

# **Digestion and absorption**

**B.Sc Second year Zoology (Honours ) Paper - 4**

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## Digestion

- The organs of digestive system are located within a tube called the gastrointestinal (GI) tract.

**Food:** It consists of organic macromolecules

1. Carbohydrates
2. Fats
3. Proteins

- These molecules are too big to cross plasma membranes.
- The purpose of digestion is to hydrolyze or break down by using specific enzyme these macromolecules to their subunit molecules.

Carbohydrates	<u>specific enzyme</u> →	Monosaccharide
Fats	<u>specific enzyme</u> →	Fatty acids & Glycerol
Proteins	<u>specific enzyme</u> →	Amino acids

- The digested units can cross plasma membranes.
- Our food also contains water, salts, vitamins and minerals.
- It help the body to function normally. The nutrients made available by digestive processes. They are carried by the blood to our cells.

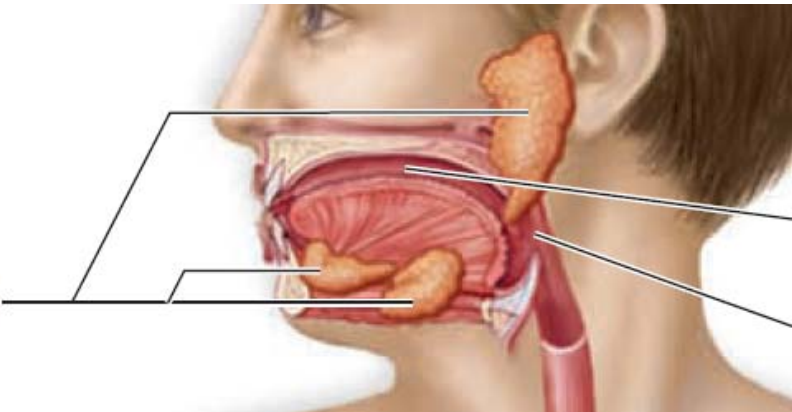
- Three pairs of salivary glands send secretions by way of ducts to the mouth.
- One pair of salivary glands lies at the side of the face immediately below and in front of the ears.
- The ducts of these salivary glands open on the inner surface of the cheek just above the second upper molar.
- This pair of glands swells when a person has the mumps, a viral disease.
- Another pair of salivary glands lies beneath the tongue, and still another pair lies beneath the floor of the oral cavity.
- The ducts from these salivary glands open under the tongue.
- Saliva is a solution of mucus and water.

- Saliva also contains salivary amylase, an enzyme that begins the chemical digestion of starch (carbohydrate), as well as bicarbonate and the antimicrobial compound called lysozyme.

### Accessory organs

#### Salivary glands

secrete saliva: contains digestive enzyme for carbohydrates



- Mechanical digestion occurs when our teeth chew food into pieces convenient for swallowing.
- During the first two years of life, the 20 smaller deciduous, or baby, teeth appear.
- These are eventually replaced by 32 adult teeth.
- The “wisdom teeth,” the third pair of molars, sometimes fail to erupt.

