WWW.IJRPR.COM

International Journal of Research Publication and Reviews

Journal homepage: www.ijrpr.com ISSN 2582-7421

Structures and Functions of The Human Digestive System; A Short Review

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ABSTRACT

human digestive system, system used in the human body for the process of digestion. The human digestive system consists primarily of the digestive tract, or the series of structures and organs through which food and liquids pass during their processing into forms absorbable into the bloodstream. The system also consists of the structures through which wastes pass in the process of elimination and other organs that contribute juices necessary for the digestive process.

Structures and functions of the human digestive system

The digestive system is a system of body which breakdown food into forms that can be absorbed and used by body cells. It also absorbs water, vitamins, and minerals, and eliminates wastes from the body. It breakdowns the larger molecules present in food into molecules that are small enough to enter body cells by a process known as digestion. The organs which are involved in the breakdown of food are collectively called the digestive system. The digestive system is a tubular system which extends from the mouth to the anus.

The digestive system can be divided into two parts:

1) The gastrointestinal (GI) tract, or alimentary canal (alimentary = nourishment), is a continuous tube that extends from the mouth to the anus. Organs of the gastrointestinal tract include the mouth, most of the pharynx, esophagus, stomach, small intestine, and large intestine.
2) The accessory digestive organs are the organs which assist in digestion of food. These include the teeth, tongue, salivary glands, liver, gallbladder, and pancreas. Teeth aid in the physical breakdown of food, and the tongue assists in chewing and swallowing. The other accessory digestive organs never come into direct contact with food but they produce secretions which aid in the chemical breakdown of food.

Functions of Digestive System:

1. Ingestion: This process involves taking foods and liquids into the mouth (eating).
2. Secretion: Cells within the walls of the GI tract and accessory digestive organs secrete about 7 liters of water, acid, buffers, and enzymes into the tract which help in digestion of food.
3. Mixing and propulsion: Alternating contractions and relaxations of smooth muscle in the walls of the GI tract mix food and secretions and propel them toward the anus. This capability of the GI tract to mix and move material along its length is called motility.
4. Digestion: Digestion is of two types- Mechanical and Chemical digestion. In mechanical digestion the teeth cut and grind food into smaller pieces. Then smooth muscles of the stomach and small intestine break it into further small pieces and mix it thoroughly with digestive enzymes. In chemical digestion the large carbohydrate, lipid, protein, and nucleic acid molecules in food are split into smaller molecules by hydrolysis and digestive enzymes. Vitamins, ions, cholesterol and water can be absorbed without chemical digestion.
5. Absorption: The entrance of ingested and secreted fluids, ions, and the products of digestion into the epithelial cells lining the lumen of the GI tract is called absorption. The absorbed substances pass into blood or lymph and circulate to cells throughout the body.
6. Defecation: Wastes, indigestible substances, bacteria, cells sloughed from the lining of the GI tract, and digested materials that were not absorbed in their journey through the digestive tract leave the body through the anus in a process called defecation. The eliminated material is termed feces.

Layers of GI Tract:

The wall of the GI tract has four layers tissues. These four layers (from deep to superficial) are the mucosa, submucosa, muscularis, and serosa.

Parts of digestive system:

1. Mouth:

- Mouth is also called Oral cavity or Buccal cavity. It is formed by cheeks, hard palate, soft palate and tongue.
- Cheeks form lateral walls of mouth and are covered by skin from outside and mucous membrane from inside.
- Hard palate forms anterior portion of roof of mouth. Hard palate is made up of palatine and maxillae bones covered with mucous membrane. Hard palate forms bony partition between oral and nasal cavity.
- Soft palate forms posterior portion of roof of mouth. It forms partition between oropharynx and nasopharynx. Soft palate is also covered with mucous membrane.
- Uvula is small muscular process hanging from soft palate. It prevents entrance of swallowed food and liquid into nasal cavity.

