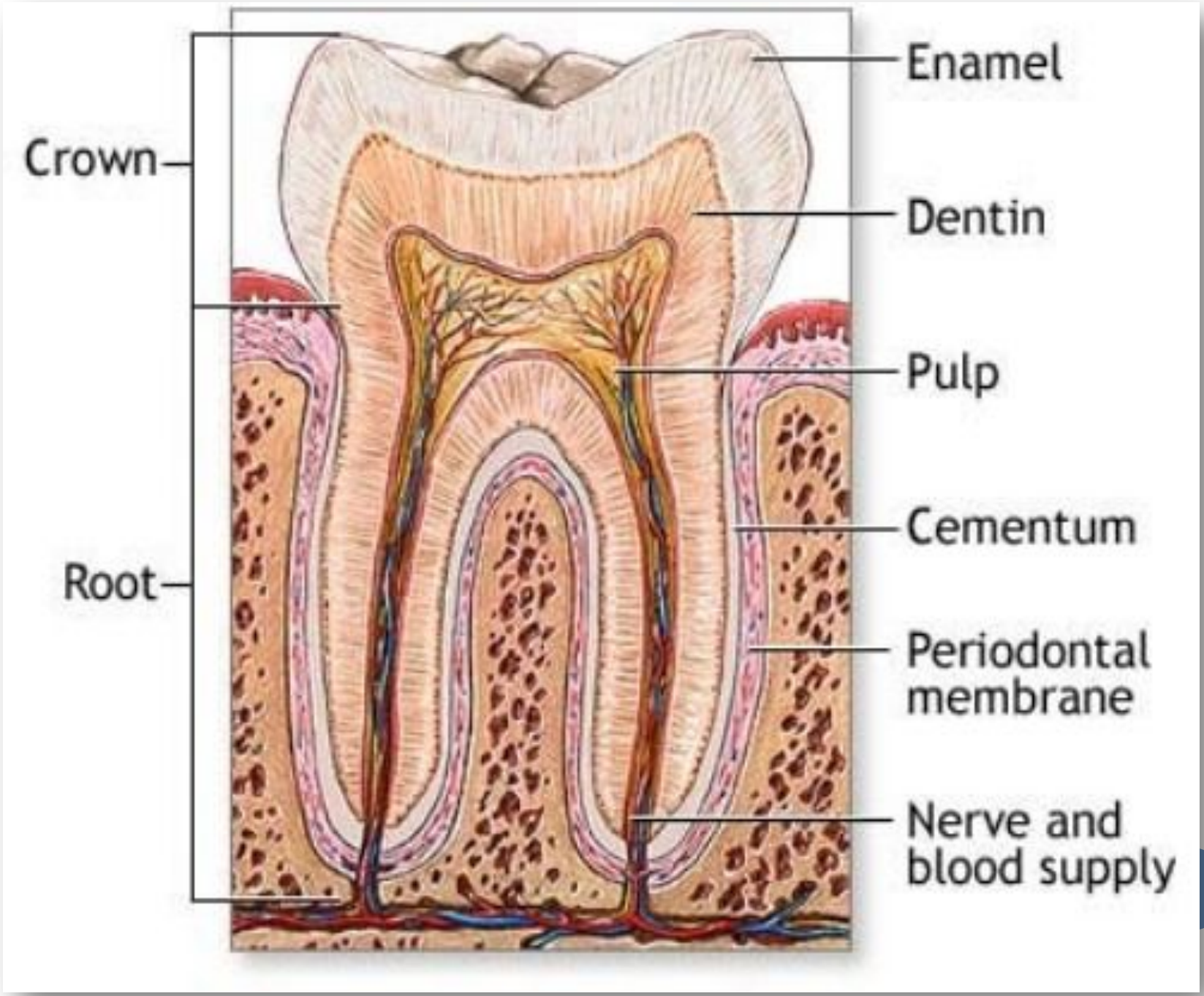
- Food enters the body through the mouth.
- **Mechanical** and **chemical** digestion occur in mouth.
- **Teeth** help in **mechanical** digestion.
- Salivary glands produce **saliva** that helps in **chemical digestion**




Incisors
Cuspid
(canine)
Bicuspids
(premolars)
Molars
Tonsil
Uvula
Opening of duct
of salivary gland

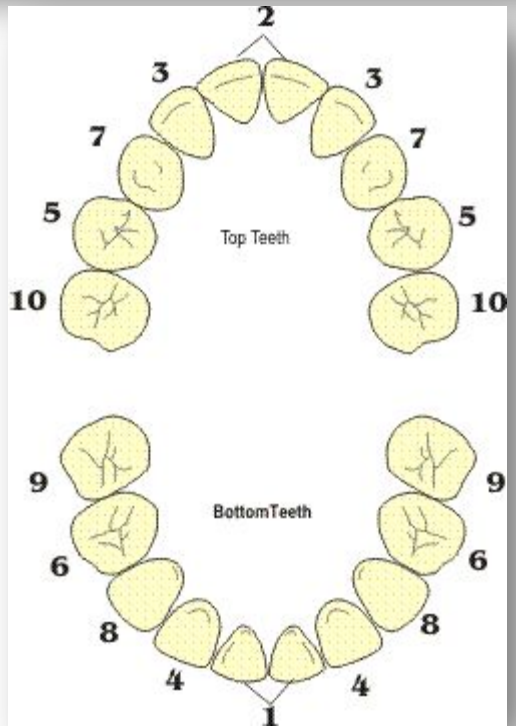
TEETH

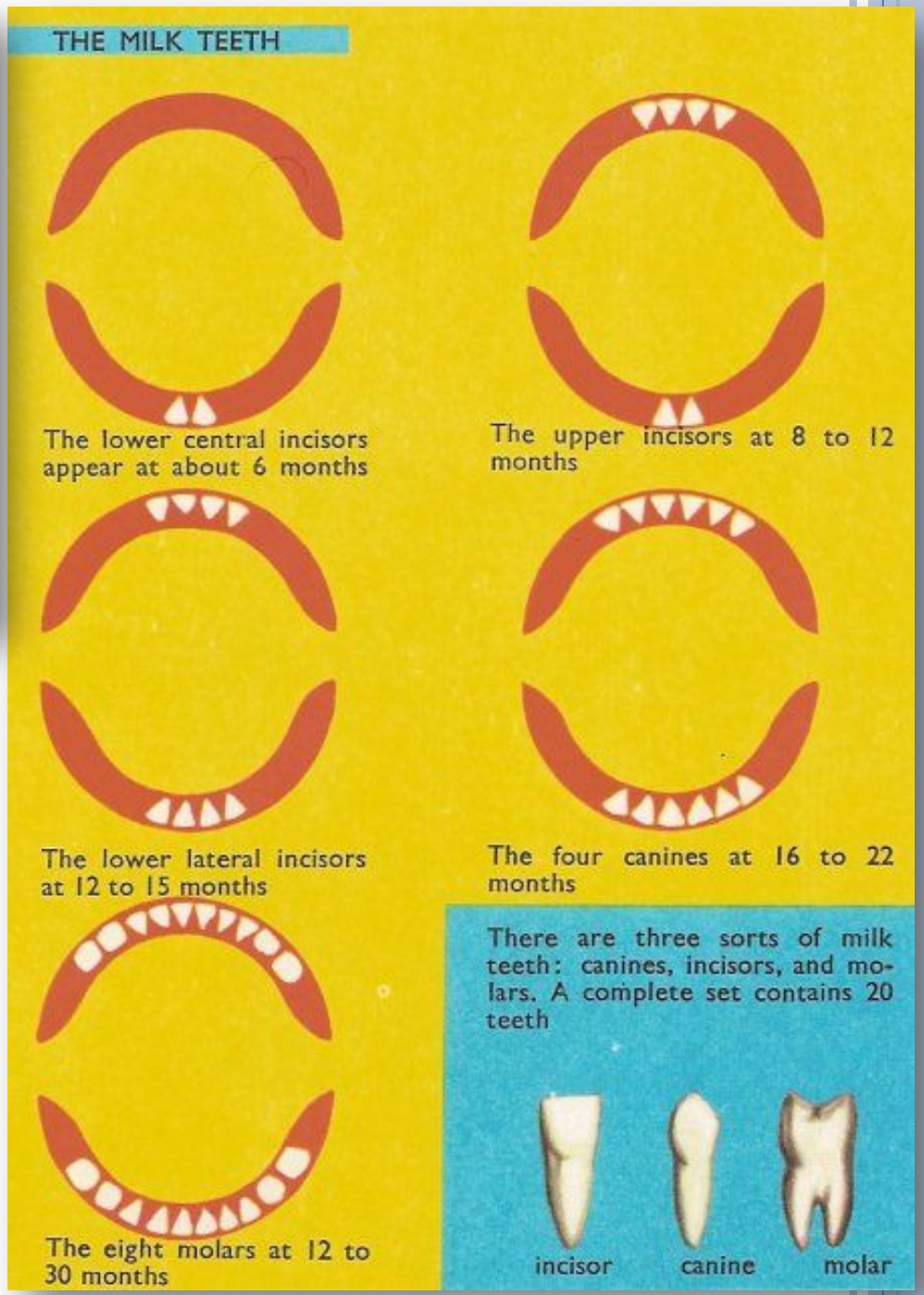
- **Teeth are designed for mechanical digestion of food.**
- **Each tooth is composed of a crown, neck and a root.**
- **The crown is covered with enamel. It is hardest material in our body.**
- **Enamel is formed from calcium,**


Crown
Root
Enamel
Dentin
Pulp
Cementum
Periodontal membrane
Nerve and blood supply