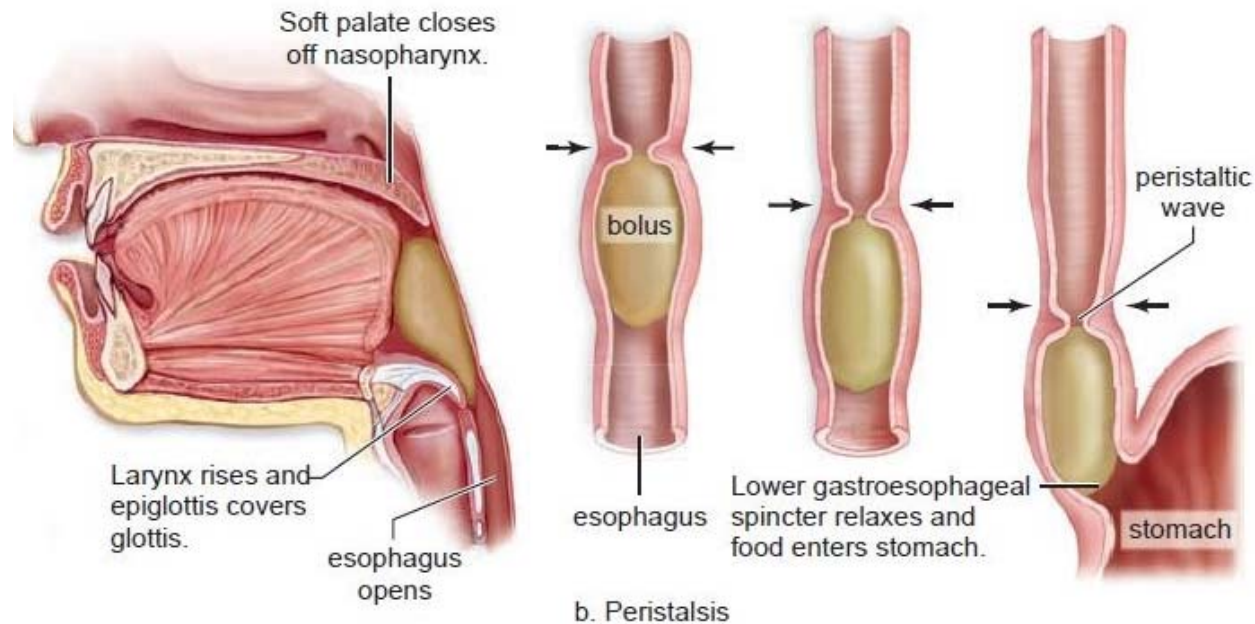
## *The Pharynx and Esophagus*

- Both the mouth and the nasal passages lead to the pharynx, a hollow space at the back of the throat.
- In turn, the pharynx opens into both the food passage (esophagus) and air passage (trachea, or windpipe).
- These two tubes are parallel to each other, with the