CBCS GENERAL THIRD SEM

UNIT 2: DIGESTION: PHYSIOLOGY OF DIGESTION IN ELEMENTARY CANAL. ABSORPTION OF CARBOHYDRATES, PROTEIN AND LIPIDS

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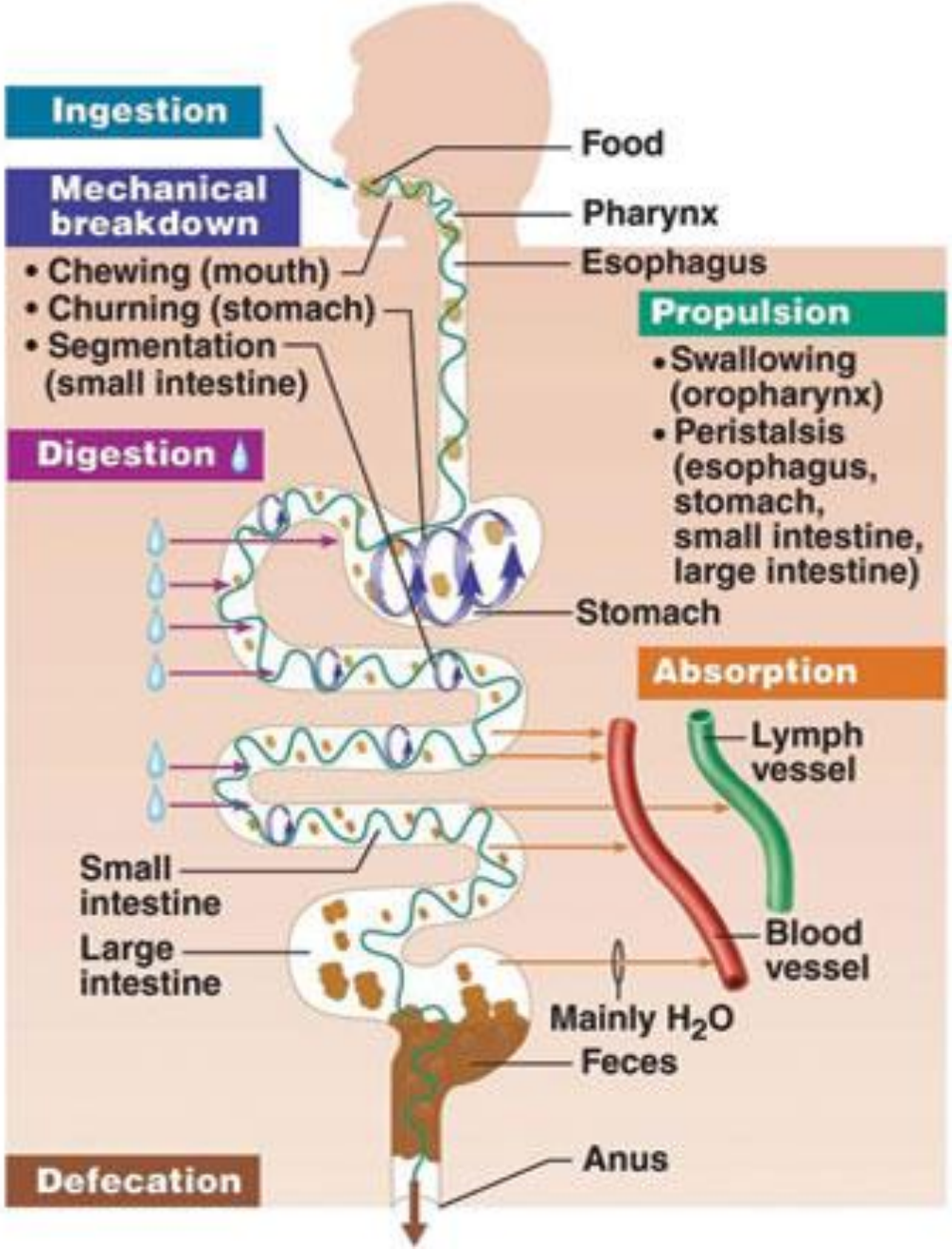
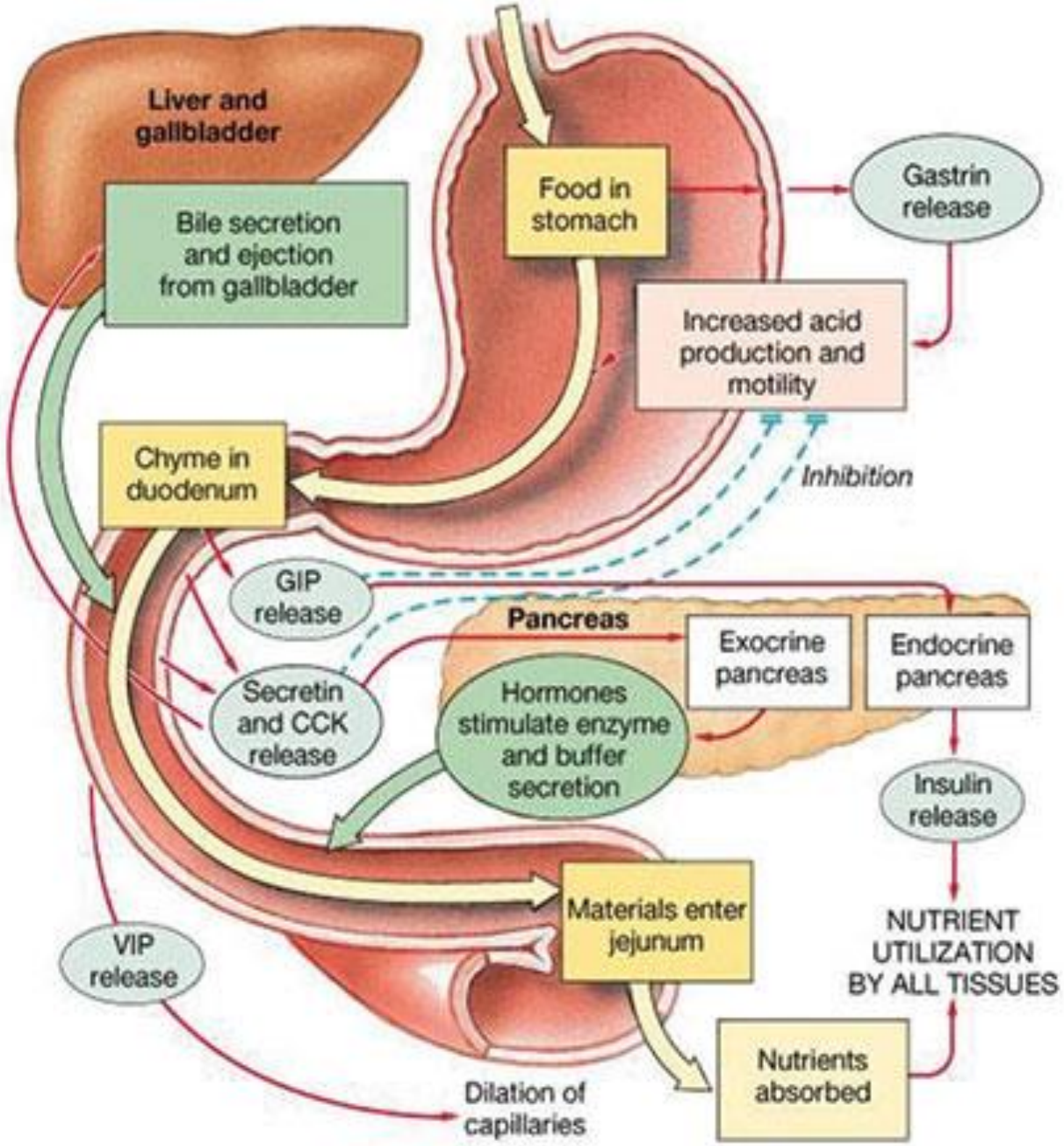
Digestion is the breakdown of large insoluble food molecules into small water-soluble food molecules so that they can be absorbed into the watery blood plasma. In certain organisms, these smaller substances are absorbed through the small intestine into the blood stream.