Teeth formation and types

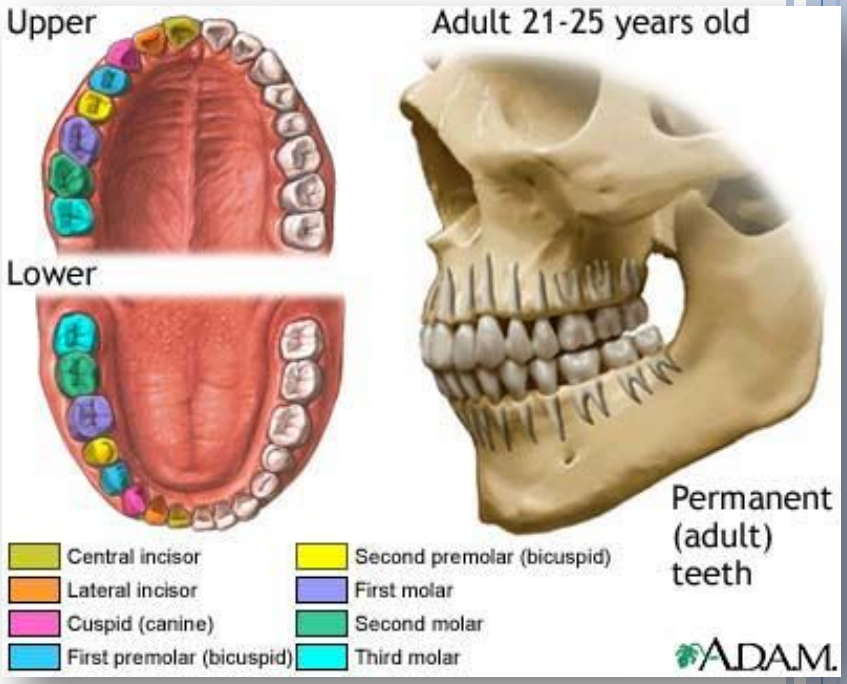
- First teeth appear from **4 to 6 months**, by the 3rd year their number is increased to 20
- These temporary teeth known as milk teeth
- At the **age of 7** milk teeth start to drop out and they are replaced with permanent teeth till the age of 20
- In normal adult human there are **32** permanent teeth

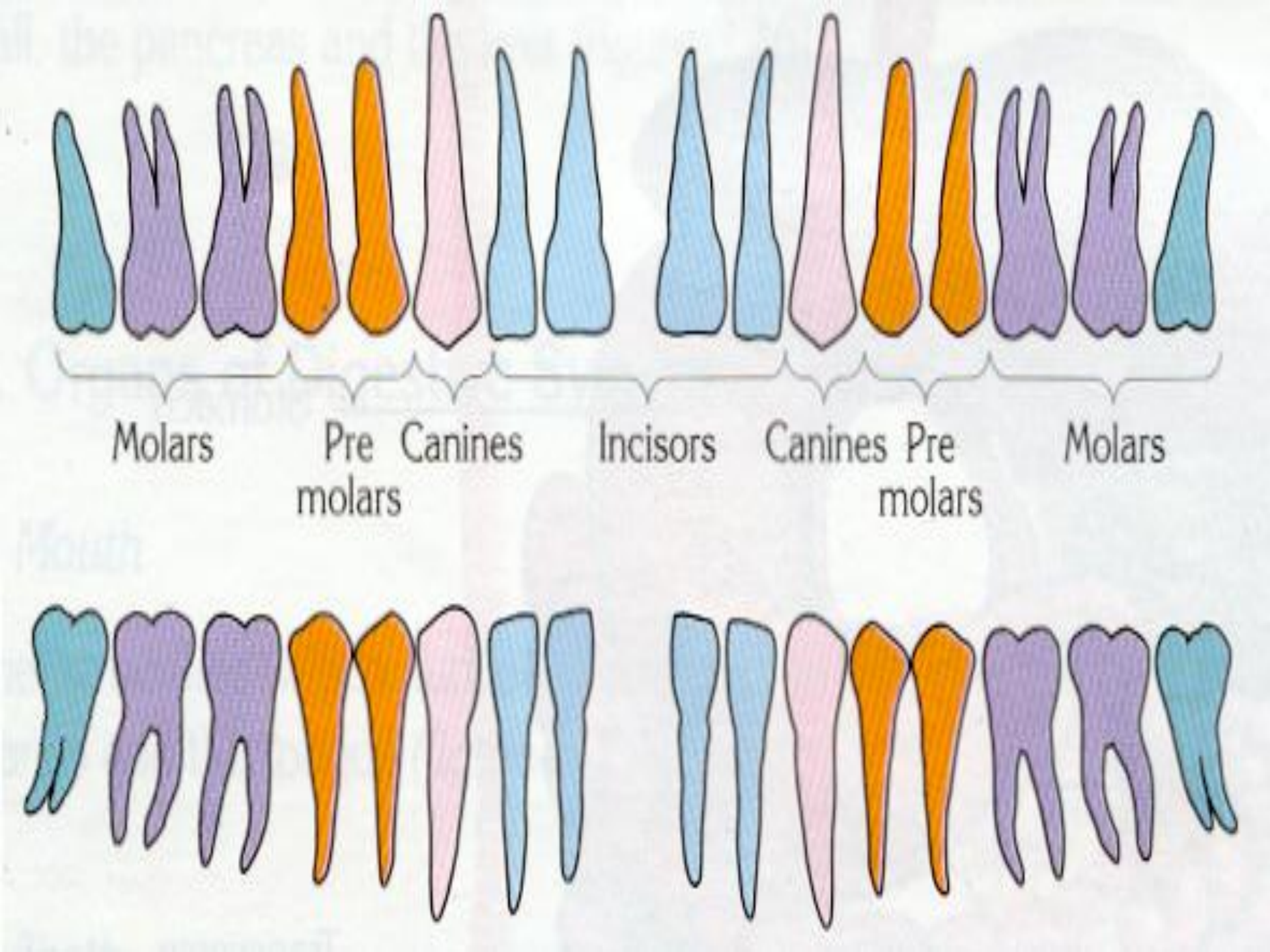

2
3
3
7
7
5
5
Top Teeth
10
10
9
9
BottomTeeth
6
6
8
8
4
4
1


THE MILK TEETH
The lower central incisors appear at about 6 months
The upper incisors at 8 to 12 months
The lower lateral incisors at 12 to 15 months
The four canines at 16 to 22 months
The eight molars at 12 to 30 months
There are three sorts of milk teeth: canines, incisors, and molars. A complete set contains 20 teeth
incisor
canine
molar

Types of teeth

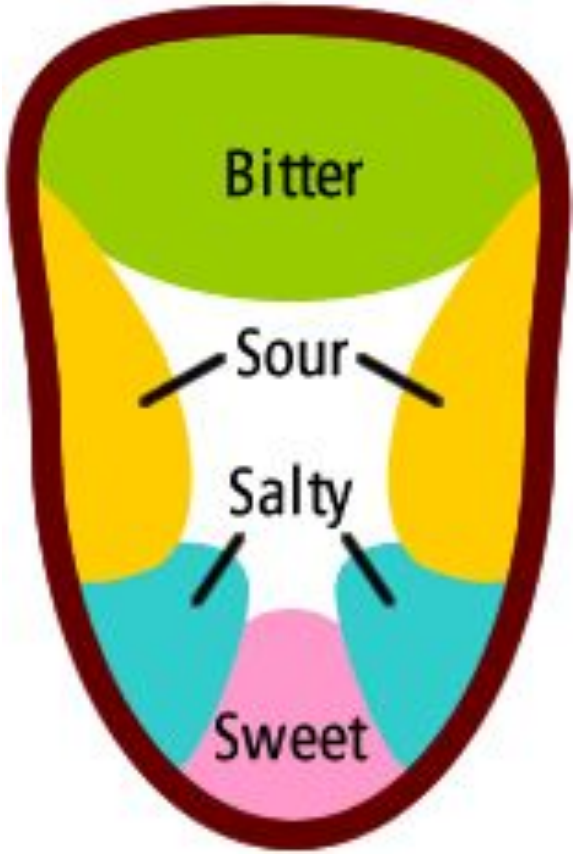
- There are 4 types of teeth
  - 1- Molars 12
  - 2- Pre molars 8
  - 3- Canines 4
  - 4- Incisors 8
- **TOTAL 32**




Molars
Pre molars
Canines
Incisors
Canines
Pre molars
Molars

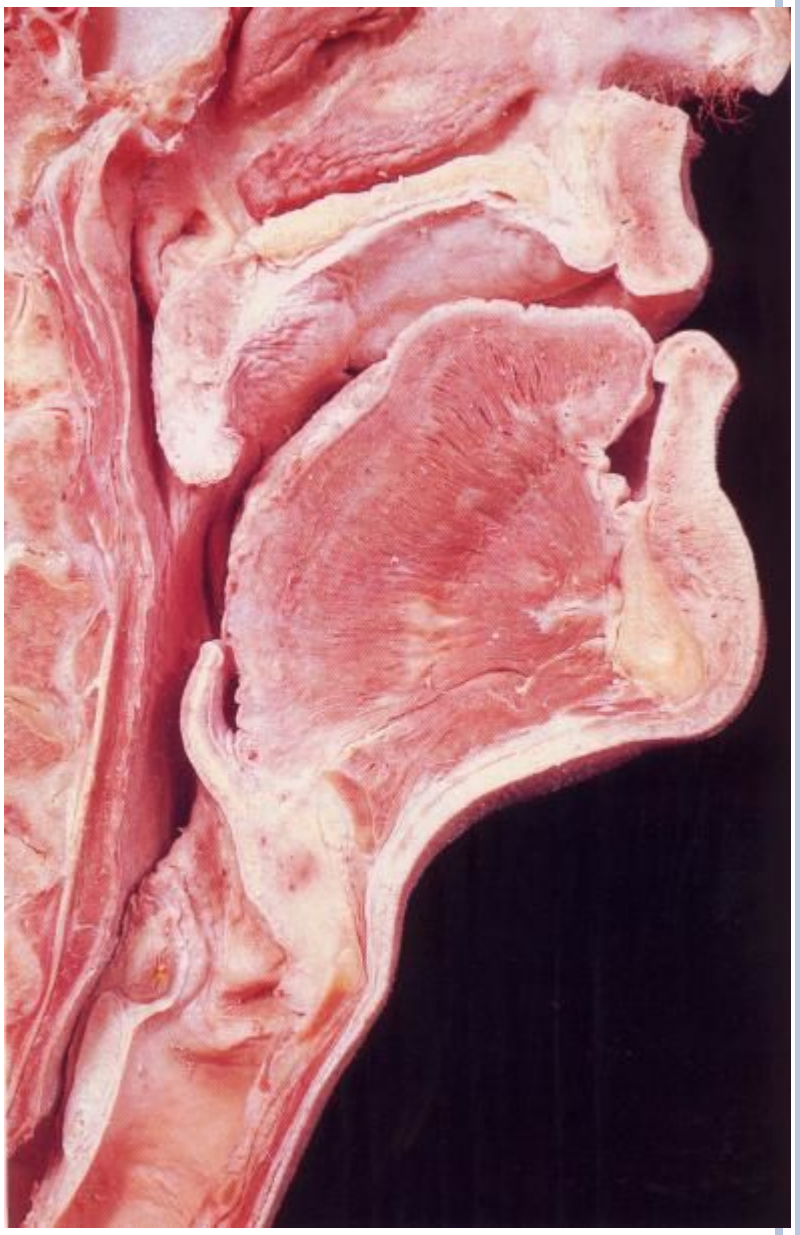
Tongue

- Tongue helps in **mixing food** with saliva
- A **bolus** formed and swallowed
- During chewing taste buds differentiate between **bitter**, **sweet**, **salty** and **sour** tastes