trachea anterior to (in front of) the esophagus.

### *Swallowing*

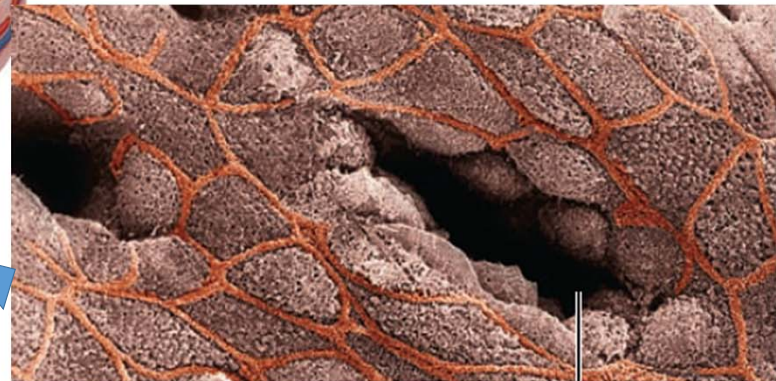
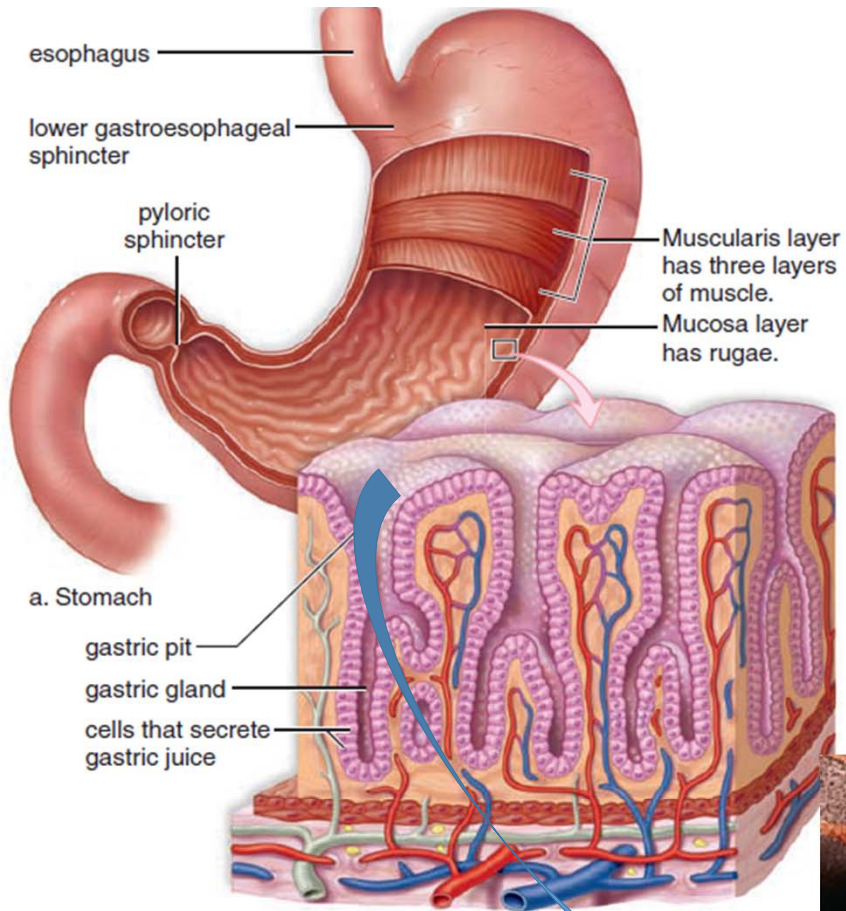
- Swallowing has a voluntary phase; however, once food or drink is pushed back far enough into the pharynx, swallowing becomes a reflex action performed automatically or involuntarily.