In other words the process by which food is broken down into simple chemical compounds that can be absorbed and used as nutrients or eliminated by the body is called digestion.

The processes of digestion include six activities: ingestion, propulsion, mechanical or physical digestion, chemical digestion, absorption, and defecation.


Ingestion
Food
Mechanical breakdown
Pharynx
Esophagus
• Chewing (mouth)
• Churning (stomach)
• Segmentation (small intestine)
Propulsion
• Swallowing (oropharynx)
• Peristalsis (esophagus, stomach, small intestine, large intestine)
Digestion
Stomach
Absorption
Lymph vessel
Small intestine
Large intestine
Blood vessel
Mainly H_2O
Feces
Anus
Defecation


Liver and gallbladder
Bile secretion and ejection from gallbladder
Food in stomach
Gastrin release
Increased acid production and motility
Inhibition
Chyme in duodenum
GIP release
Pancreas
Exocrine pancreas
Endocrine pancreas
Secretin and CCK release
Hormones stimulate enzyme and buffer secretion
Insulin release
Materials enter jejunum
NUTRIENT UTILIZATION BY ALL TISSUES
VIP release
Nutrients absorbed
Dilation of capillaries

1.Ingestion

The entry of food into the alimentary canal through the mouth is called ingestion. Simply put, the act of eating and drinking is called ingestion.