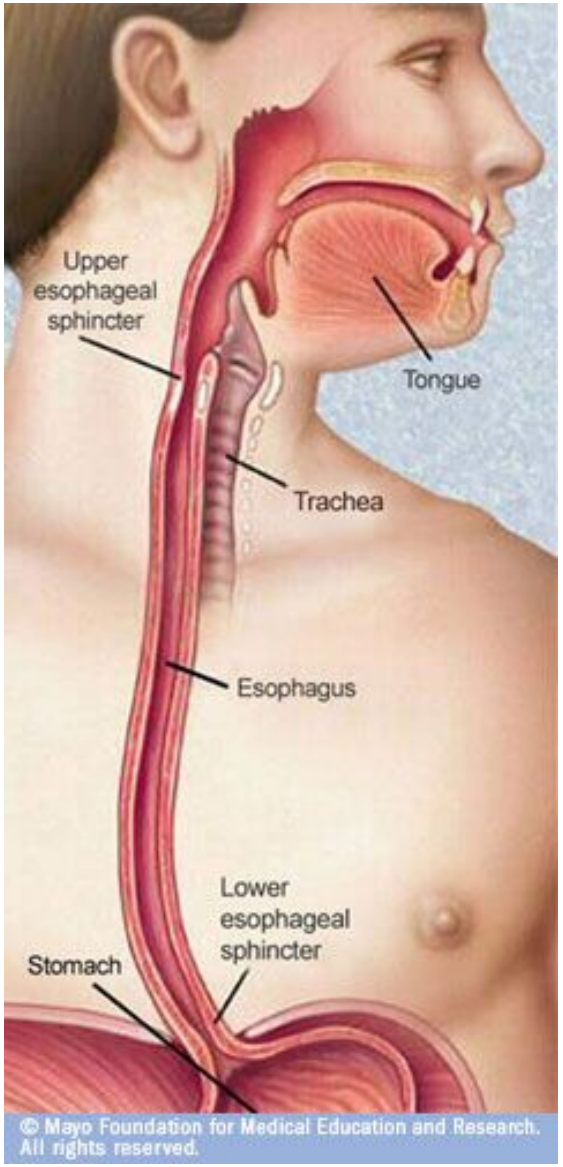
Pharynx

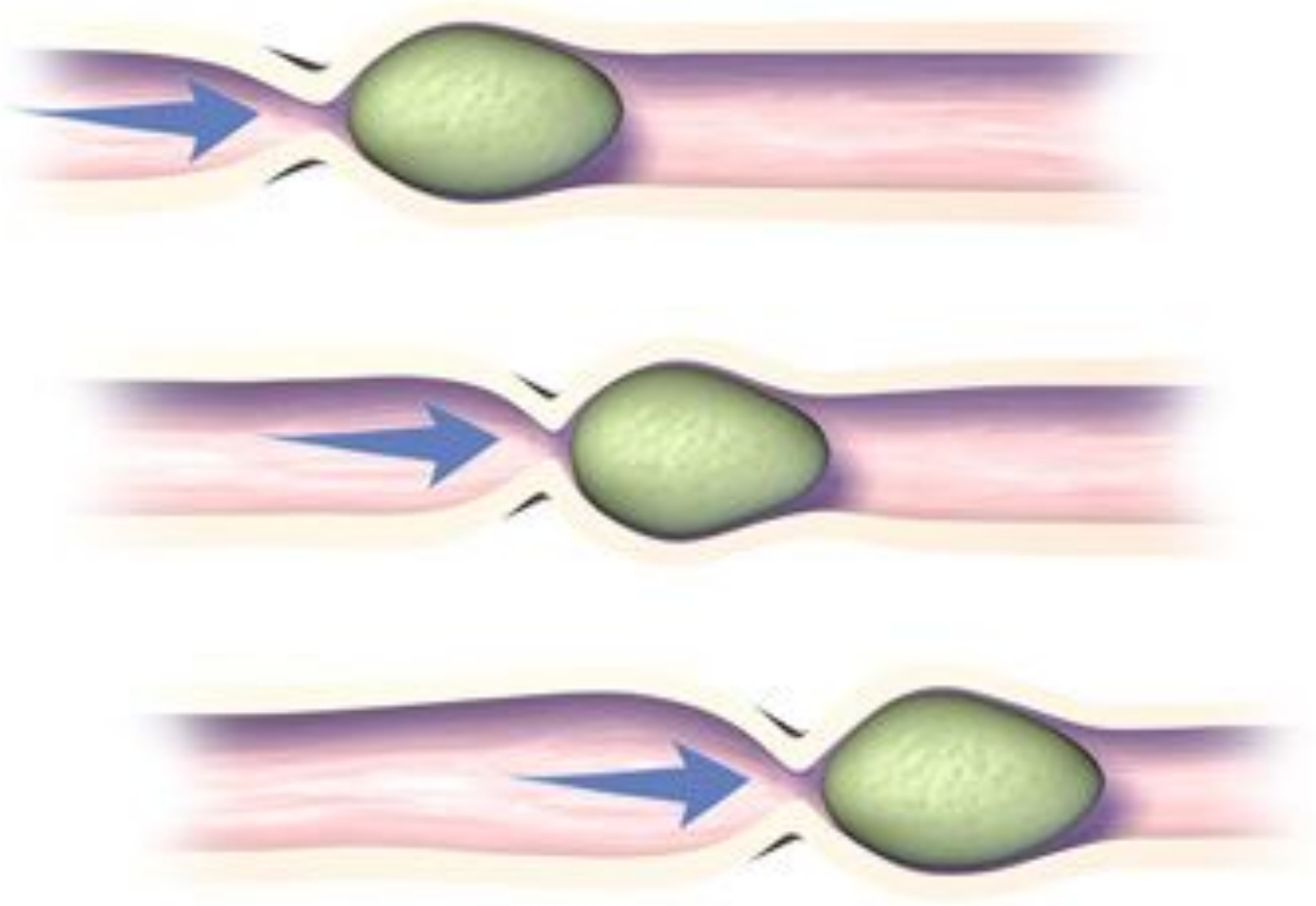
- Through pharynx both food and air pass
- There is epiglottis that prevents food from entering trachea



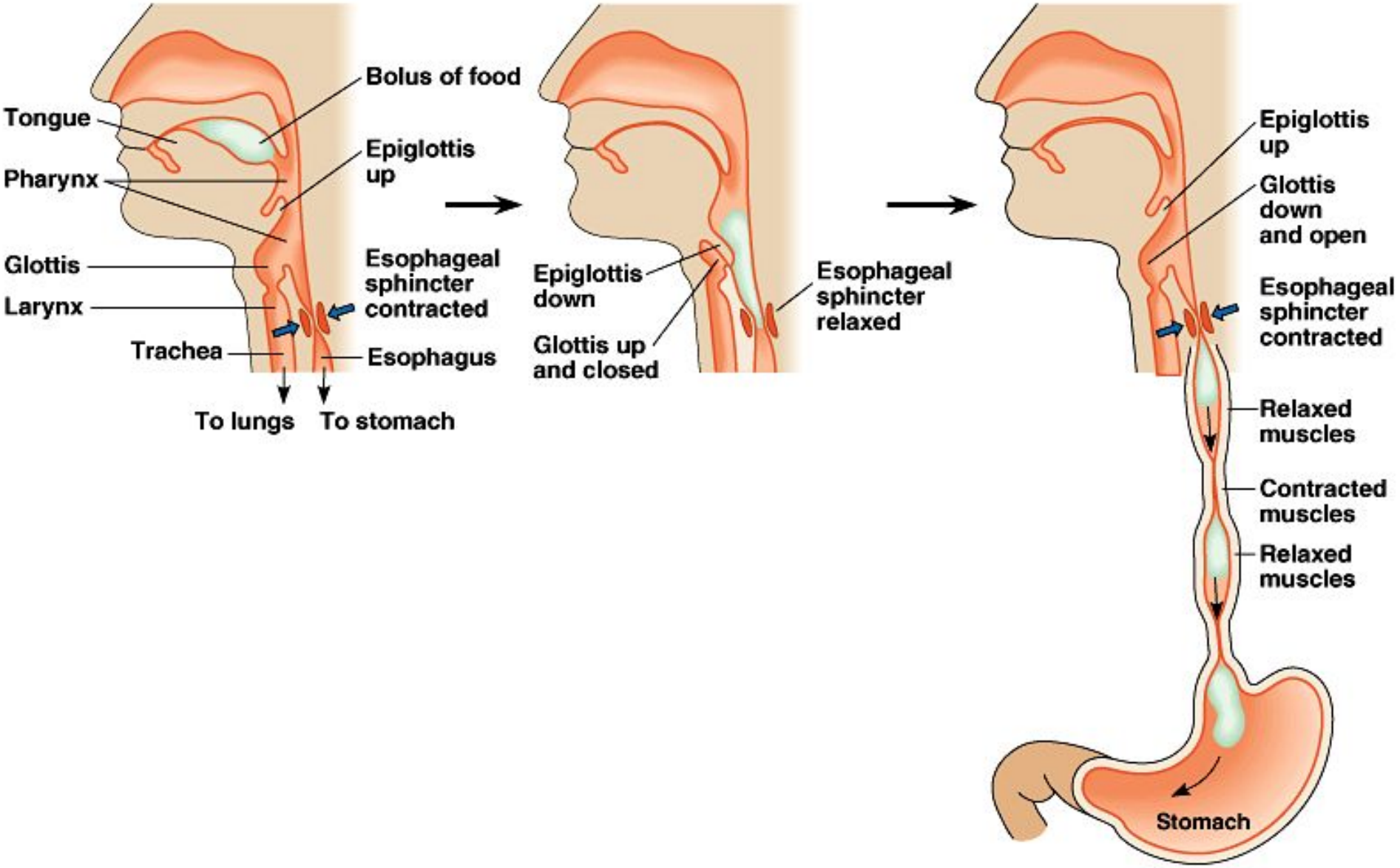
Esophagus

- The esophagus is a long tube that **connects** the **mouth** to the **stomach**.
- It is 25 cm in length and 2 cm in width
- Waves of smooth muscle contractions is called **peristalsis** that move the food toward the stomach.
- No digestion occurs in the esophagus.



