UNIT 3: DIGESTIVE SYSTEM

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3.1 LEARNING OBJECTIVES

After going through this unit, you will be able to:

- learn the structure and functions of digestive system
- understand the mechanism of digestion
- explain the effect of yogic practices on digestive system

3.2 INTRODUCTION

This is the third unit of the Human Anatomy and Physiology course. We will discuss about the basic knowledge of Digestive system with their structure and function in this unit. At the beginning of the unit we will discuss about anatomy and physiology of digestive system. There after we will discuss about the secretions of gastrointestinal tract organs. At the end we will discuss the effect of yogic practices on digestive system.

3.3 ANATOMY AND PHYSIOLOGY OF DIGESTIVE SYSTEM

3.3.1 DIGESTIVE SYSTEM

The human body needs energy to perform various internal and external functions, which the body receives from food, but the food that is consumed by this body is not useful for the body in that form, rather some changes have to be made in it to make it suitable for the body.

What is Digestion? Digestion is the process of converting the food we eat into nutrients, which the body uses for energy, growth and cell repair.

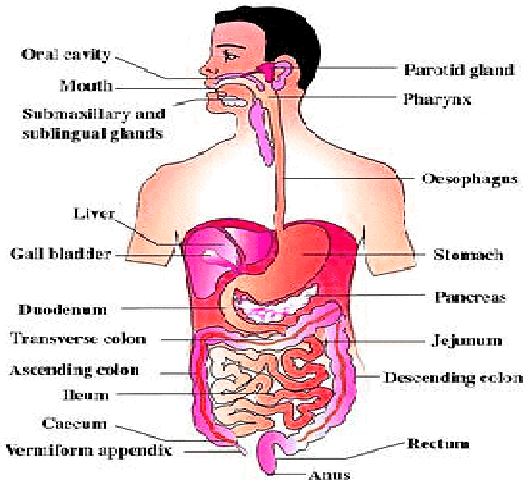
Digestive system is a network of organs and tissue that work together to perform digestion. Digestion is a complex process that involves the breakdown and absorption of nutrients from ingested food.

The Digestive system has mainly four functions –

- Ingestion: Food enters the mouth
- Digestion: It involves mechanical (chewing) and chemical digestion (enzymes break down nutrients).
- Absorption: Nutrients are absorbed into the blood.
- Elimination: Waste is eliminated through feces.

3.3.2 STRUCTURE AND FUNCTION OF THE DIGESTIVE SYSTEM

The Digestive system organs divided into two parts – Gastrointestinal tract or Alimentary Canal and Accessory organs



Gastrointestinal tract consists of organs are – Mouth, Pharynx, Esophagus, Stomach, Small Intestine, Large Intestine, Rectum and Anus.Accessory organs are – Salivary gland, Liver, Gall bladder and Pancreas.

Mouth – It is also known as Oral cavity or Buccal cavity. It's the beginning of gastrointestinal tract or Alimentary canal. It consists of teeth, tongue and salivary gland.

Teeth: In childhood, the number of teeth is 20 and when we grow up, this number becomes 32.Only the jaw with the lower teeth of our mouth can move here and there. The role of teeth in digestion is to break up food into a soft copy pulpy mass that can be swallowed.

Tongue: The tongue helps to move the food between the teeth. It also contains the taste receptors. There are four kinds of taste cells. Each cell is determined by the type of taste message it send to the brain; salty, sweet, sour and bitter. Salty and sweet cells dominate at the top of the tongue and about salty back along the side, sour cells are more numerous all the way back along the sides; bitter buds are desert at the back of the tongue.

Saliva: Saliva also does a favour for our tongue and teeth. Without saliva the taste buds of the tongue we will not function properly. It also has an antibacterial effect which helps protect our mouth and teeth from bacterial infection.

Pharynx— It is a muscular shaped tube, common pathway for both respiratory and digestive system. It consists of nasopharynx, oropharynx and laryngopharynx. The soft palate seals the nasopharynx and allows food to pass into the oesophagus after it has been appropriately crushed and transformed into a soft bolus. To prevent food from entering the respiratory system, the epiglottis also seals the glottis at that moment. Mastication is the crushing of food; deglutition is the transit of that bolus into the oesophagus. The procedure is voluntary thus far. However, from the final stage of deglutition to the anus, the process is involuntary and controlled by the autonomous neurological system.