2. Propulsion

Propulsion refers to the movement of food through the digestive tract. It includes both the voluntary process of swallowing and the involuntary process of peristalsis.

Peristalsis consists of sequential, alternating waves of contraction and relaxation of alimentary wall smooth muscles, which act to propel food along.

These waves also play a role in mixing food with digestive juices. This both mixes and moves the contents along the alimentary tract.

Also, the act of swallowing, the last voluntary act until defecation, is an example of propulsion.

3. Mechanical Digestion

Digestion is a purely physical process that does not change the chemical nature of the food.

Instead, it makes the food smaller to increase both surface area and mobility.
It includes mastication, or chewing, as well as tongue movements that help break food into smaller bits and mix food with saliva.
The mechanical churning of food in the stomach serves to further break it apart and expose more of its surface area to digestive juices, creating an acidic "soup" called chyme.

Segmentation, which occurs mainly in the small intestine, consists of localized contractions of circular muscle of the muscularis layer of the alimentary canal. These contractions isolate small sections of the intestine, moving their contents back and forth while continuously subdividing, breaking up, and mixing the contents.
By moving food back and forth in the intestinal lumen, segmentation mixes food with digestive juices and facilitates absorption

4. Chemical digestion

Chemical digestion of food by enzymes present in secretions produced by glands and accessory organs of the digestive system.

In chemical digestion, starting in the mouth, digestive secretions break down complex food molecules into their chemical building blocks (for example, proteins into separate amino acids).

These secretions vary in composition but typically contain water, various enzymes, acids, and salts. The process is completed in the small intestine.

5. Absorption

This is the process by which digested food substances pass through the walls of some organs of the alimentary canal into the blood and lymph capillaries for circulation around the body.

It takes place primarily within the small intestine.
There, most nutrients are absorbed from the lumen of the alimentary canal into the bloodstream through the epithelial cells that make up the mucosa.

6. Elimination

Food substances that have been eaten but cannot be digested and absorbed are excreted by the bowel as feces.

Physiology of Digestion

In the Oral Cavity

After ingestion, the food is chewed and mixed with saliva, which contains enzymes that begin breaking down the carbohydrates in the food plus some lipid digestion via lingual lipase.

Saliva contains the enzyme amylase that begins the breakdown of complex sugars, reducing them to the disaccharide maltose.

Chewing by the teeth increases the surface area of the food and allows an appropriately sized bolus to be produced.

Food leaves the mouth when the tongue and pharyngeal muscles propel it into the esophagus.

Pharynx and Esophagus

The presence of the bolus in the pharynx stimulates a wave of peristalsis which propels the bolus through the esophagus to the stomach.

The walls of the esophagus are lubricated by mucus which assists the passage of the bolus during the peristaltic contraction of the muscular wall. The cardiac sphincter guarding the entrance to the stomach relaxes to allow the descending bolus to pass into the stomach.

In the Stomach

When a meal has been eaten the food accumulates in the stomach in layers, the last part of the meal remaining in the fundus for some time.

Numerous gastric glands are situated below the surface in the mucous membrane of the stomach. They consist of specialized cells that secrete gastric juice into the stomach.

- Gastric juice has an acidic pH and consists of water, mineral salts, mucus secreted by goblet cells, hydrochloric acid secreted by parietal cells, intrinsic factor, and inactive enzyme precursors: pepsinogens secreted by chief cells in the glands.
- The hydrochloric acid present in the juice acidifies the food and stops the action of salivary amylase, kills ingested microbes, and provides the acid environment needed for effective digestion by pepsins.
- Further, pepsinogens are activated to pepsins by hydrochloric acid and by pepsins already present in the stomach. They begin the digestion of proteins, breaking them into smaller molecules.
- Mixing with gastric juice takes place gradually and it may be some time before the food is sufficiently acidified to stop the action of salivary amylase.
- Gastric muscle contraction consists of a churning movement that breaks down the bolus and mixes it with gastric juice and peristaltic waves that propel the stomach contents towards the pylorus.