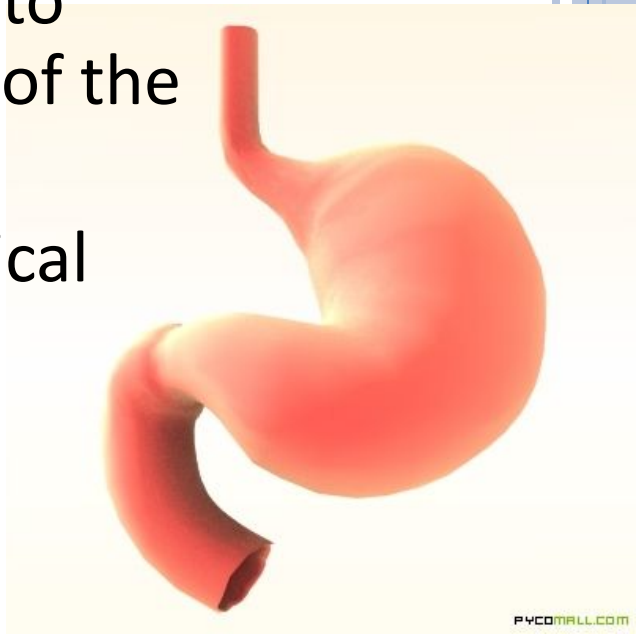


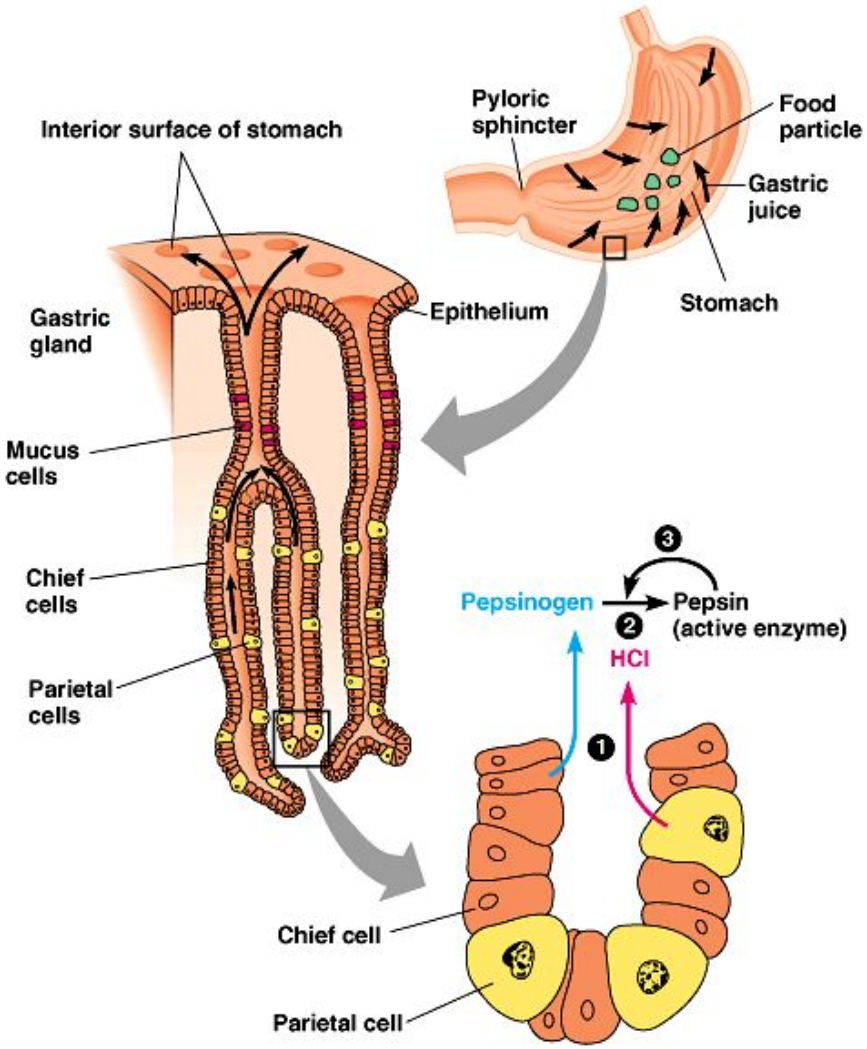
PERISTALSIS

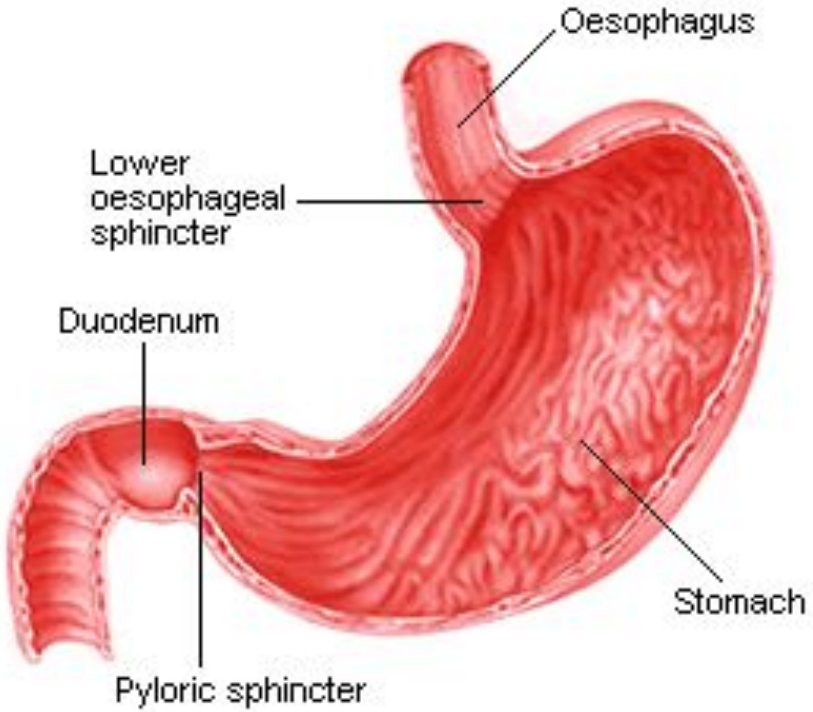


Stomach

- Food is stored temporary in the stomach.
- It is J shaped, 25 cm in length, 12 cm in width, 1250 cm^3 volume, **surface area 600 m^2**
- **Mechanical** and **chemical** digestion occur in the stomach.
- Food is broken down mechanically into smaller particles by the contractions of the muscles.
- Stomach secretes enzymes for chemical digestion of proteins.

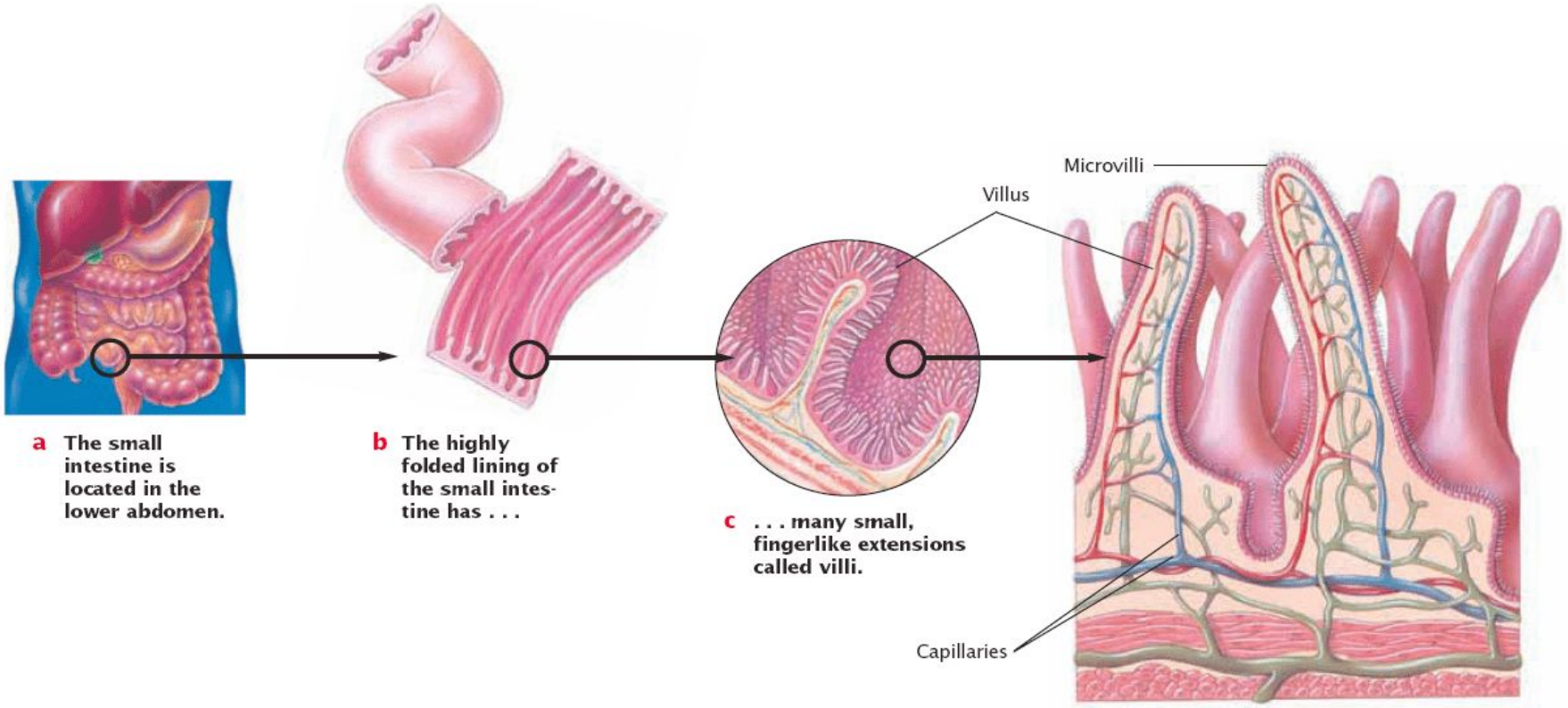



Interior surface of stomach
Pyloric sphincter
Food particle
Gastric juice
Stomach
Epithelium
Gastric gland
Mucus cells
Chief cells
Parietal cells
Pepsinogen
Pepsin (active enzyme)
HCl
Chief cell
Parietal cell


Oesophagus
Lower oesophageal sphincter
Duodenum
Stomach
Pyloric sphincter

SMALL INTESTINE

- Most **chemical digestion** and all **absorption** occur in small intestine.
- The lining of the small intestine is covered with fingerlike projections called **villi**, which increase the surface area (up to 600 square meter) available for absorption of nutrients.
- The small intestine has three parts. They are **duodenum**, **jejunum** and **ileum**.



a The small intestine is located in the lower abdomen.