Oesophagus- It is a muscular tube that is located in the chest directly behind the trachea and measures around 25 cm (10 in). It is also known as food pipe. It is in collapsible shape at all times. Only after the food goes through it does it open. It

connects to the stomach at the lower side, where it pierces the diaphragm. There is a sphincter at the intersection of the two. Another sphincter is located at the upper end of the oesophagus. A soft food bolus travels through the oesophagus with ease. A hard bolus makes the chest feel uneasy and like it choking. That stiff material can occasionally put pressure on the trachea, creating a feeling of suffocation. Therefore, it is usually preferable to either avoid eating really hard food or to chew it properly to soften it.

Stomach- It is a large food bag located directly behind the diaphragm in the upper portion of the abdominal cavity. It appears J-shaped when it is empty. However, the stomach swells in every direction after eating. During digestion the stomach release chemicals which are break down the food, so that we can use it for energy. As a gland, the inner wall of the stomach secretes two to three litres of gastric juice daily, which includes pepsinogen, gastric lipase, HCI (hydrochloric acid), some mucus, and an intrinsic factor (for absorption of vitamin B-12). Chyme is the term for the liquefied food that occurs in the stomach. The stomach wall wave-like motions and secretions aid in the formation of the right chyme.

Small intestine- It is tube about three meters (10 feet) long. The small intestine is where the majority of digestion and absorption takes place. The duodenum, jejunum, and ileum comprise the lengthy tube. It eventually joins the cecum, a section of the large intestine. There is an ileocecal sphincter at the intersection. One to two litres of juice are secreted by the small intestine, and it comprises water, mucus, enzymes that break down sugar (such as lactase, sucrose, and maltase), and enzymes that break down proteins (such as peptidases and nucleosidases). In addition, the small intestine inner wall has projections that resemble fingers and are referred to as villi. Special cells for absorbing digested food are found in each villus.

Large intestine- It is the last segment of the digestive tract. It is roughly 2.5 inches in diameter and 5 feet long. A large portion of the abdominal cavity is occupied by it. Its four structural components are the rectum, anus, colon (ascending, transverse, descending, and sigmoid), and cecum. The ileocecal and anal sphincters are located at the intersection with the ileum and at the end, respectively. The appendix, a little tail-like portion that is about 8 cm long, is connected to the cecum. The large intestine does not break down food, but it

does absorb a lot of water, minerals, and vitamins. The faeces solidify after absorbing fluids and subsequently expelled during the defecation process.

Rectum-The terminal portion of the big intestine is called the rectum. Its length is around 12 cm. Rectum temporarily faces or stores waste. The rectum's walls enlarge as it fills, activating the stretch receptor. This aids in bowel emptying by stimulating the neural system.

Anus-The rectum's external orifice is called the anus. It aids in the face removal process. It has two sphincters an involuntary, smooth muscle-based internal sphincter and a voluntary, external sphincter.

Accessory Organs – There are four accessory organs, which are outside the gastrointestinal tract and they help in the digestion.

Salivary gland- The mucous membrane lining the mouth contains many minute glands called buccal glands, which pour their secretion into the mouth. Thus, our mouth is always kept moist for 24 hours. It is located in the mouth and throat region. It produces saliva (a clear liquid) that helps in digestion of the food. Saliva gland contains three pairs of compound saccular glands, the salivary glands, namely parotid, submandibular and sublingual glands. Each parotid gland is placed just under in front of the ear; it is duct, the parotid, opens upon the inner

surface of the cheek opposite the second molar of the upper jaw. The submandibular and sublingual glands lie below the jaw and under the tongue, the submandibular being placed further back than the sublingual.

It makes the food more palatable by moistening it. Saliva aids in the digestion of meals. It has enzymes like lipase and amylase that break down fats and carbohydrates. Antibodies in saliva also aid in the body's defence against infection.

Liver- The liver is a vital organ (weight 1.5 kg) situated in the right-side upper quadrant of the abdominal cavity. It is the largest internal organ in the human body. It is divided into two major lobes (right and left) and two minor lobes (Caudate and quadrate). It is reddish brown colour. The liver is the site of numerous chemical reactions related to metabolism (fat, protein, and sugar).

Glycogen, or stored sugar, is kept there. It is among the most significant detoxification centres. It breaks down alcohol, hormones, drugs and other harmful compounds. The liver also breaks out old blood cells. The liver stores a lot of vitamins A, B, D, E and K.