When the stomach is active the pyloric sphincter closes.
Strong peristaltic contraction of the pyloric antrum forces gastric contents, after they are sufficiently liquefied, through the pylorus into the duodenum in small spurts.
By slowing the emptying rate of the stomach, the contents of the duodenum become more thoroughly mixed with bile and pancreatic juice.

In the Small Intestines

When acid chyme passes into the small intestine it is mixed with pancreatic juice, bile, and intestinal juice, and is in contact with the enterocytes of the villi.
When a meal has been eaten the hormone CCK is secreted by the duodenum during the intestinal phase of secretion of gastric juice. This stimulates the contraction of the gall bladder and relaxation of the hepatopancreatic sphincter, enabling the bile and pancreatic juice to pass into the duodenum together.

Digestion by Pancreatic Juice

Pancreatic juice enters the duodenum at the hepatopancreatic ampulla. Pancreatic juice is alkaline (pH 8) because it contains significant quantities of bicarbonate ions, which are alkaline in solution.

When acid stomach contents enter the duodenum they are mixed with pancreatic juice and bile and the pH is raised to between 6 and 8. This is the pH at which the pancreatic enzymes, amylase, and lipase, act most effectively.

Digestion of proteins. Trypsinogen and chymotrypsinogen are inactive enzyme precursors activated by enterokinase (enteropeptidase), an enzyme in the microvilli, which converts them into the active proteolytic enzymes trypsin and chymotrypsin. These enzymes convert polypeptides to

Digestion of carbohydrates. Pancreatic amylase converts all digestible polysaccharides (starches) not acted upon by salivary amylase to disaccharides.

Digestion of fats. Lipase converts fats into fatty acids and glycerol. To aid the action of lipase, bile salts emulsify fats.

Digestion by Bile Juice

Bile, secreted by the liver has a pH of 8 and between 500 and 1000 ml are secreted daily. It consists of water, mineral salts, mucus, bile salts, bile pigments (mainly bilirubin), and cholesterol.

The bile salts, sodium taurocholate, and sodium glycocholate emulsify fats in the small intestine. The breakdown of fat globules in the duodenum into tiny droplets, which provides a larger surface area on which the enzyme pancreatic lipase can act to digest the fats into fatty acids and glycerol is called bile emulsification.

Fatty acids are insoluble in water, which makes them very difficult to absorb through the intestinal wall. Bile salts also make fatty acids soluble, enabling both these and fat-soluble vitamins (e.g. vitamin K) to be readily absorbed.

Digestion by Intestinal juice

Alkaline intestinal juice (pH 7.8 to 8.0) assists in raising the pH of the intestinal contents to between 6.5 and 7.5.

Enterokinase activates pancreatic peptidases such as trypsin which convert some polypeptides to amino acids and some to smaller peptides. The final stage of breakdown to amino acids of all peptides occurs inside the enterocytes.

Lipase completes the digestion of emulsified fats to fatty acids and glycerol partly in the intestine and partly in the enterocytes.

Sucrase, maltase, and lactase complete the digestion of carbohydrates by converting disaccharides such as sucrose, maltose, and lactose to monosaccharides inside the enterocytes.

The intestinal glands are simple tubular glands situated below the surface between the villi. The cells of the glands migrate upwards to form the walls of the villi replacing those at the tips as they are rubbed off by the intestinal contents.

During migration, the cells form digestive enzymes that lodge in the microvilli and, together with intestinal juice, complete the chemical digestion of carbohydrates, protein, and fats.

Thus, in the small intestine the digestion of all the nutrients is completed:

carbohydrates are broken down to monosaccharides

proteins are broken down to amino acids

fats are broken down into fatty acids and glycerol.

In the Large Intestines

The large intestines are joined to the end of the small intestine at the cecum, via the ileocecal valve.

The contents of the ileum which pass through the ileocaecal valve into the caecum are fluid, even though some water has been absorbed in the small intestine.

In the large intestine absorption of water continues until the familiar semisolid consistency of feces is achieved.

Mineral salts, vitamins, and some drugs are also absorbed into the blood capillaries from the large intestine.

The large intestines descend to the rectum and its endpoint at the anal canal.

After the absorption of useful materials, the remaining waste material is stored as feces before being removed by defecation through the anus.

Defaecation involves involuntary contraction of the muscle of the rectum and relaxation of the internal anal sphincter.

Contraction of the abdominal muscles and lowering of the diaphragm increases the intra-abdominal pressure (Valsalva's maneuver) and so assists the process of defaecation.

Thank you