2. Salivary glands:

A salivary gland is a gland that releases a secretion called saliva into the oral cavity. Saliva is secreted to keep the mucous membranes of the mouth and pharynx moist and to cleanse the mouth and teeth. When food enters the mouth, secretion of saliva increases, and it lubricates, dissolves and begins the chemical breakdown of the food. There are 3 pairs of major salivary glands which secrete saliva:

- The parotid glands
- The submandibular glands
- The sublingual glands

Composition and functions of saliva:

- Water dissolves food and helps to produce taste of food to initiate digestion.
- Chloride ions in saliva activate salivary amylase which is an enzyme that starts breakdown of starch.
- Phosphate and bicarbonate ions buffer acidic food so that saliva is only slightly acidic.
- Mucus lubricates and moistens food for easy swallowing.
- IgA prevents microbes to enter or attach epithelial cells whereas lysozyme destroys harmful bacteria.

3. Tongue:

Tongue is an accessory digestive organ composed of skeletal muscle covered with mucous membrane. It helps to taste the food, swallow food and to speak. Tongue and its associated muscles form floor of tongue. Tongue is divided into 2 symmetrical lateral parts by a median septum that extends its whole length.

Tongue consists of two types of muscles:

- The extrinsic muscles
- The intrinsic muscles

4. Teeth:

Teeth or teeth are the additional digestive organs that cut, tear and pulverize solid foods to break them into smaller particles that facilitate their ingestion and digestion. The teeth are located in the aveolar processes of the lower and upper jaw.

A tooth consists of three parts: the crown, the root and the neck.

The crown is the visible part above the level of the gums.

The roots are the embedded part in the socket. The neck is the constricted junction of the crown and the root near the gum line.

Mechanical and Chemical digestion in the mouth:

- Mechanical digestion:

Mechanical digestion begins with the mechanical breakdown of food by the teeth through chewing or chewing. After chewing and mixing with saliva, the food is converted into a soft, flexible, easy-to-swallow mass called a bolus (chunk). Small food molecules are dissolved in saliva and water, after which they are converted by enzymes.

- Chemical digestion:

It is done by 2 enzymes:

a) Salivary amylase: is secreted by the salivary glands. It causes the breakdown of starch into simple units of monosaccharides and bisaccharides. Food contains mono, bi and polysaccharides, but only monosaccharides are absorbed. It then starts breaking down the polysaccharides into smaller ones until it is inactivated by the acid in the stomach.

b) Lingual lipase: is secreted by the glands of the tongue and causes the breakdown of triglycerides into diglycerides and fatty acids. It is activated in the acidic environment of the stomach. So it is inactive in the mouth and starts functioning after ingesting food.

5. Pharynx:

Pharynx is funnel shaped tube, covered with mucous and composed of skeletal muscle. It is present in region which extends from internal nares to esophagus.
It is divided into 3 parts:
Nasopharynx: helps in respiration;
Oropharnyx and laryngopharynx: it helps in respiration as well as swallowing of food.

6. Esophagus:

It is a collapsible muscular tube (25 cm long) which starts from inferior end of laryngopharynx and it ends at superior portion of stomach. It lies posterior to trachea and anterior to vertebral column. Its main function is to transfer the bolus from mouth to stomach.
The movement of food from the mouth into the stomach is achieved by the act of swallowing, or deglutition.
Deglutition is facilitated by the secretion of saliva and mucus and involves the mouth, pharynx, and esophagus.
Swallowing occurs in three stages:

1. the voluntary stage, in which the bolus is passed into the oropharynx;
2. the pharyngeal stage, the involuntary passage of the bolus through the pharynx into the esophagus; and
3. the esophageal stage, the involuntary passage of the bolus through the esophagus into the stomach.

During esophageal phase, peristalsis (stalsis = constriction), a progression of coordinated contractions and relaxations of the circular and longitudinal layers of the muscularis, pushes the bolus toward stomach.