It produces bile for digestion, which is kept in the gall bladder, a unique sack located beneath the liver. The secretion then travels via the bile duct to the duodenum. Additionally, the pancreatic juice and bile ducts merge, and both secretions then open into the duodenum. Bile helps to digest the fat into fatty acids and glycerol.

Gall Bladder- The gall bladder store s excess bile. It is a pear-shaped organ that sits beneath (under) the liver. Bile passes from the gall bladder through the duct and it's stored until it is needed for the digestion of fats. The bile empties out into the duodenum. The gall bladder serves as a useful function, to digest fats, but it is not vital to maintain it for our normal body functions.

Pancreas- It is about 12 to 15 cm long and 2.5 cm wide, and it sits behind and just beneath the stomach. It is both an exocrine and an endocrine gland. The pancreatic juice (1 to 1.5 litres) secreted by the exocrine portion comprises water, salts, sodium bicarbonate, and enzymes such as lipase, trypsin, and amylase. The pancreas is an endocrine gland that aids in the metabolism of sugar by secreting hormones like glucagon and insulin into the blood.

3.3.3 Mechanism of Digestion

Food stays in the mouth for a few seconds, during which time the muscles of the teeth contract, causing the mouth to move and the teeth to break into small pieces. At the same time, saliva is secreted, softening the food and making it easier to swallow. This type of food is called a bolus. Food molecules start to dissolve in the salivary water, and only in a liquid medium can enzymes react with food molecules, so a lot of food is digested in the mouth.

The soft bolus travels smoothly from the oesophagus to the stomach in three to five seconds. As it enters the stomach, the stomach begins to move gently in what are known as mixing waves. Three to four waves every minute. These waves macerate food, combining it with stomach fluids to transform the soft, solid

meal into a soup-like, thick liquid. We refer to this as chyme. The pylorus, the lower portion of the stomach, aids in the gradual passage of certain chyme into the small intestine.

We refer to this as gastric emptying. Typically, a reasonable amount of food stays in the stomach for two to three hours. Heavy meals could take four hours or longer. Comparatively speaking, high sugar takes less time, but high protein takes a long period.

It takes a lot longer when high fat and high protein are combined. For instance, it takes less time to digest if a glass of orange juice is consumed on an empty stomach. A glass of milk takes a little longer to consume on an empty stomach than a glass of juice. However, it takes a lot longer to digest milk that has been mixed with juice.

The food stays in the small intestine for three to five hours. The process of segmental peristalsis facilitates the mixing of chyme and enzyme.

The small intestine's end is where the three constituents' digestion is finished. Villi absorb the results of digestion. Additionally, the undigested portion is pushed into the cecum. Everything that enters the big intestine first is in liquid form. This fills the cecum. Then proceeds to fill more sections of the colon's transverse, ascending, etc. sections. Haustral churning is the term for the specific movement in these segments. For example, the first part permits the filling of the liquid. Then, as the liquid is flowing, it also bulges somewhat. It later contracts to force the material into more segments.

The large intestine retains the undigested chyme for six to eight hours. The large intestine absorbs 90% of the water from this chyme. The large intestine is therefore the primary location for maintaining the body's water balance. In addition, vitamins and minerals are also absorbed. The chyme now becomes a soft, solid faecal substance after absorption.

The material then rushes towards the rectum and anus during mass peristalsis before being expelled during defecation.

The food takes 5 to 8 hours to digest from the mouth to the small intestine and another 6 to 8 hours to digest in the large intestine when the entire process is taken into account. After 11 to 16 hours of feasting, it emerges outdoors as a stool.

Assume that someone who eats at 7 a.m. will pass faeces made from that food at 8 p.m. or midnight. The amount and combination of food determine this. It also depends on the digestive system's prior state. In gross terms, food can be classified as light, moderate, or heavy.

3.4 SECRETIONS OF GASTROINTESTINAL TRACT

Start by introducing the concept of the digestive system and its role in breaking down food andabsorbing nutrients. Gastrointestinal tract secretions play a crucial role in the digestion process by facilitating the breakdown of food, neutralizing acids, and aiding in the absorption of nutrients.

- **Salivary Secretion:** There are three pairs of Salivary glands (parotid, submandibular, and sublingual). It has components Salivary Amylase and its enzyme that starts the digestion of carbohydrates by breaking down starches into sugar; mucus Lubricates food for easier swallowing and lysozyme it an antimicrobial enzyme that helps protect the mouth from bacteria.