- A constriction called the lower gastroesophageal sphincter marks the entrance of the esophagus to the stomach.
- The tubes close when the sphincters contract and they open when the sphincters relax.
- When food or saliva is swallowed, the sphincter relaxes for a moment to allow the food or saliva to enter the stomach.
- The sphincter then contracts, preventing the acidic stomach contents from backing up into the esophagus.



## ***The Stomach and Small Intestine***

- The stomach and small intestine complete the digestion of food, which began in the mouth.
- The stomach is a thick-walled, J-shaped organ that lies on the left side of the body beneath the diaphragm.
- The stomach is continuous with the esophagus above and the duodenum of the small intestine below.
- The stomach stores food, initiates the digestion of protein, and controls the movement of food into the small intestine.
- Nutrients are not absorbed by the stomach. However, it does absorb alcohol, because alcohol is fat soluble and can pass through membranes easily.
- The stomach wall has the usual four layers, but two of them are modified for particular functions.
- The muscularis contains three layers of smooth muscle.
- *In addition* to the circular and longitudinal layers, the stomach also contains a layer of smooth muscle that runs obliquely to the other two.



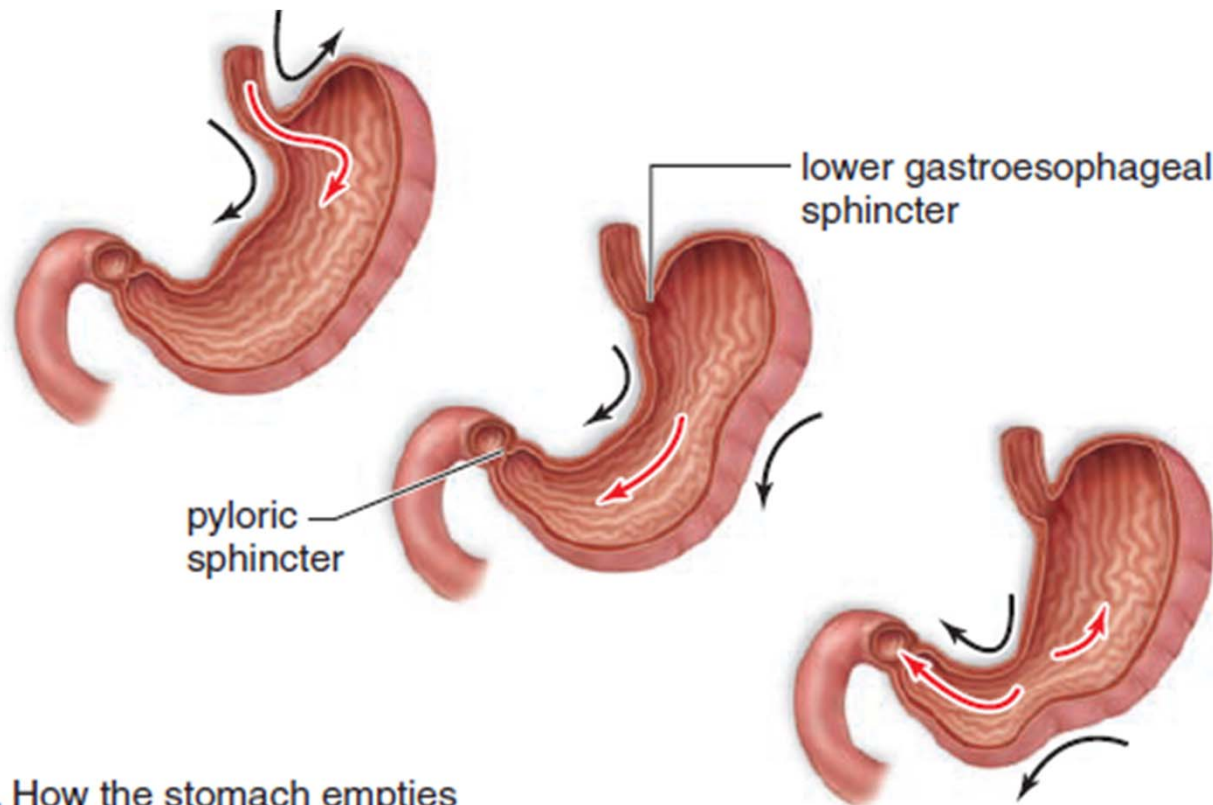
c. Gastric pits in mucosa

gastric pit



- The oblique layer allows the stomach to stretch and to mechanically break down food into smaller fragments that are mixed with gastric juice. The mucosa of the stomach has deep folds called rugae. These disappear as the stomach fills to an approximate capacity of 1 liter.
- The mucosa of the stomach has millions of gastric pits, which lead into gastric glands.
- The gastric glands produce gastric juice. Gastric juice contains an enzyme called pepsin, which digests protein, plus hydrochloric acid (HCl) and mucus.
- HCl causes the stomach to be very acidic with a pH of about 2.
- This acidity is beneficial because it kills most bacteria present in food. Although HCl does not digest food, it does break down the connective tissue of meat and activates pepsin.
- Normally, the stomach empties in about 2 to 6 hours.
- When food leaves the stomach, it is a thick, soupy liquid of partially digested food called chyme.

- Chyme's entry into the small intestine is regulated into small amounts entering at intervals.
- Peristaltic waves move the chyme toward the pyloric sphincter, which closes and squeezes most of the chyme back, allowing only a small amount to enter the small intestine at one time.



## *The Small Intestine*

- The small intestine is named for its small diameter compared with that of the large intestine.
- The small intestine is very long, averaging about 6 m (18 ft) in length, compared with the large intestine, which is about 1.5 m (4½ ft) in length.
- The small intestine contains enzymes to digest all types of foods, primarily carbohydrates, proteins, and fats.

### *Digestion gets Completed in the Small Intestine*

- Most of these enzymes are secreted by the pancreas and liver release bile and enter via separate ducts at the **duodenum**.
- Bile emulsifies fat. Emulsification causes fat droplets to disperse in water.
- After fat is mechanically broken down to fat droplets by bile, it is hydrolyzed to monoglycerides and fatty acids by the enzyme lipase present in pancreatic juice.