7. Stomach:

The stomach is a "J" shaped extension of the gastrointestinal tract that sits just below the diaphragm. It connects the esophagus to the duodenum (first part of the small intestine). The stomach serves as a mixing chamber and food storage container. When food is ingested, the stomach periodically pushes a small amount of food into the duodenum. Because the stomach can vary in size, it can store large amounts of food. In the stomach a semisolid bolus is converted into liquid, starch digestion continues, digestion of triglycerides and proteins begins, and absorption of various substances occurs.
Anatomy of stomach:
The stomach has four main regions: the cardia, fundus, body and pylorus. The cardia surrounds the superior opening of the stomach.
The fundus is the rounded part above and to the left of the cardia.
The body is lower than the fundus and is the large central part of the stomach.
The pylorus is the region of the stomach that connects to the duodenum. (pyl = gate; orus = guardian).
The pylorus consists of two parts, the pyloric antrum, which connects to the body of the stomach, and the pyloric canal, which leads to the duodenum.

8. Pancreas:

Pancreas (Pan = all, creas = flesh) is a retroperitoneal (behind peritoneum) gland, which lies posterior to greater curvature of stomach. It is 12-15cm long and 2-3cm thick.
Anatomically it is divided into 3 parts:
Head: It is expanded portion and lies near to curve of duodenum
Body: It is central part and is left and superior to head.
Tail: It is last tapering portion of pancreas.
Pancreas has two ducts that open into duodenum and these ducts carry pancreatic juices into duodenum:

- Pancreatic duct: It is larger in size. It combines with common bile duct from liver and forms hepatopancreatic ampulla which opens into duodenum.
- Accessory duct: It is smaller and also opens into duodenum.

Pancreas secretes 4 types of hormone:
Glucagon: It increases blood sugar level.
Insulin: It decreases blood sugar level.
Somatostatin: It maintains Gluacagon and Insulin level in body.
Pancreatic polypeptide: It controls somatostatin secretion

9. Liver and Gall bladder:

10. Liver is the 2 nd largest organ in body, located inferior to diaphragm. Gall bladder is pear shaped sac located inferiorly and posteriorly to liver.

Anatomy:

- Liver is divided into 2 lobes; Right lobe (larger) and left lobe (smaller). Right and left lobes are separated by falciform ligament.
- Gall bladder has 3 portions. The inferior broad portion is called fundus, the middle portion is called body and the upper taper portion is called

neck.

Functions of liver:

a) Carbohydrate metabolism: Liver maintains normal blood glucose level.
b) Lipid metabolism: Hepatocytes store some triglycerides; break down fatty acids to generate ATP; synthesize lipoproteins.
c) Protein metabolism: Hepatocytes remove amino group (NH2) from amino acids so that amino acids can be used for ATP production or can be converted into carbohydrates or fats.
d) Processing of drugs and hormones: The liver can detoxify substances such as alcohol and excrete drugs such as penicillin, erythromycin, and sulfonamides into bile.
e) Excretion of billirubin:
f) Synthesis of bile salts: Bile salts are used in the small intestine for the emulsification and absorption of lipids.
g) Storage: In addition to glycogen, the liver is a prime storage site for certain vitamins (A, B12, D, E, and K) and minerals (iron and copper).
h) Phagocytosis: The stellate reticuloendothelial (Kupffer) cells of the liver phagocytize aged red blood cells, white blood cells, and some bacteria.
i) Activation of vitamin D: Liver along with skin and kidneys participate in synthesizing the active form of vitamin D.

11. Small Intestine:

Small intestine starts from pyloric sphincter of stomach, coils through central and inferior part of abdominal cavity and ends at large intestine.
It has major role in digestion and absorption of nutrients.
Anatomy: It has 3 major parts:

a) Duodenum: This is first part of small intestine. It starts from pyloric sphincter, extends up to 25 cm and merges into jejunum.
b) b. Jejunum: It is middle part and extends up to ileum.
c) c. Ileum: It is last part of small intestine and ends at ileocecal junction of large intestine.