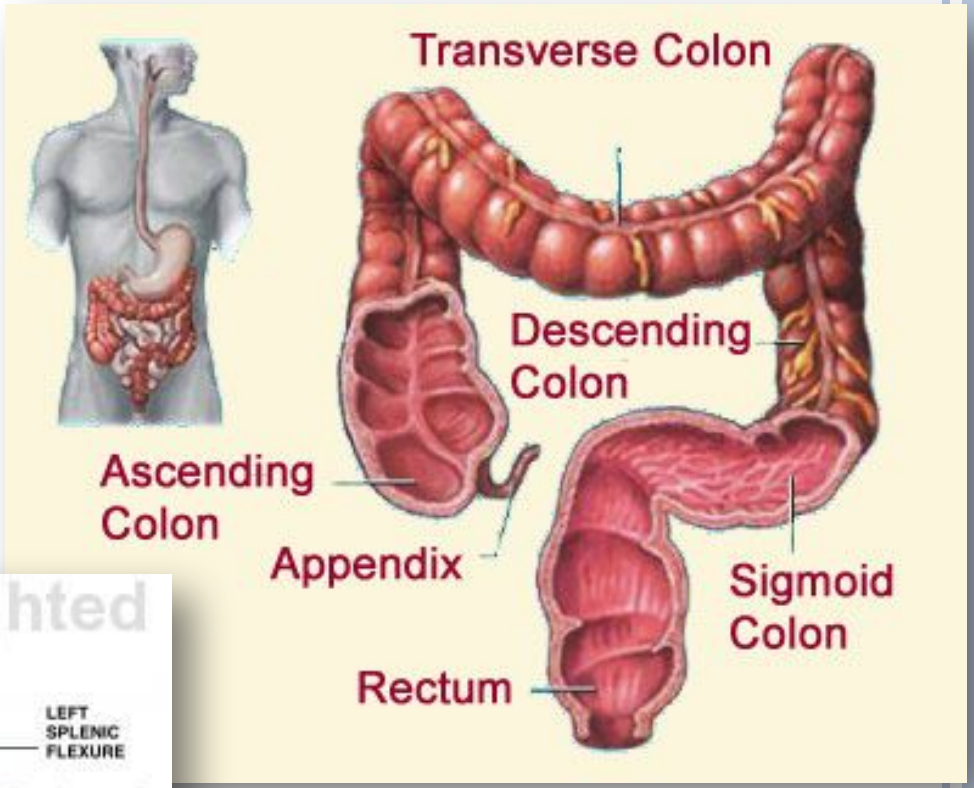
b The highly folded lining of the small intestine has . . .

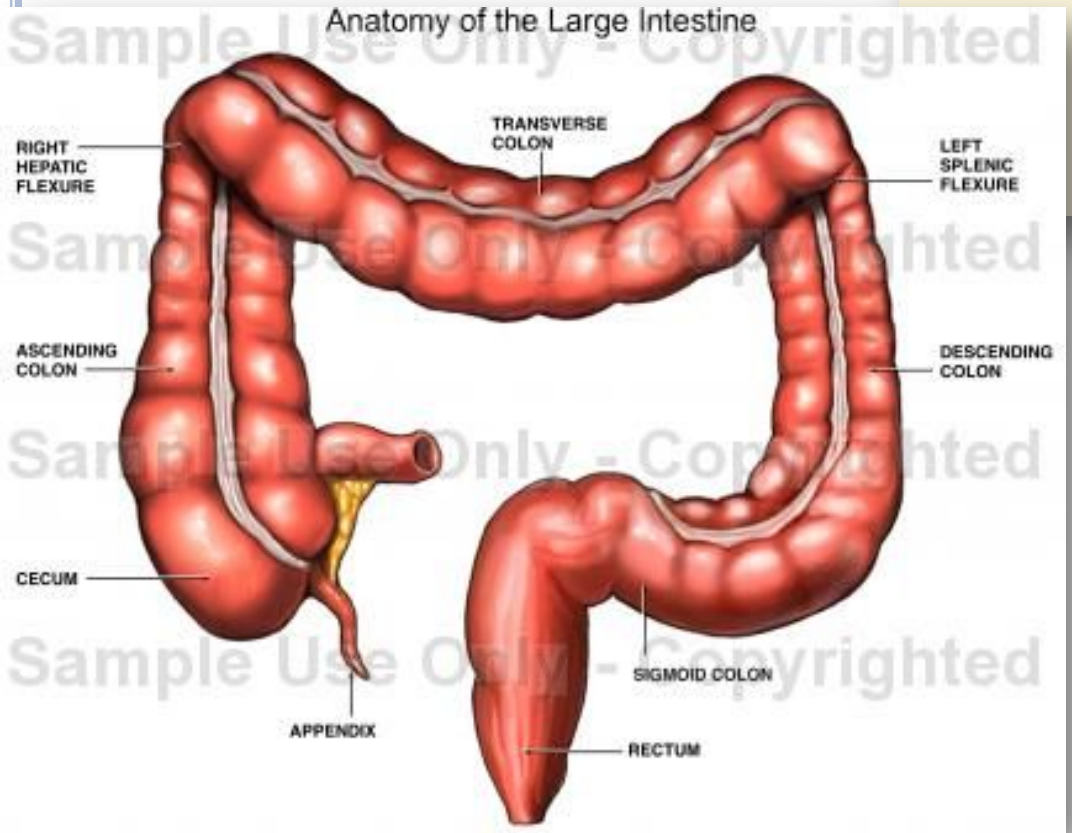
c . . . many small, fingerlike extensions called villi.

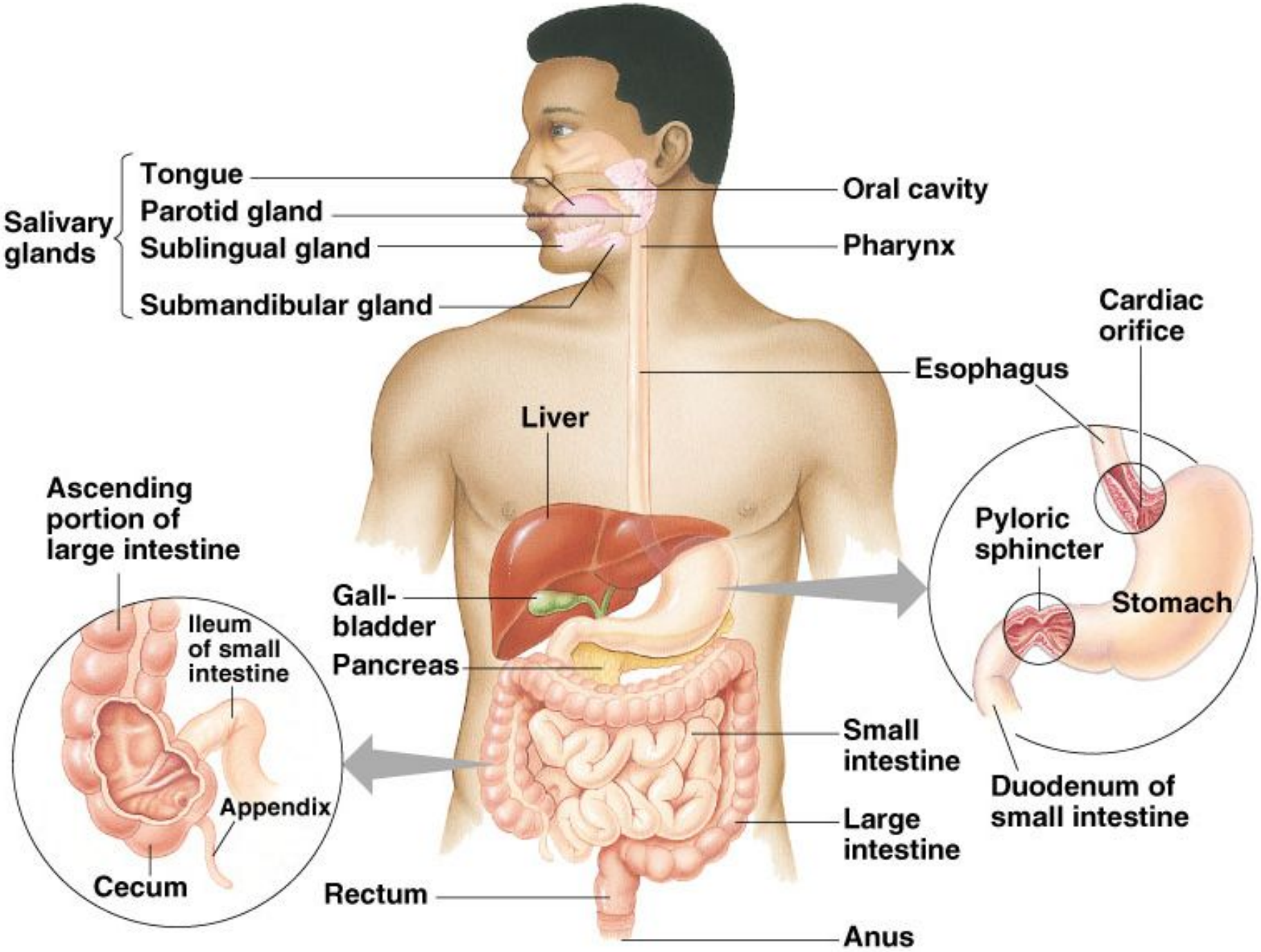
d Inside each villus are capillaries and tiny lymph vessels. It is here that nutrients enter the bloodstream.

