ORGANS OF THE DIGESTIVE SYSTEM

OBJECTIVES:

1. List and describe the major activities of the digestive system.
2. Identify and give the functions of the organs in and along the digestive tract.

MAJOR ACTIVITIES OF THE DIGESTIVE SYSTEM

The major activities of the digestive system involve the following processes:

1. **Ingestion** – the intake of food into the digestive tract through the mouth.
2. **Mechanical processing** – the physical manipulation of solid food including the chewing of food in the mouth and the mixing of food along the digestive tract.
3. **Digestion** – the chemical breakdown of food into its building blocks. Proteins are chemically broken down into amino acids. Carbohydrates are chemically broken down into monosaccharides (simple sugars) and lipids are chemically broken down into glycerol and fatty acids.
4. **Secretion** – the release of water, acids, enzymes, and buffers by cells in the digestive tract wall and by cells in the accessory organs.
5. **Absorption** – the movement of small organic molecules (amino acids, monosaccharides, glycerol, and fatty acids), water, electrolytes, and vitamins from the lumen of the digestive tract into the blood stream.
7. **Defense** – the high acidity, action of enzymes, and the macrophages found in the lymph nodes along the digestive tract help prevent the invasion of foreign organisms.
8. **Peristalsis** – the involuntary, sequential contractions of smooth muscle tissue in the wall of the digestive tract that move food materials through the tract.

ORGANS OF THE DIGESTIVE TRACT:

The digestive system consists of the digestive tract or alimentary canal and various accessory organs. By following a mouthful of food through the digestive tract, we can observe the organs of the tract, the various accessory organs, and how each structure contributes to the digestive process.

Food enters the digestive system through the mouth or oral cavity. In the oral cavity, the teeth tear, cut, and grind the food into smaller pieces. While the food
is being chewed, saliva from the salivary glands is added to the food. The saliva, which is mostly water, moistens and softens the food. Saliva also contains an enzyme (salivary amylase) that starts the break down of large carbohydrate molecules into smaller sugar molecules. Many buccal and minor salivary glands as well as the three largest pair of salivary glands (parotid, submandibular, and sublingual) produce the saliva.

The tongue helps move food around the mouth and along with the lips and cheeks, form the food into a bolus. During swallowing, the soft palate is raised to prevent the bolus from entering the nasopharynx and nasal cavity. The tongue is then thrust backward, pushing the bolus into the oropharynx. The epiglottis, a flap of cartilage, is pushes from a vertical to a horizontal position, and covers the opening to the larynx. This action helps to keep food from entering the trachea.

Once food enters the oropharynx, peristalsis propels the bolus into the esophagus and down the esophagus to the stomach. When the bolus reaches the junction between the esophagus and stomach, the lower esophageal (cardiac) sphincter relaxes allowing the bolus to enter the stomach.

The stomach stores ingested food until it is released into the small intestine. The smooth muscle layers in the wall of the stomach contract, churning the ingested food, mixing the food with gastric juices, and forming a soupy liquid mixture called chyme. Specialized cells in the lining of the stomach secrete hydrochloric acid (HCl) and enzymes that begin protein digestion. The high acidic levels in the stomach also kill most of the bacteria and other pathogens found on the food we eat.

After 1 to 3 hours in the stomach, the chyme begins to move into the small intestine. Strong peristaltic waves propel the chyme through the pyloric canal toward the pyloric orifice (the opening between the stomach and small intestine). The pyloric sphincter controls the rate and the amount of chyme entering the small intestine.

The small intestine is divided into three sections – duodenum, jejunum, and ileum. The first section of the small intestine is called the duodenum. The duodenum is C-shaped and about 10 inches long. The presence of acidic chyme in the duodenum stimulates the released of pancreatic secretions from the pancreas into the duodenum. Pancreatic secretions are clear, slightly alkaline, and contain mostly water, several enzymes or precursors of enzymes, and sodium bicarbonate. The alkaline secretions help to neutralize the acid in the chyme.

The liver constantly produces bile that is dumped into the duodenum. Excess bile backs up through various ducts into the gall bladder where it is stored in a concentrated form until is needed for fat digestion. Bile is an alkaline solution that contains water, sodium bicarbonate, bile salts, bile pigments, and cholesterol. Bile contains do digestive enzymes but is required for fat digestion.
Bile emulsifies fat, breaking large fat droplets into smaller droplets so enzymes can digest the fat into its building blocks.

Complete digestion of the food molecules in the chyme occurs in the lumen of the duodenum along the brush borders of the epithelial cells lining the lumen. Most of the absorption of the digested food occurs in the duodenum and **jejenum**. Bile salts and vitamin B$_{12}$ are absorbed in the **ileum**.

The chyme remains in the small intestine for 1 to 6 hours after which it passes through the **ileocecal valve** and into the cecum. The ileocecal valve is a sphincter located at the junction between the ileum and the large intestine. The **cecum** is the first part of the large intestine. Extending from the cecum is the **vermiform appendix**, commonly called the appendix. Sometimes bacteria and indigestible material become trapped in the appendix, leading to inflammation (appendicitis).

By the time the chyme (mostly indigestible material) enters the cecum digestion is complete and the large intestine functions to remove water and ions from the liquid waste. Removal of water and the action of bacteria convert the liquid waste into a semisolid mixture called feces.