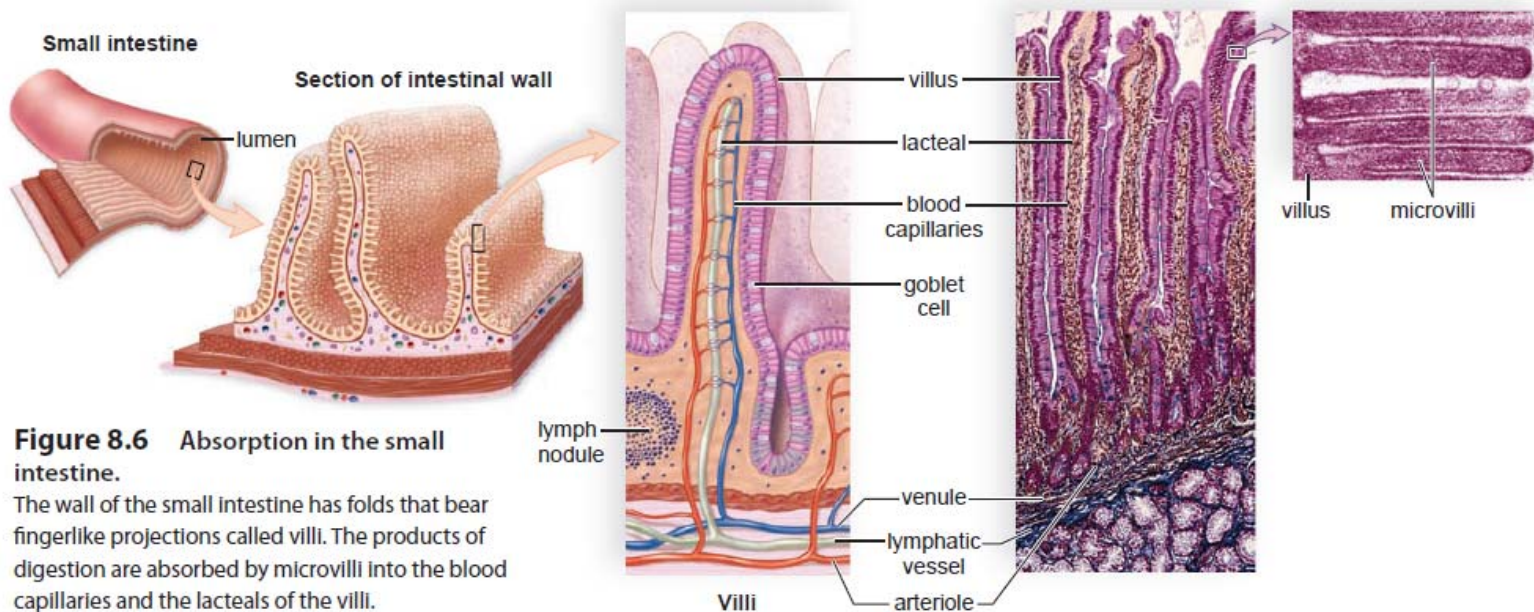
- Pancreatic amylase begins the digestion of carbohydrates. An intestinal enzyme (maltase) completes the digestion of carbohydrates to glucose.
- Similarly, pancreatic trypsin begins and intestinal enzymes (trypsin and peptidases) finish the digestion of proteins to amino acids.
- The intestine has a slightly basic pH because pancreatic juice contains sodium bicarbonate (NaHCO<sub>3</sub>), which neutralizes chyme.

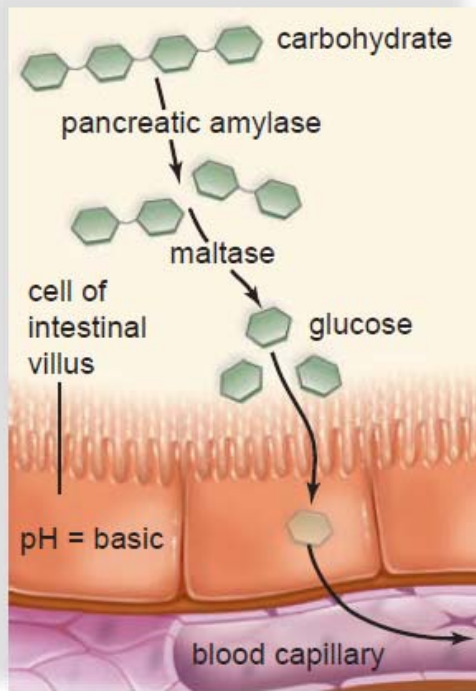
Table 8.1		Major Digestive Enzymes		
Enzyme	Produced By	Site of Action	Optimum pH	Digestion
<b>Carbohydrate Digestion</b>				
Salivary amylase	Salivary glands	Mouth	Neutral	Starch + H <sub>2</sub> O → maltose
Pancreatic amylase	Pancreas	Small intestine	Basic	Starch + H <sub>2</sub> O → maltose
Maltase	Small intestine	Small intestine	Basic	Maltose + H <sub>2</sub> O → glucose + glucose
Lactase	Small intestine	Small intestine	Basic	Lactose + H <sub>2</sub> O → glucose + galactose
<b>Protein Digestion</b>				
Pepsin	Gastric glands	Stomach	Acidic	Protein + H <sub>2</sub> O → peptides
Trypsin	Pancreas	Small intestine	Basic	Protein + H <sub>2</sub> O → peptides
Peptidases	Small intestine	Small intestine	Basic	Peptide + H <sub>2</sub> O → amino acids
<b>Nucleic Acid Digestion</b>				
Nuclease	Pancreas	Small intestine	Basic	RNA and DNA + H <sub>2</sub> O → nucleotides
Nucleosidases	Small intestine	Small intestine	Basic	Nucleotide + H <sub>2</sub> O → base + sugar + phosphate
<b>Fat Digestion</b>				
Lipase	Pancreas	Small intestine	Basic	Fat droplet + H <sub>2</sub> O → monoglycerides + fatty acids