Mechanical and chemical digestion in small intestine:

- Mechanical Digestion: Two types of movements occur in small intestine which result in mechanical digestion:
- Segmentation: These are localized mixing contractions that occur in portions of small intestine distended with large volume of chime.
- Migrating motality complex (MMC): This is a type of peristaltic movement which occurs when volume of chyme in distended portion of small intestine decreases.
- Chemical digestion: Chyme entering the small intestine contains partially digested carbohydrates, proteins, and lipids by the enzymes in mouth and stomach.
- Digestion of carbohydrates: Starches are broken into maltose, maltriose and α-dextrin units by pancreatic amylase.
- **Following brush border enzymes act on these and convert it even smaller units.
  - α-Dextrinase acts on α-dextrin to produce glucose.
  - Maltase splits maltose and maltriose into 2-3 units of glucose.
  - Lactase digests lactose into a glucose and galactose.
  - Sucrase breaks sucrose into molecule of glucose and fructose.
  - Cellulose (a polysaccharide) is not digested by amylase enzymes and hence it is called roughage.
- Digestion of proteins: Trypsin, chymotrypsin, carboxypeptidase and elastase convert proteins into peptide units. These peptides are converted into small amino acids by two enzymes aminopeptidase and Dipeptidase which break amino acids into single amino acids.
- Digestion of lipids:
- Digestion of nucleic acids: Pancreatic juice contains two nucleases (nucleic acid digesting enzymes) ribonuclease (digests RNA) and deoxyribonuclease (digests DNA) into nucleotides.
- Absorption in small intestine: All chemical and mechanical phases of digestion convert large molecule into smaller one which can be easily absorbed.
- Absorption of lipids: All dietary lipids are absorbed by simple diffusion.
- Absorption of electrolytes: Electrolytes absorbed in small intestine come from ingested food, liquids and from gastrointestinal sescretions.
- Absorption of vitamins: Fat soluble vitamins like Vit. A, D, E, K are absorbed by simple diffusion by micelle formation. Water soluble vitamins Vit. B and C are also absorbed by simple diffusion.
- Absorption of water: All water absorption in the GI tract occurs via osmosis.

12. Large Intestine:

The colon is the terminal portion of the gastrointestinal tract. The general functions of the colon are the completion of absorption, the production of certain vitamins, the formation of feces and the expulsion of feces from the body.
Colon anatomy: The large intestine is about 1.5m long and extends from the ileum to the anus. The connection of the small and large intestine occurs at the level of the ileocecal sphincter muscle which controls the movement of material from the small intestine to the large intestine. The large intestine consists of 4 main regions: cecum, colon, rectum and anal canal.

The cecum is a small pocket-like organ present next to the ileocecal sphincter. Attached to the cecum is a coiled and twisted tube called a vermiform appendix or appendage.
The colon is a long tube present near the cecum. The open end of the cecum attaches to the colon.
The colon is divided into 4 parts, namely ascending colon, transverse colon, descending colon and sigmoid colon.
The rectum is approximately the last 20 cm of the gastrointestinal tract. The 2-3 cm terminal of the rectum is called the anal canal.

Disorders of digestive system:

i. Gastroesophageal reflux disease (GERD):
ii. Vomiting:
iii. Jaundice:
iv. Gallstone:
v. Peptic Ulcer Disease (PUD):
vi. Hepatitis:
vii. Hepatitis A (infectious hepatitis),Hepatitis B, Hepatitis C, Hepatitis D

CONCLUSION

The gastrointestinal tract is a series of hollow organs connected in a long, winding tube running from the mouth to the anus. The hollow organs of the gastrointestinal tract are the mouth, esophagus, stomach, small intestine, large intestine, and anus. Liver, pancreas and gallbladder are the solid organs of the digestive system.
The digestive system performs three main processes: mixing food, moving food through the digestive tract (peristalsis), and using chemicals to break food down into smaller molecules.
Ultimately, the main purpose of the digestive system is to break down energy-carrying compounds and put them into circulation for use by the rest of the body. Equally important are the systems the body has to remove compounds from the blood.

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