The digestible material moves from the cecum, up through the **ascending colon**, horizontally through the **transverse colon**, down through the **descending colon**, and into the **sigmoid colon**. The ascending, transverse, descending, and sigmoid colon are all divisions of the large intestine. The indigestible material remains in the large intestine for 12 to 36 hours at which time it passes from the sigmoid colon, through the **rectum**, through the **anal canal**, and out the anus in a process called defecation.
QUESTIONS

1. Color the following parts on the diagram below. Use light colors for D, E, T, V, and W. Overlapping portions should receive the color of both parts.

- Oral cavity (A)
- Pharynx (B)
- Esophagus (C)
- Stomach (D)

**Small intestine**
- Duodenum (E)
- Jejunum (F)
- Ileum (G)

**Large intestine**
- Cecum (H)
- Vermiform appendix (H₁)
- Ascending colon (I)
- Transverse colon (J)
- Descending colon (K)
- Sigmoid colon (L)
- Rectum (M)
- Anal canal (N)

- Teeth (O)
- Tongue (P)

**Salivary glands**
- Sublingual (Q)
- Submandibular (R)
- Parotid (S)
- Liver (T)
- Gall bladder (U)
- Bile ducts (V)
- Pancreas (W)
2. Match the structure with its function.

A. Cardiac sphincter  I. Pancreas
B. Epiglottis  J. Pyloric sphincter
C. Esophagus  K. Salivary glands
D. Gall bladder  L. Small intestine
E. Large intestine  M. Stomach
F. Ileocecal valve  N. Teeth
G. Liver  O. Tongue
H. Oral cavity

______ Moves food around the mouth, pushes food (bolus) back into pharynx during swallowing
______ Cut, tear, and grind food
______ Secrete saliva, a watery mixture that contains mostly water and an enzyme that begins starch digestion
______ Receives food; site of bolus formation

______ Closes over the opening to the larynx and helps prevent food from entering trachea
______ Moves food from the pharynx to the stomach

______ Mixes food; forms liquid chyme; secretions contain HCl (hydrochloric acid) that disinfects food and enzymes that start protein digestion
______ Site of most digestion and absorption of digested food

______ Removes water and ions from liquid waste concentrating the waste into the semisolid feces
______ Secretes a liquid that contains digestive enzymes and sodium bicarbonate
______ Secretes bile

______ Stores bile in a concentrated form

______ Opens to allow food to enter the stomach; prevents acidic stomach contents from backing up into the esophagus
______ Controls the rate at which chyme from the stomach enters the duodenum

______ Controls the rate at which the liquid waste enters the cecum
3. Match the structure with the correct letter from the diagram

_____ Anus
_____ Esophagus
_____ Gall bladder
_____ Large intestine
_____ Liver
_____ Oral cavity
_____ Pancreas
_____ Pharynx
_____ Rectum
_____ Salivary glands
_____ Small intestine
_____ Stomach
4. Match the structure with the correct letter from the diagram.

______ Anus
______ Appendix
______ Ascending colon
______ Descending colon
______ Duodenum
______ Esophagus
______ Ileum
______ Jejunum
______ Liver
______ Oral cavity
______ Pancreas
______ Parotid salivary gland
______ Pharynx
______ Rectum
______ Sigmoid colon
______ Spleen
______ Stomach
______ Sublingual salivary gland
______ Submandibular salivary gland
______ Tongue
5. Match the structure with the correct letter from the diagram.

______ Appendix
______ Ascending colon
______ Cardiac sphincter
______ Cecum
______ Common bile duct
______ Cystic duct
______ Descending colon
______ Duodenum
______ Esophagus
______ Gallbladder
______ Hepatic duct
______ Ileocecal valve
______ Ileum
______ Jejunum
______ Liver
______ Pancreas
______ Parotid salivary gland
______ Pharynx
______ Pyloric sphincter
______ Rectum
______ Sigmoid colon
______ Stomach
______ Sublingual salivary gland
______ Submandibular salivary gland
______ Tongue
______ Transverse colon
6. Match the description with the correct digestive system activity.

   A. Absorption   B. Defecation
   C. Defense      D. Digestion
   E. Ingestion    F. Mechanical processing
   G. Peristalsis  H. Secretion

   ______ Involuntary, sequential contractions of the smooth muscle in the wall of the digestive tract that result in the movement of food materials through the tract
   ______ Movement of digested food from the intestine into the blood stream
   ______ Intake of food
   ______ Removal of solid wastes from the body
   ______ Action of acid, enzymes, and macrophages in lymph nodes that fight the invasion of foreign organisms
   ______ Chemical break down of food into building blocks
   ______ Chewing and mixing of food
   ______ Release of water, enzymes, acids, and buffers by cells in the digestive tract wall and by cells in the accessory organs

7. Determine if each of the following is true of Mechanical or Chemical digestion.

   ______ Chewing food
   ______ Churning of food caused by contraction of muscles in the wall of the stomach
   ______ Break down of large pieces of food into small pieces
   ______ Break down of food molecules into their building blocks
   ______ Requires enzymes
   ______ Break down of proteins into amino acids
   ______ Break down of carbohydrates into simple sugars (monosaccharides)
   ______ Break down of fats into glycerol and fatty acids
8. Why must food be digested before it can be used by the body?

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9. Name the building blocks (monomers) for each of the following food molecules.

Proteins: _____________________________________________________________

Carbohydrates: _______________________________________________________

Lipids (fats): _________________________________________________________