Large intestine

- **Wastes** move into the large intestine (or colon) from small intestine. Between them there is a valve.
- Large intestine has 3 parts **caecum**, **colon** and **rectum**
- **No digestion** takes place in the **colon**. Mineral ions and water are absorbed through the walls of the large intestine.
- The large intestine contains many **bacteria**. They produce vitamins such as **vitamin K**.
- The large intestine has a fingerlike extension, the **appendix**, that makes a minor contribution to body defense.
- Large intestine is opened to the outside of the body through the anus.





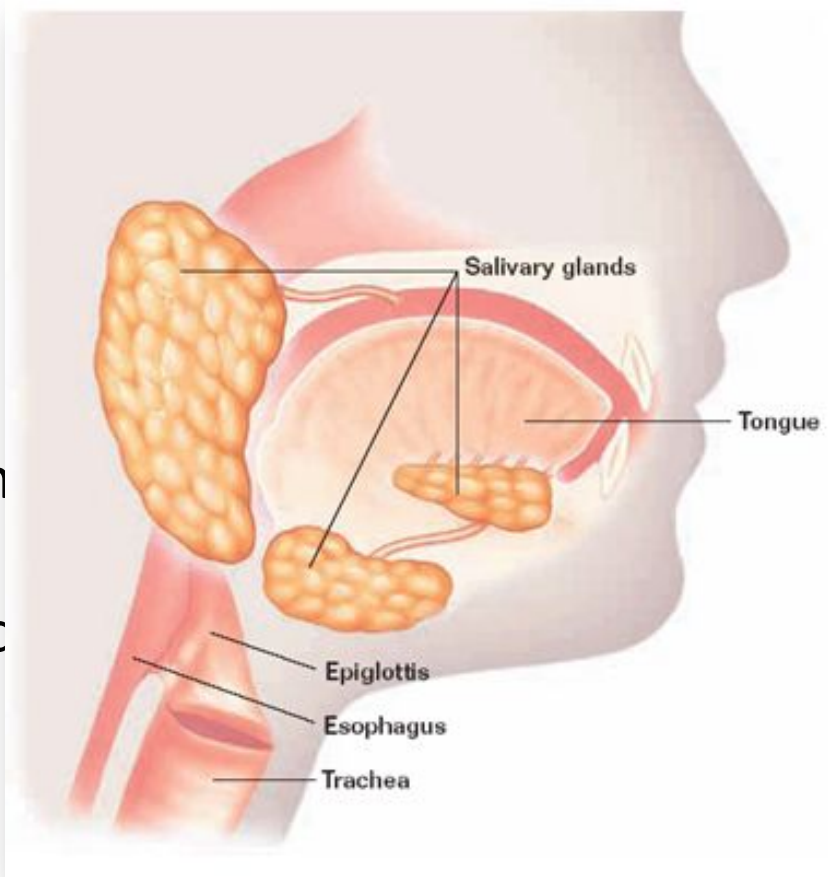


Digestive system glands

- Salivary glands
- Gastric glands in stomach
- Intestinal glands
- Liver
- Pancreas

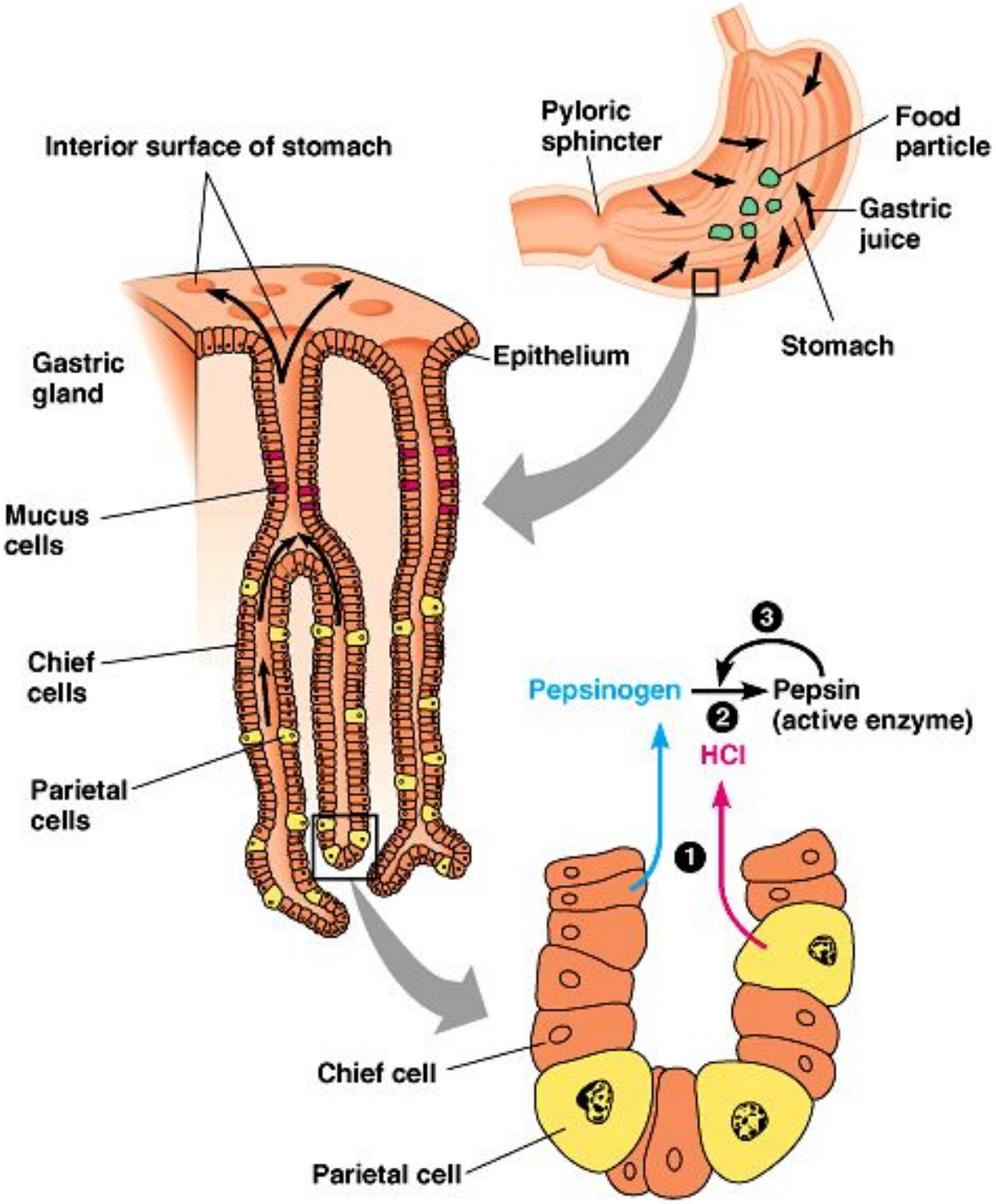
Salivary glands

- There are **three pairs of salivary glands** in the lining of the mouth.
- They are sublingual, submandibular and parotid glands
- Salivary glands secrete enzyme **AMYLASE** into the mouth. Amylase helps in chemical digestion of carbohydrates.
- Saliva contains a slippery glycoprotein called **mucin**, which protects the soft lining of the mouth from abrasion and lubricates the food for easier swallowing.



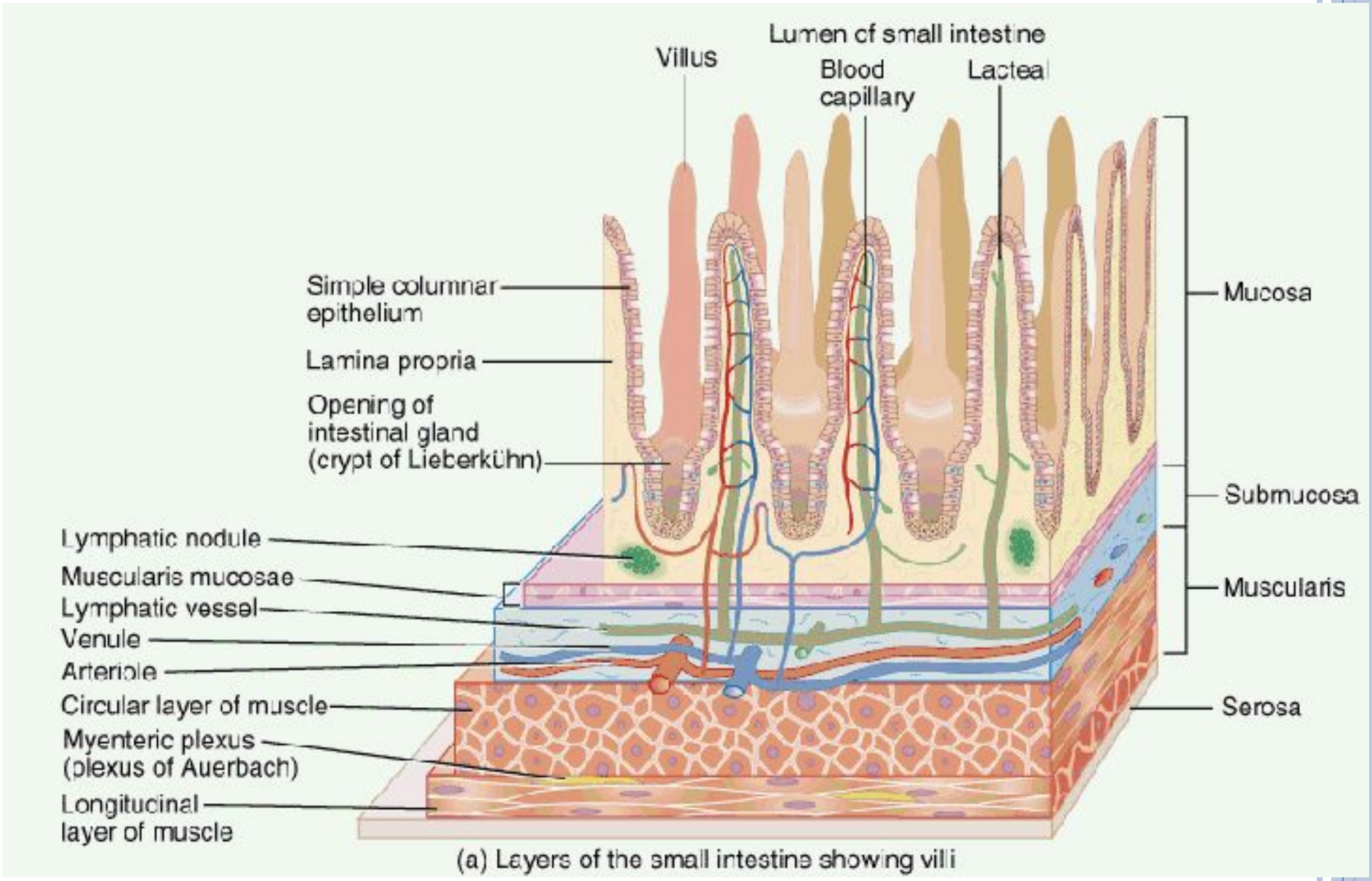
Gastric glands in stomach

- The Gastric glands that line the inside of the stomach release **gastric juice**.
- Gastric juice is a combination of **HCl acid and PEPSIN**.
- Pepsin is a digestive enzyme produced by the stomach.
- Pepsin breaks down **proteins**.