  The major function of Saliva moistens food, starts carbohydrate digestion, and protects the mouth from infections. It aids in the formation of a bolus for easy swallowing.
- **Gastric Secretion:** The Gastric glands in the stomach lining (chief cells, parietal cells, and mucous cells). It has major Components Hydrochloric Acid (HCl) it creates an acidic environment (pH 1.5 to 3.5) that activates; pepsinogen and helps break down proteins. Pepsinogen inactive enzyme that, when activated by HCl, breaks down proteins into smaller peptides; Intrinsic Factor it is important for the absorption of vitamin B12 in the small intestine. And Mucus it is protects the stomach lining from acidic damage.

  The major functions of Gastric secretions help digest proteins, activate digestive enzymes, and provide protection to the stomach lining from the acidic environment.
- **Bile Secretion:** The Liver is the main organ in digestive system and it produces bile, stored in the gallbladder. The main Components are bile salts it is help emulsify fats, breaking them into smaller droplets for easier digestion; bile pigments are bilirubin, which is a by-product of red blood cell breakdown and cholesterol and phospholipids it is aid in fat digestion and absorption.

The main functions of bile facilitate the digestion and absorption of fats in the small intestine by merge large fat molecules into smaller, digestible droplets.

- **Pancreatic Secretion:** Pancreatic juice secreted by Pancreas (exocrine part). It has components of amylase it breaks down carbohydrates into simple sugars; lipase it breaks down fats into fatty acids and glycerol; proteases (Trypsin, Chymotrypsin, Carboxypeptidase) it break down proteins into smaller peptides and amino acids and bicarbonate it neutralizes the acidic chyme entering the small intestine from the stomach.

  The main function of pancreatic secretions digests carbohydrates, fats, and proteins, and bicarbonate neutralizes stomach acid to provide an optimal environment for enzyme activity in the small intestine.
- **Intestinal Secretion:** The small intestine secreted with the help of intestinal glands like the crypts of Lieberkühn. It has components di-saccharides (such as lactase, sucrose, maltase) and it break down disaccharides into mono-saccharides for absorption; peptidases it breaks down peptides into amino acids for absorption and mucus it protects the intestinal lining and facilitates food movement.

  The main function of intestinal secretions final digestion by breaking down carbohydrates, proteins, and fats into absorbable molecules. The mucus protects the intestines from digestive enzymes and helps food move smoothly through the intestines.
- **Enterogastrone** (Regulatory Hormones): Cells in the small intestine (S cells, I cells). It has Components are secretin Stimulates the pancreas to release bicarbonate and inhibits gastric acid secretion; cholecystokinin (CCK) stimulates the release of bile from the gallbladder and digestive enzymes from the pancreas, while also slowing gastric emptying and gastric Inhibitory Peptide (GIP) it inhibits gastric acid secretion and motility.

  These hormones regulate the digestive process by coordinating the release of digestive enzymes and bile, ensuring that the digestive system operates efficiently.

3.5 EFFECT OF YOGIC PRACTICES ON DIGESTIVE SYSTEM

Yoga practices can have several positive effects on the digestive system. These benefits stem from a combination of physical postures, breathing techniques, and relaxation exercises. Here's a breakdown of how yoga influences digestion:

1. **Improved Blood Flow and Circulation:** Many yoga poses, such as twists, forward bends, back bending and inversions, the contracted muscles of abdomen and gentles pressure on stomach and intestine which stimulates peristalsis and better blood circulation to the abdominal area. It also stimulates digestive glands for the secretion, contract pelvic muscles and increases the heat in pelvic region. This enhanced blood flow can support the functioning of digestive organs, like the stomach, intestines, and liver.
2. **The breathing excises and pranayama:**After complete exhalation the diaphragm moves downward and pressure on the abdominal organs and produce massaging in the internal organs. Again, after deep inhalation the contracted abdominal muscle and gentle massage inside the organs. Slow breathing exercises helps to stimulate parasympathetic nervous system which accelerates the process of digestion
3. **Stress Reduction:** Yoga encourages relaxation and helps reduce stress. Chronic stress can interfere with digestion, leading to issues like bloating, indigestion, and constipation. Practices such as deep breathing (Pranayama) and meditation activate the parasympathetic nervous system, promoting a rest-and-digest state that aids digestion.
4. **Balance of Autonomic Nervous System:** Yoga helps balance the autonomic nervous system, specifically enhancing the parasympathetic nervous system, which plays a key role in digestion. This helps regulate the release of digestive enzymes and other necessary functions.
5. **Enhanced Bowel Movements:** Regular practice of yoga can help alleviate constipation and encourage regular bowel movements. Certain poses, like Downward Dog and Cat-Cow, encourage movement within the abdomen, improving the flow of waste and gas through the intestines.
6. **Detoxification:** Some yoga poses stimulate the body detoxification processes by promoting the elimination of waste products. Some cleansing practices like basti kriya cleans the large intestine and it also avoids the vicious circle of formation gases and toxins, Shankhaprakshalana it also cleans the digestive tract. Vaman