## ***Nutrients Are Absorbed in the Small Intestine***

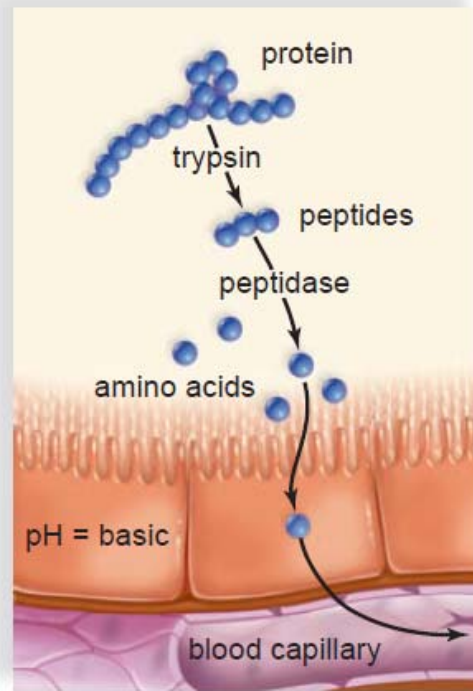
- The wall of the small intestine absorbs glucose, amino acids, fatty acids, and glycerol which are the products of the digestive process.
- The **mucosa of the small intestine is modified for absorption** and has great surface area approximately that of a tennis court which help to absorb more nutrients than a smaller area .
- The mucosa of the small intestine contains fingerlike projections called villi, which give the intestinal wall a soft, velvety appearance. A villus has an outer layer of columnar epithelial cells, and each of these cells has thousands of microscopic extensions called microvilli that is known as “brush border” which contain some enzymes which are known as brush border enzymes .
- \*Nutrients are absorbed into the vessels of a villus . A villus contains blood capillaries and a small lymphatic capillary called a lacteal.

- Sugars and amino acids enter the blood capillaries of a villus.
- Single molecules of glycerol, called monoglycerides, and fatty acids enter the epithelial cells of the villi.
- Lipoprotein droplets, called chylomicrons, are formed when monoglycerides and fatty acids are rejoined in the villi epithelia cells. Chylomicrons then enter a lacteal.
- After nutrients are absorbed, they are eventually carried to all the cells of the body by the bloodstream.

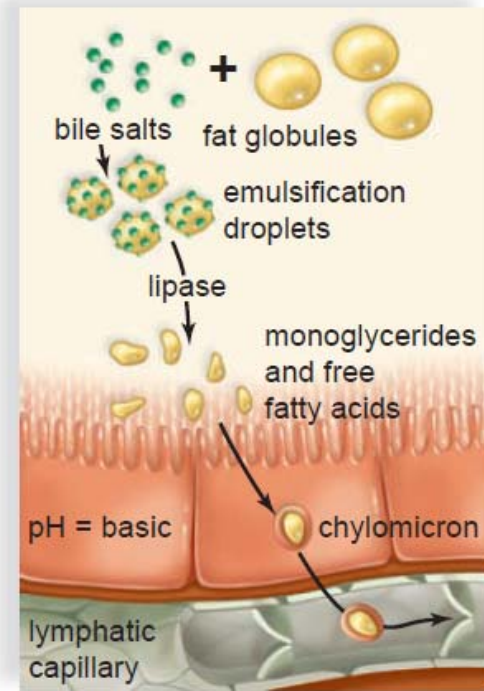




a. Carbohydrate digestion



b. Protein digestion



c. Fat digestion