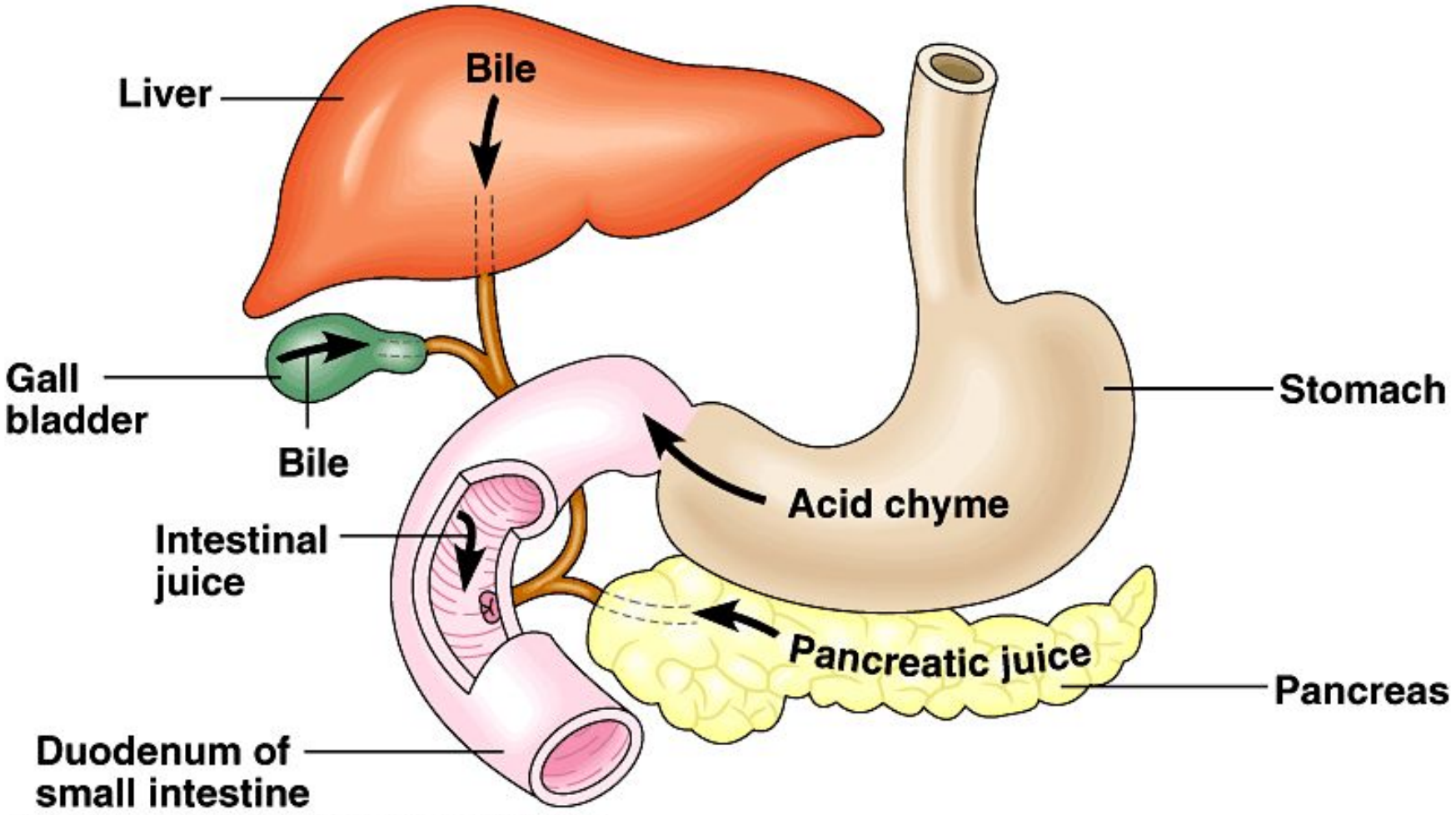

Interior surface of stomach
Pyloric sphincter
Food particle
Gastric juice
Stomach
Epithelium
Gastric gland
Mucus cells
Chief cells
Parietal cells
3
Pepsinogen
Pepsin (active enzyme)
2
HCl
1
Chief cell
Parietal cell

Intestinal glands

- Intestinal glands secrete several enzymes which help chemical digestion of **carbohydrates** (disaccharides), **nucleic acids** and **proteins**.