dhauti also active role play to activate peristalsis of large intestine for defecation. This can reduce bloating and discomfort, while improving overall digestive health.

7. **Hormonal Balance:** Yoga can help regulate hormones that affect digestion, such as those related to stress or hunger. For instance, Kundalini yoga and some breathing exercises can influence hormones that improve gut health.

In summary, yoga's combination of physical postures, breathing, shatkarma and meditation practices can enhance the digestive system's functioning, relieve digestive discomforts, reduce stress, and support the overall health of the digestive tract. Regular practice can significantly contribute to long-term digestive health.

CHECK YOUR PROGRESS

Q 1 Where does the process of digestion of food begin in Humans?

Q 2 What is the role of mucus secreted by stomach?

Q 3 Which is the longest organ of digestive system in human body?

Q 4 Which part of the digestive system helps in the absorption of water?

Q 5 Fill in the blanks –

i) Saliva helps in digestion of ---------

ii) Bile juice is formed in the ----------.

iii) Tiny fingers – like projections in the small intestine, called ---------, increase the surface area for absorption.

iv) ---------- secreted by Pancreas (exocrine part).

v) The --------- stores bile and release it when needed.

3.6 LET US SUM UP

- Digestion is the process of converting the food we eat into nutrients, which the body uses for energy, growth and cell repair.
- Digestion is a complex process that involves the breakdown and absorption of nutrients from ingested food.
- Without saliva the taste buds of the tongue we will not function properly. It also has an antibacterial effect which helps protect our mouth and teeth from bacterial infection.

- stomach secretes two to three litters of gastric juice daily, which includes pepsinogen, gastric lipase, HCI (hydrochloric acid), some mucus, and an intrinsic factor (for absorption of vitamin B-12).
- Chyme is the term for the liquefied food that occurs in the stomach.
- The small intestine is where the majority of digestion and absorption takes place.
- The liver is the site of numerous chemical reactions related to metabolism (fat, protein, and sugar). Glycogen, or stored sugar, is kept there. It is among the most significant detoxification centres.
- The gall bladder serves as a useful function, to digest fats, but it is not vital to maintain it for our normal body functions.
- Gastrointestinal tract secretions play a crucial role in the digestion process by facilitating the breakdown of food, neutralizing acids, and aiding in the absorption of nutrients.
- Different Yogic practices of physical postures, breathing; shatkarma and meditation practices can enhance the digestive system's functioning, relieve digestive discomforts, reduce stress, and support the overall health of the digestive tract.

✓ 3.7 ANSWERS TO CHECK YOUR PROGRESS

1. Ans: Mouth

2. Ans: It protects the lining of the stomach.

3. Ans: Small intestine

4. Ans: Large intestine

5. Ans: i) Starch

ii) Liver

iii) Villi

iv) Pancreatic juice

vi) Gallbladder

3.8 FURTHER READING

Bhalekar. S (2018). ANATOMY &PHYSIOLOGY: YOGIC CONTEXT, Kaivalyadham, Lonavala.

1) Waugh, A. & Grant, A. (2014). Ross & Wilson Anatomy and physiology in health andillness, Elsevier Health Sciences
2) Gray, H. Anatomy of the Human Body, Lea & Febiger, Philadelphia

3.9 MODEL QUESTIONS

A) Short Questions

Q1. What is Digestive system?

Q2. List the Digestive organs from beginning to end.

Q3. What is the main function of the digestive system?

Q4. What is the role of saliva in digestion?

Q5. Where does digestion begin in the body?

B) Long questions

Q 1. How is food mechanically broken down in your stomach?

Q 2. Write down the structure and functions of the digestive system.

Q 3. What are the functions of the digestive system?

Q4. How nutrients do gets absorbed into the body?

Q5. What is the Yoga major effective on digestive system?

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