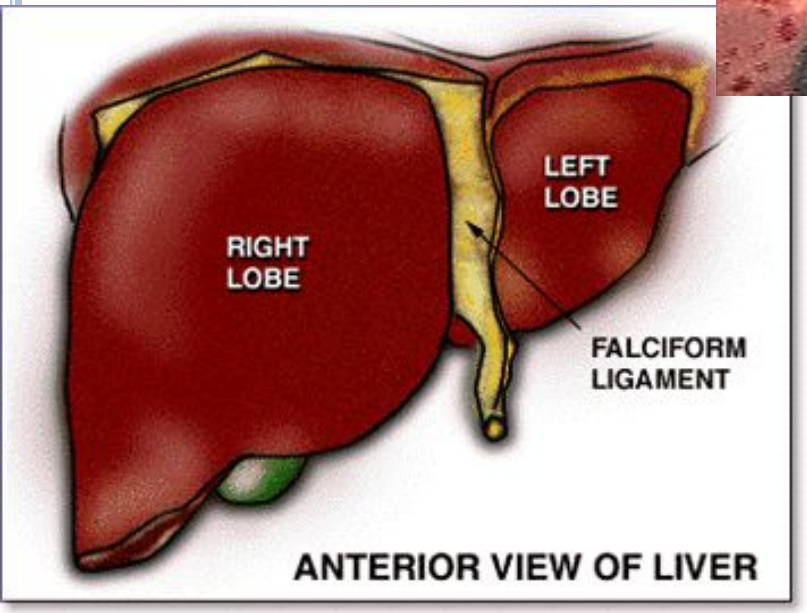


(a) Layers of the small intestine showing villi



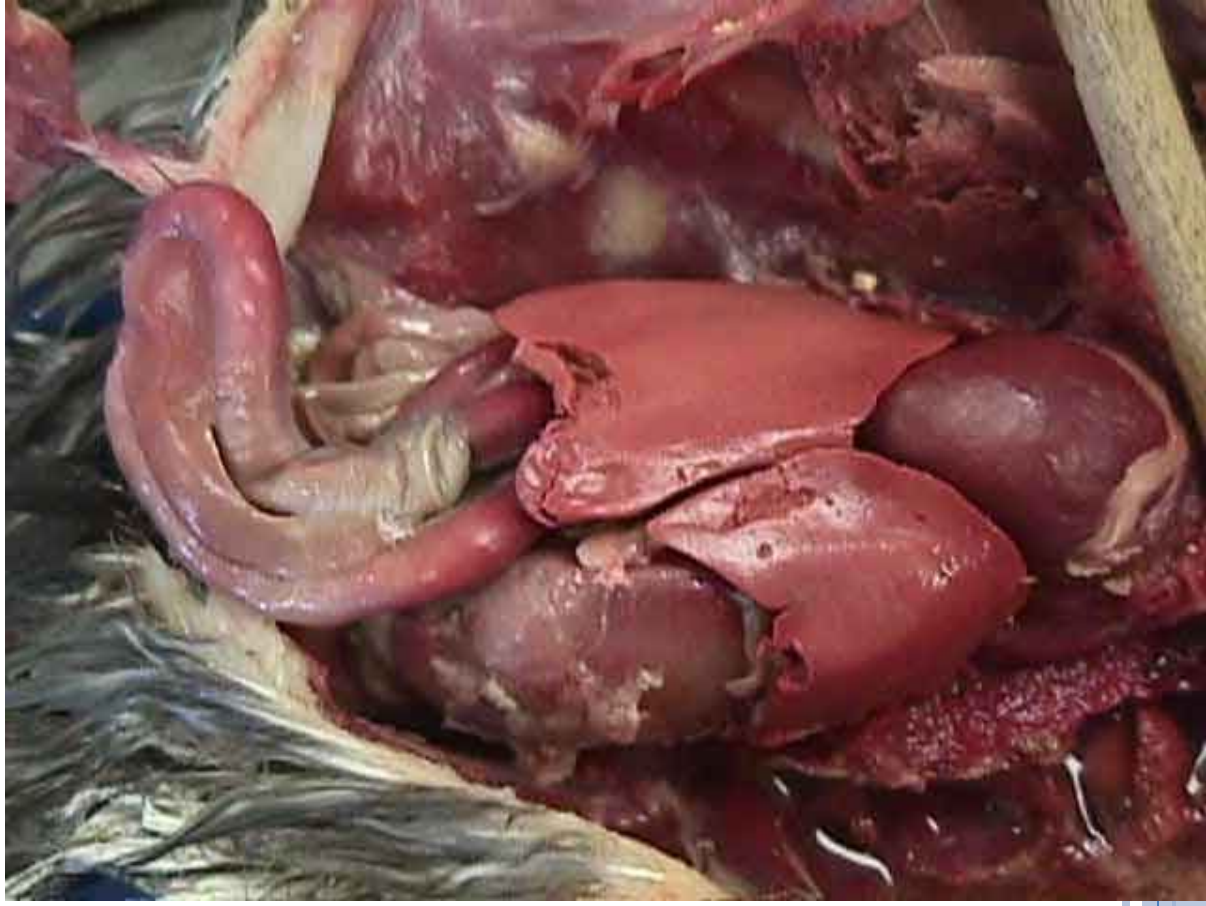
Liver

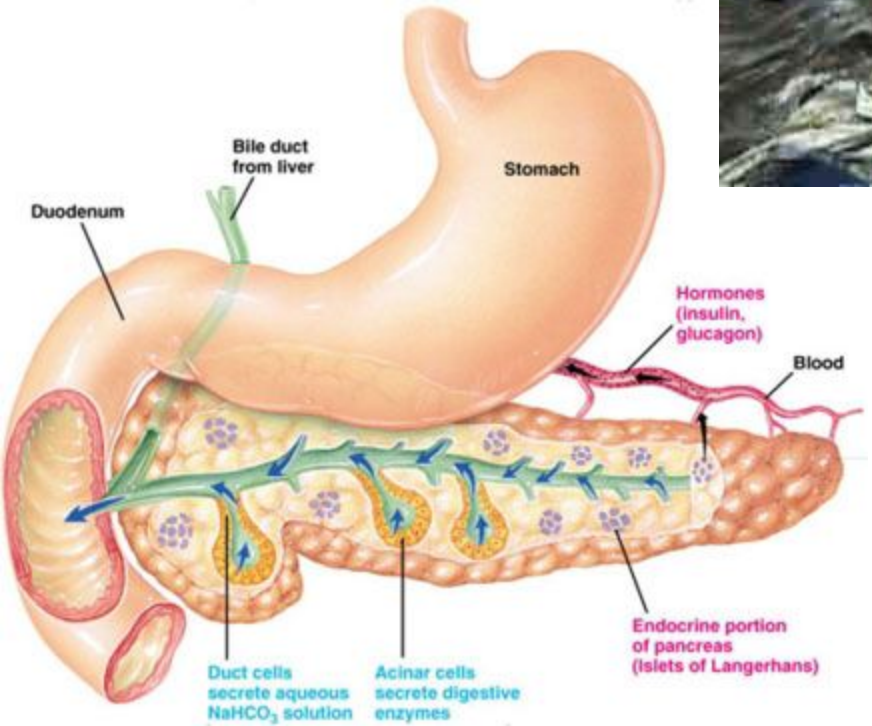
- Liver cells are known as **hepatocytes**
- ***Hepatic means related to liver***
- The liver secretes **bile**, which aids the breakdown of fats.
- Bile also promotes the **absorption** of fatty acids and the fat-soluble vitamins **A, D, E,** and **K**.
- Bile is stored in the **gall bladder** until needed.


LEFT
LOBE
RIGHT
LOBE
FALCIFORM
LIGAMENT
ANTERIOR VIEW OF LIVER

Pancreas

- The pancreas secretes **pancreatic juice** that includes many enzymes, which aids the breakdown of proteins, fats, carbohydrates and nucleic acid.
- Pancreas also secretes hormones **insulin** and **glucagon** to regulate blood glucose level.




Bile duct from liver
Stomach
Duodenum
Hormones (insulin, glucagon)
Blood
Endocrine portion of pancreas (Islets of Langerhans)
Duct cells secrete aqueous $NaHCO_3$ solution
Acinar cells secrete digestive enzymes

Digestion of polymers

- Polymers are chemically digested in different parts of digestive tract

Polymers:

- Carbohydrates
- Proteins
- Lipids or fats
- Nucleic acids

Digestion of carbohydrates

- **In mouth:** digestion begins in mouth by AMYLASE enzyme. Amylase breaks down starch into dextrin and maltose.
- Starch+water $\xrightarrow{\text{AMYLASE}}$ dextrin+maltose
- **In stomach:** no carbohydrate digestion, amylase doesn't function in acidic area
- **In intestine:**
- Pancreas release enzymes including amylase which act on polysaccharides.
- Intestinal glands secrete enzymes maltase, lactase and sucrase that act on disaccharides.

- **Intestinal reactions:**
- Dextrin+H_2O $\xrightarrow{\text{AMYLASE}}$ glucose+glucose...
- Maltose+H_2O $\xrightarrow{\text{MALTASE}}$ glucose+glucose
- Sucrose+H_2O $\xrightarrow{\text{SUCRASE}}$ glucose+fructose
- Lactose+H_2O $\xrightarrow{\text{LACTASE}}$ glucose+galactose

- **Maltase, sucrase and lactase are disaccharidases**
- **Digestion of carbohydrates are finished in intestine**

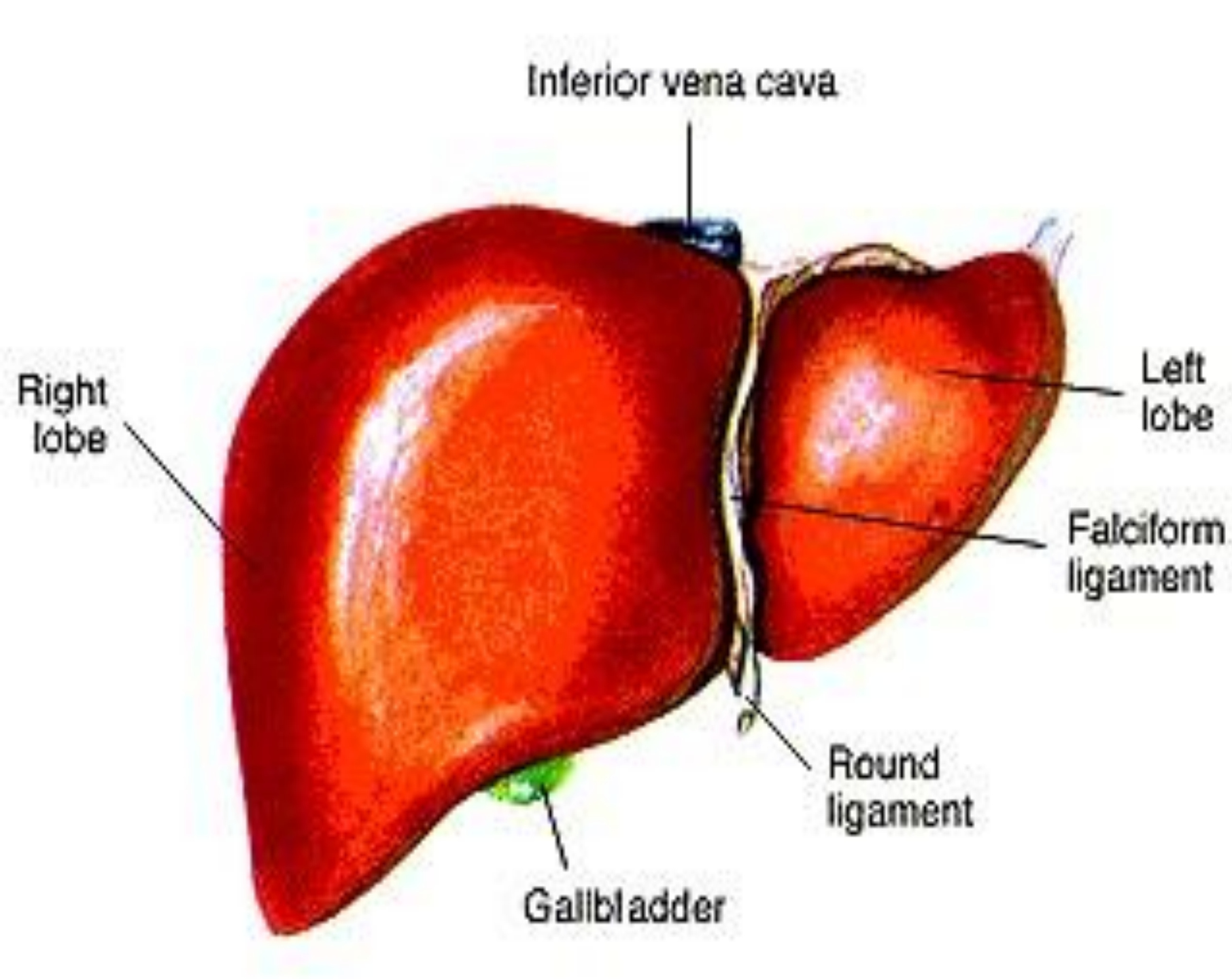
Digestion of proteins

- **In mouth:** no chemical digestion
- **In stomach: begins** in stomach by gastric juice and pepsinogen, **reactions in stomach:**
- Pepsinogen(inactive)+HCl=Pepsin(active)
- Protein+H_2O $\xrightarrow{\text{PEPSIN}}$> peptones

- **In intestine:** the final breakdown of proteins occur in intestine. **Pancreas** produces **trypsinogen** and **chymotrypsin** and **intestinal glands** produce **enterokinase** and **erepsin** for protein digestion.
- **Reactions in Intestine:**
- Trypsinogen+enterokinase=trypsin
- Peptones+H_2O $\xrightarrow{\text{TRYPSIN}}$ peptides+amino acids
- Peptides+H_2O $\xrightarrow{\text{EREPSIN}}$ amino acids+amino acids…

Digestion of lipids

- **In mouth:** no chemical digestion
- **In stomach:** no chemical digestion
- **In intestine: begins in intestine**
- The cells of the liver produce **bile**. Then it is stored in **gall bladder**.
- Bile **does not contain enzyme** but it aids mechanical digestion of lipids. This process is called **emulsification**


Inferior vena cava
Right lobe
Left lobe
Falciform ligament
Round ligament
Gallbladder

Reaction in small intestine:

- Lipid $\xrightarrow{\text{BILE}}$ emulsified lipid, small particles

- After emulsifying **LIPASE** is secreted from pancreas and it breaks down lipid molecules into fatty acids and glycerol.
- Lipid+H_2O $\xrightarrow{\text{LIPASE}}$ 3fatty acids+glycerol

Thank You For Your Deep Attention